995 TRAFFIC CONTROL SIGNAL AND DEVICE MATERIALS. (REV 10-24-22) (FA 10-24-22) (FY 2023-24)

SECTION 995 is deleted and replaced with the following:

995-1 Description.

995-1.1 General: This Section governs the requirements for all permanent traffic control signals and devices. All equipment shall be permanently marked with manufacturer name or trademark, part number, and date of manufacture or serial number.

995-1.2 Product Acceptance: All specified products shall be items listed on the Department's Approved Product List (APL), unless otherwise noted below. Manufacturers seeking evaluation of products for inclusion on the APL shall submit an application in accordance with Section 6 and include the following documentation. A separate application must be submitted for each product to be evaluated, showing that the product meets the applicable requirements.

Table 995-1

Documentation	Requirements
Assembly and Installation Instructions	Include any surface preparations, assembly/installation instructions, operation manual, troubleshooting guides, and repair procedures.
Independent Laboratory Test Results	Product meets requirements of this Section.
Product Label Photo	Labeling shows the manufacturer's name, trademark, and product model number/name. Label shows the date of manufacture and/or the manufacturer's batch number. Additional label requirements, as listed within this Section.
Product Photo	Displays the significant features of the product as required in this section.
Compliance Matrix	Include completed compliance matrix at https://www.fdot.gov/traffic/traf-sys/product-specifications.shtm
Manufacturer's Product Specifications	Include product specifications showing electrical requirements, voltages, etc.
Product Drawings or Cut Sheet	Show mounting points, mechanical details, block diagrams, schematics, etc.
Parts List	List major parts and field serviceable components.

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)

995-2 Vehicle Detection Systems.

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.

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

995-2.3 Video Vehicle Detection System (VVDS):

995-2.3.1 Configuration and Management: The VVDS shall be provided with software that allows local and remote configuration and monitoring. The system shall be capable of displaying detection zones and detection activations overlaid on live video inputs. The VVDS shall meet the following criteria:

1. Allows a user to edit previously defined configuration parameters, including size, placement, and sensitivity of detection zones.

2. Retains its programming in nonvolatile memory. The detection system configuration data shall be capable of being saved to a computer and restored from a saved file. All communication addresses shall be user programmable.

3. Offers an open Application Programming Interface (API) and software development kit available to the Department at no cost for integration with third party software and systems.

995-2.3.2 Detection Camera: Camera shall be recommended by the video detection system manufacturer. Cameras that are integrated and included in a VVDS 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.

995-2.3.3 Machine Vision Processor: The VVDS shall include a machine vision processor that allows video analysis, presence detection, data collection, and interfaces for inputs and outputs as well as storage and reporting of collected vehicle detection data.

995-2.3.4 Communications: The VVDS shall include a minimum of one serial or Ethernet communications interface and shall meet the following criteria.

1. Serial interface and connectors shall conform to TIA-232 standards. Ensure that 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 interfaces shall provide 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 shall be secure and wireless devices shall be Federal Communications Commission (FCC) certified. The FCC identification number shall be displayed on an external label and all detection system devices shall operate within their FCC frequency allocation.

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

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

995-2.3.5 Video Inputs and Outputs: Analog video inputs and outputs shall utilize BNC connectors.

995-2.3.6 Solid State Detection Outputs: Outputs shall meet the requirements of NEMA TS2-2021, 6.5.2.26.

995-2.3.7 Electrical Requirements: The system shall operate using a nominal input voltage of 120 V of alternating current (V_{AC}) and with an input voltage ranging from 89 to 135 V_{AC}. If a system device requires operating voltages other than 120 V_{AC}, a voltage converter shall be supplied.

995-2.4 Microwave Vehicle Detection System (MVDS): Sidefire MVDS sensors shall have a minimum 200-foot range and the capability to detect a minimum of 8 lanes of traffic.

995-2.4.1 Configuration and Management: The MVDS shall be provided with software that allows local and remote configuration and monitoring. The system software shall be capable of displaying detection zones and detection activations in a graphical format. The MVDS shall meet the following criteria:

1. Allows a user to edit previously defined configuration parameters, including size, placement, and sensitivity of detection zones.

2. Retains its programming in nonvolatile memory. Ensure that the detection system configuration data can be saved to a computer and restored from a saved file. Ensure that all communication addresses are user programmable.

3. Detection system software offers an open API and software development kit available to the Department at no cost for integration with third party software and systems.

995-2.4.2 Communications: Major components of the detection system (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 interfaces provide 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 detection system 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. Cameras that are integrated and included in a MVDS 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.

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

995-2.4.4 Electrical Requirements: The microwave detector shall operate with a nominal input voltage of 12 V_{DC} and with an input voltage ranging from 89 to 135 V_{AC}. If any system device requires operating voltages other than 120 V_{AC}, a voltage converter shall be supplied.

The detector shall be FCC certified and has been granted authorization to operate within a frequency range established and approved by the FCC. The FCC identification number shall be displayed on an external label.

995-2.5 Wireless Magnetometer Detection System (WMDS):

995-2.5.1 Configuration and Management: The detection system shall be provided with software that allows local and remote configuration and monitoring and shall meet the following criteria.

1. Allows a user to edit previously defined configuration parameters.

2. Retains its programming in nonvolatile memory and the detection system configuration data can be saved to a computer and restored from a saved file. All communication addresses shall be user programmable.

3. The detection system software offers an open API and software development kit available to the Department at no cost for integration with third party software and systems.

995-2.5.2 Communications: Components of the detection system (such as sensors, access points, and contact closure cards) 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 interfaces provide a 10/100 Base TX connection and 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 detection system devices operate within their FCC frequency allocation.

4. Cellular communications devices are e-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.

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

995-2.5.4 Electrical Requirements: The WDMS shall operate with an input voltage ranging from 89 to 135 V_{AC}. If any system device requires operating voltages other than 120 V_{AC}, a voltage converter shall be supplied.

995-2.6 Automatic Vehicle Identification (AVI):

995-2.6.1 Configuration and Management: The detection system shall be provided with software that allows local and remote configuration and monitoring.

995-2.6.2 Communications: Components of the detection system (such as sensors, controllers, and processing hardware) 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 interfaces provide a 10/100 Base TX connection and 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 detection system 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.

995-2.6.3 Probe Data Detector Requirements:

1. Transponder Readers shall be compatible with multiple tag protocols, including Allegro and the protocol defined in ISO18000-6B.

2. Bluetooth Readers shall be capable of operating using either solar power or AC power.

3. License Plate Readers shall not require the use of visible strobes or other visible supplemental lighting.

995-2.6.4 Electrical Requirements: The AVI shall operate with an input voltage ranging from 89 to 135 V_{AC}. If any system device requires operating voltages other than 120 V_{AC}, a voltage converter shall be supplied. For solar powered devices, the detection system must operate for 5 days without solar assistance.

995-2.7 Wrong Way Vehicle Detection Systems (WWVDS):

995-2.7.1 Configuration and Management: The WWVDS shall be provided with software that allows local and remote configuration and monitoring. That the system

shall have the capability to display detection zones and detection activations. The WWVDS shall meet the following criteria:

1. WWVDS controllers shall support either an on-board real-time clock/calendar with on-board battery backup, or the controller's internal time clock can be configured to synchronize to a time server using the network time protocol (NTP) in order to maintain the current local date/time information. For NTP, the synchronization frequency must be user configurable and permit polling intervals from once per minute to once per week in one-minute increments. For NTP, the controller must allow the user to define the NTP server by IP address.

2. Allows a user to edit previously defined configuration parameters, including size, placement, and sensitivity of detection zones.

3. Retains its programming in nonvolatile memory. The detection system configuration data shall be capable of being saved to a computer and restored from a saved file. All communication addresses shall be user programmable.

4. Offers an open Application Programming Interface (API) or software development kit available to the Department at no cost for integration with third party software and systems.

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 interfaces 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, 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 URL: 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.

995-2.7.3 Electrical Specifications: Equipment shall operate on solar power or with an input voltage ranging from 89 to 135 V_{AC}. If the device requires operating voltages of less than 120 V_{AC}, supply the appropriate voltage converter. Solar powered systems shall be designed to operate for minimum of 5 activations per day and provide 10 days of operation without sunlight.

995-2.8 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 TS2-2021, 6.5.2.17.

995-2.8.1 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.	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.	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.

995-2.8.2 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, divided by total time, expressed as a percentage.

In the equation in 995-2.8.2.1, "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

995-2.8.2.1 Early Morning Vehicle Presence Detection Accuracy for a Single Detector Expressed as a Percentage:

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

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 995-2.8.2.2, "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.).

995-2.8.2.2 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 995-2.7.2.3.

995-2.8.2.3 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

995-2.9 Traffic Data Detection System Acceptance Requirements:

995-2.9.1 Data Accuracy: The vehicle detection system shall be capable of meeting the minimum total roadway segment accuracy levels of 95% for volume, 90% for occupancy, and 90% for speed for all lanes, up to the maximum number of lanes that the device can monitor as specified by the manufacturer.

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 TERL. Sample data shall be 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 shall 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.

995-2.9.2 Calculation of Volume Accuracy: Determine individual lane volume accuracy per period by subtracting from 100 percent the absolute difference of the total volume measured by the detector and the ground truth volume measurement, divided by the ground truth volume measurement, expressed as a percentage.

In the equation in 995-2.9.2.1, “EM” represents the early morning period. The subscript “*i”* represents a lane at the detection zone on the roadway segment and could vary from 1,…, N, where “N” is the maximum number of lanes being detected.

Substitute other lane numbers and periods as necessary to determine the accuracy for each lane during each period (i.e., dawn, AM peak, late AM off-peak, etc.).

Variables and subscripts used in the equations below are identified as follows:

VT = Total volume
VD = Vehicle detection data (in this case, count data)
GT = Ground truth measurement
VA = Volume accuracy

995-2.9.2.1 Early Morning Volume Accuracy for a Lane Expressed as a Percentage:

$$VA_{EM,\ln_i} = 100 - \frac{\left|VT_{EM,VD,\ln_i} - VT_{EM,GT,\ln_i}\right|}{VT_{EM,GT,\ln_i}} x100$$

Where:

VA_{EM,ln_i} = Volume accuracy for early morning traffic conditions in the i th lane.

VT_{EM,VD,ln_i} = Total volume for the 15-minute early morning period using the vehicle detector in the i th lane.

VT_{EM,GT,ln_i} = Total volume for the 15-minute early morning period in the i th lane using human observation or another method approved by the Engineer.

The period volume accuracy will be the arithmetic mean of the lane volume accuracy over all lanes.

In the equation in 995-2.9.2.2, "EM" represents the early morning period and "*N"* is the total number of lanes of detection on the roadway segment under test. 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 Volume Accuracy Expressed as a Percentage:

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

Where:

VA_{EM} = Average volume accuracy for early morning traffic conditions for all lanes.

VA_{EM,ln_i} = Volume accuracy for early morning traffic conditions in the i th lane.

Calculate the total volume accuracy over all periods using the equation in 995-2. 9.2.3.

995-2.9.2.3 Total Volume Accuracy Expressed as a Percentage:

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

Where:

VA_{Total} = Volume accuracy for all lanes for all periods
VA_{EM} = Volume accuracy for early morning traffic conditions
VA_{DA} = Volume accuracy for dawn traffic conditions
VA_{AMP} = Volume accuracy for AM peak traffic conditions
VA_{LAOP} = Volume accuracy for late AM off-peak traffic conditions
VA_{NO} = Volume accuracy for noon traffic conditions
VA_{AOP} = Volume accuracy for afternoon off-peak traffic conditions
VA_{PMP} = Volume accuracy for PM peak traffic conditions
VA_{DU} = Volume accuracy for dusk traffic conditions
VA_{NI} = Volume accuracy for night traffic conditions

995-2.9.3 Calculation of Speed Accuracy: For computing the accuracy of the detector speed measurement, the average speed readings obtained from the detection system are compared to ground truth values.

The equation in 995-2.9.3.1 represents the ground truth average speed computation procedure for a particular lane during a specific time period. The equation in 995-2.9.3.2 represents the average speed computation procedure for a particular lane during a specific time period using data gathered from the detection system.

In the equations in 995-2.9.3.1 and 995-2.9.3.2, the time period described is the early morning period, represented by "EM", and the subscript "k" represents a vehicle traveling on the roadway and could vary from 1,…, K, where "K" is the total number of vehicles in lane i during the time period under consideration. The subscript "i" represents a lane in a roadway and could vary from 1,…, N, where "N" is the total number of lanes of detection on the roadway segment. Substitute other lanes and periods as necessary and compute the accuracy for each lane for all time periods.

Variables and subscripts used in the equations below are identified as follows:

SA = Speed accuracy
S = Speed of an individual vehicle
K = Total number of vehicles in lane during time period
veh = Vehicle

995-2.9.3.1 Early Morning Average Ground Truth Speed:

$$S_{Avg,EM,GT,\ln_i} = \frac{1}{K}\sum_{k=1}^{K} S_{EM,GT,\ln_i,veh_k}$$

Where:

SA_{Avg,EM,GT,ln_i} represents the average ground truth vehicle speed for the i th lane during the early morning period.

S_{EM,GT,ln_i,veh_k} represents the ground truth speed for the k^{th} vehicle in the i^{th} lane during the early morning period using human observation or another method approved by the Engineer.

995-2.9.3.2 Early Morning Average Vehicle Detector Speed:

$$S_{Avg,EM,VD,\ln_i} = \frac{1}{K}\sum_{k=1}^{K} S_{EM,VD,\ln_i,veh_k}$$

Where:

S_{Avg,EM,VD,ln_i} represents the average speed recorded by the vehicle detector for the ith lane during the early morning period.

S_{EM,VD,ln_i,veh_k} represents the speed for the k th vehicle in the i th lane during the early morning period using the vehicle detector.

Determine lane speed accuracy per period by subtracting from 100 percent the absolute difference of the average lane speed measured by the detector and the average lane ground truth speed, divided by the average lane ground truth speed, expressed as a percent.

In the equation in 995-2.9.3.3, "EM" represents the early morning period. The subscript "*i*" represents a lane of detection on a roadway and could vary from 1,…,N, where "N" is the total number of lanes of detection on the roadway segment. Substitute other lanes as necessary to determine the accuracy for each period (i.e., dawn, AM peak, late AM off-peak, etc.).

995-2.9.3.3 Early Morning Lane Speed Accuracy Expressed as a Percentage:

$$SA_{Avg,EM,\ln_i} = 100 - \frac{\left|S_{Avg,EM,VD,\ln_i} - S_{Avg,EM,GT,\ln_i}\right|}{S_{Avg,EM,GT,\ln_i}} \times 100$$

Where:

SA_{Avg,EM,ln_i} represents the average speed accuracy during early morning traffic conditions for all vehicles that traveled in lane i of the roadway segment.

The period speed accuracy will be the arithmetic mean of the lane speed accuracy, computed using the equation in 995-2.9.3.3, over all lanes.

In the equation in 995-2.9.3.4, "EM" represents the early morning period. The subscript "i" represents a lane of detection on a roadway and could vary

from 1,…, N, where "N" is the maximum number of lanes on the roadway segment. Substitute data as necessary to determine the accuracy for each period (i.e., dawn, AM peak, late AM off-peak, etc.).

995-2.9.3.4 Early Morning Speed Accuracy Expressed as a Percentage:

$$SA_{EM} = \left(\frac{\sum_{i=1}^{N} SA_{Avg,EM,\ln_i}}{N} \right)$$

Where:

SA_{EM} represents the average speed accuracy during early morning traffic conditions for all lanes of detection on the roadway segment.

Calculate detector speed accuracy for the roadway segment over all periods using the equation in 995-2.9.3.5.

995-2.9.3.5 Total Roadway Segment Accuracy Expressed as a Percentage:

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

Where:

SA_{Total} = Speed accuracy for all lanes for all periods
SA_{EM} = Speed accuracy for early morning traffic conditions
SA_{DA} = Speed accuracy for dawn traffic conditions
SA_{AMP} = Speed accuracy for AM peak traffic conditions
SA_{LAOP} = Speed accuracy for late AM off-peak traffic conditions
SA_{NO} = Speed accuracy for noon traffic conditions
SA_{AOP} = Speed accuracy for afternoon off-peak traffic conditions
SA_{PMP} = Speed accuracy for PM peak traffic conditions
SA_{DU} = Speed accuracy for dusk traffic conditions
SA_{NI} = Speed accuracy for night traffic conditions

995-2.10 Probe Data Detection System Performance Requirements: Probe data detectors shall establish a unique and consistent identifier for each vehicle detected and the time and location that the vehicle was detected and shall provide the following:

1. A minimum match rate of 5% for probe data detection systems that match upstream and downstream detection of the same vehicle
2. A minimum total roadway segment speed and travel time accuracy level of 90%. Verify system performance over several time periods under a variety of traffic conditions as described in 995-2.9.1.

995-2.10.1 Calculation of Match Rate: Match rate is the percentage of the total vehicle population of a road segment that is detected and matched at consecutive probe data detection sites.

995-2.10.1.1 Early Morning Match Rate Expressed as a Percentage:

$$MR_{EM} = 100 - \frac{\left| M_{EM,VD} - V_{EM,GT} \right|}{V_{EM,GT}} \times 100$$

Where:

MR_{EM} = Match Rate for early morning.

$M_{EM,VD}$ = Number of matched detections between two probe vehicle detection sites (typically a pair of sites at each end of a roadway segment) during early morning.

$V_{EM,GT}$ = Total volume of vehicles that pass the detection area for the 15-minute early morning period using human observation or another method approved by the Engineer.

995-2.11 Wrong Way Vehicle (WWVDS) Detection System Performance Requirements: To verify conformance with the accuracy requirements in this Section and as a precondition for listing on the APL, the wrong way detection system will be evaluated at the FDOT Traffic Engineering Research Lab (TERL). Under controlled conditions at the TERL facility, the wrong way detection system must be capable of meeting the detection accuracy of 100% and zero false positive readings, using a sample size of 200 vehicles.

995-3 Loop Sealant.

Loop sealant shall be furnished in a premeasured two-part formulation and meet the following requirements:

Table 995-3 Loop Sealant Properties		
Property	Test Method	Performance Criteria
Self-leveling		
Viscosity	ASTM D562 @77°F	Sealant shall not run out of unlevel slots
Adhering to concrete and asphalt	Install in 3/8 inch by 3-inch saw cut, cure for 2 weeks at 77°F	Visual inspection: sealant shall securely adhere to concrete and asphalt No visible signs of shrinkage after curing when tested for shrinkage using a dimensional measurement
Curing	ASTM C679 at 77°F	Tack-Free at 2 hours from time of application
Resistance to Fluids	ASTM D570	Sealant shall resist weather, oils, gasoline, antifreeze, and brake fluid when tested for absorption for water, No. 3 oil, gasoline, antifreeze, and brake fluid for 24 hours
Penetration	ASTM D2240 Shore A	Sealant shall resist penetration of foreign materials when tested for durometer hardness for 24 hours
Expansion Cracking	ASTM D412	Sealant shall resist cracking caused by expansion and contraction due to temperature changes when tested for tensile strength and elongation
Cracking	ASTM C1246	Sealant shall not become brittle with age or temperature extremes when tested for weight loss, cracking, and chalking
Shelf Life	Manufacturer's Recommendations	Sealant shall have a minimum shelf life of 12 months when stored in accordance with the manufacturer recommendations

995-4 Vehicular Traffic Signal Assemblies.

995-4.1 General: Vehicular traffic signal assemblies must meet the requirements of Section 603 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.

995-4.2 Twelve Inch Signal Head Assemblies: Construct the assembly of materials and alloys specified in the ITE Standard for Vehicle Traffic Control Signal Heads.

Construct signal housings to allow adjustment in multiple directions for proper signal alignment. If a serrated connection is used for positioning and alignment of the

signal, the top and bottom opening of each signal head section must include a circular 72-tooth serrated connection (2-inch nominal I.D.) capable of providing positive positioning and alignment in 5-degree increments. When assembled and tightened, these connections must prevent rotation or misalignment of the signal head as well as misalignment between sections. The serrated area must start at the outside of the 2-inch hole and be at least 1/8 inch wide. The teeth must have a minimum depth of 3/64 inch between peaks and valleys, be free from burrs or other imperfections, and provide positive locking with the grooves of mating sections, framework, and brackets. The serration on the top circular connection of a signal section must have a valley at the 0-degree position and the serration on the bottom circular connection must have a peak at the 0-degree position, both aligned perpendicular to the front of the section. Connections must permit the assembly of a multi-section signal with the front of each section aligned within 1 degree.

Provide at least two latching points with latch pads and manual Type 316 or 304 stainless steel latching devices that are tamper resistant.

If backplates are mechanically attached, each signal section must have four backplate mounting attachment points on the back of the signal, on or no more than three inches from each section corner. Attachment points must be capable of accepting No. 10-16x3/8 inch or No. 10-24x3/8 inch Type 316 or 304 stainless steel screws for attaching backplates.

Tri-stud washers, when utilized to secure signal sections, must have a minimum thickness of 0.090 inches. For five-section cluster assemblies, tri-stud washers used to attach the top signal section to the multi-signal bracket and the multi-signal bracket to the bottom four signal sections must have a minimum thickness of 3/8 inches. When fastened together, washer distortion is not allowed.

Design each signal section to prevent the accumulation of standing water within the assembly. All sections comprising a single multi-section assembly must be securely fastened together to form a rigid and weather-proof unit.

995-4.2.1 Doors: Construct each signal section with at least two hinges for mounting a door. Hinge pins must be captive. Doors must remain captive and secure at all times and be capable of either left or right swing. The door latch must hold the door tightly closed. The door must include slotted pads that allow the door to be opened and closed by engaging or disengaging the latching device. The outside face of the door must include four holes equally spaced around the circumference of the lens opening for the attachment of a visor. The lens opening in the door must have a diameter of 11 to 11-1/2 inches.

995-4.2.2 Visors: The rear of the visor must have four tabs, notches, or holes for securing the visor to the signal housing door. The visor mounting method must permit the visor to be rotated and secured at 90 degrees for horizontal signal head installations. All visors must have a minimum length of 9-1/2 inches, and a minimum downward tilt of 3.5 degrees measured from the center of the lens. Tunnel visors must encircle and shield the lens from 300 degrees, plus or minus 10 degrees. Louvers may only be used in combination with full circle visors. Light must not escape between the visor and the door.

995-4.2.3 Gaskets: Gaskets must be constructed of weather-resistant material and be glued or sealed where they meet to provide one continuous length of gasket capable of providing a weatherproof seal for the signal assembly. Provide seals between the housing and door, between the lens and the door, and between any other mating surfaces where dust and

moisture could enter. Gasket material must meet NEMA 250 and be constructed of temperature stabilized material that prevents any residue from collecting on the internal surfaces of the signal head.

995-4.2.4 Terminal Blocks: Provide at least one five-connection terminal block in all three or more section signal head assemblies and at least three five-connection terminal blocks in all five section signal head assemblies. Terminal block connections in the signal assembly must not require any tools other than a screwdriver.

Mount terminal blocks to the signal housing with Type 316 or 304 passivated stainless steel hardware. Use only non-corrosive wire attachment screws approved by the Department.

995-4.2.5 Color and Finish: The housing, doors, visors and backplates must be powder coated dull black (Federal Standard 595-37038) with a reflectance value not exceeding 25 percent as measured by ASTM E1347. For plastic heads, the black color must be incorporated into the plastic material before molding.

The finish on interior and exterior surfaces of aluminum signal head assemblies, visors, doors, and housing, must be painted in accordance with Military Standard MIL-PRF-24712A or American Architectural Manufacturers Association (AAMA) -2603-02 and must meet the requirements of ASTM D3359, ASTM D3363, and ASTM D522. Surface erosion, flaking, or oxidation must not occur within the normal life expectancy under typical installation conditions.

995-4.2.6 Plastic Signal Housings and Visors: Construct signal housing assembly, door, and visors of UV stabilized plastic with a minimum thickness of 0.1 inches, plus or minus, 0.01 inches, with the following physical properties:

Table 995-4
Plastic Signal Housings and Visors

Test	Minimum Requirement	Method
Specific Gravity	1.17	ASTM D792
Vicat Softening Temp.	305-325°F (152 – 163°C)	ASTM D1525
Brittleness Temp.	Below -200°F (-129°C)	ASTM D746
Flammability	Self-extinguishing	ASTM D635
Tensile Strength	Yield, 8500 psi (58 MPa)	ASTM D638
Elongation at yield	5.5 - 8.5%	ASTM D638
Shear Strength	Yield, 5500 psi (38 MPa)	ASTM D732
Izod impact strength	15ft-lb/in (800 J/m)	ASTM D256
Fatigue strength	950 psi (6.5MPa) at 2.5 mm cycles	ASTM D671
Fatigue strength	950 psi (6.5MPa) at 2.5 mm cycles	ASTM D671

995-4.2.7 Backplates: Backplates may be constructed of either aluminum or plastic. Minimum thickness for aluminum backplates is 0.060 inch and the minimum thickness for plastic backplates is 0.120 inch. The required width of the top, bottom, and sides of backplates must measure between five to six inches. Color of backplates must be black in accordance with 995-4.2.5. Backplate thickness measurement must not include the retroreflective sheeting thickness.

If backplates are mechanically attached, provide a minimum of four corner mounting attachment points per signal section (for example, a three-section signal assembly would have 12 mounting points). Attachment points must not interfere with the operation of traffic signal section doors. Backplate outside corners must be rounded and all edges must be de-burred.

If louvers are provided, louver orientation must be vertical on sides and horizontal on top and bottom of the backplate and must be at least 1/2 inch from the inner and outer edge of the backplate panel. Universal backplates must fit all traffic signals listed on the APL.

Mount the backplate securely to the signal assembly with Type 316 or 304 passivated stainless steel installation hardware. Backplates, if mechanically attached, must be marked in accordance with 995-1, on the long sides of the backplate.

Backplates must include retroreflective borders using Type IV yellow retroreflective sheeting listed on the APL. Place a 2-inch border on the entire outer perimeter of the backplate panel, no closer than 1/2 inch from any louvers.

All materials must be designed for exterior use and be UV stable.

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 reduced to 2.5 inches or less, when influenced by high wind conditions, and return to zero degrees after the wind conditions subside. Flexible backplates must maintain visibility of the retroreflective border to approaching traffic, with up to 40 mph winds.

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.

995-4.2.9 Electrical: Electrical conductors for LED signal modules must be a minimum of 36 inches in length. Each lead from the LED module must be terminated with insulated slide-on terminals. The conductors must be color coded to identify the color of the module as follows:

1. White must identify the neutral lead.

2. Red circular signals must be identified with a red lead, yellow circular signals with a yellow lead, and green circular signals with a green lead.

3. Red arrows must be identified with a red and black tracer lead, yellow arrows with a yellow and black tracer lead, and green arrows with a green and black tracer lead.

995-5 Pedestrian Signal Assemblies.

995-5.1 General: Pedestrian signal assemblies must meet the requirements of Section 603, the MUTCD, and the ITE standard for Pedestrian Traffic Control Signal Indications.

995-5.2 Housing and Visor: The housing must be weatherproof, sectional and may consist of as many sections as optical units. The housing must prevent light from escaping from one unit to another. The top and bottom opening of the housing must include a circular 72-tooth serrated connection (2-inch nominal I.D.) capable of providing positive positioning and alignment in 5 degree increments. When assembled and tightened, these connections must prevent rotation or misalignment. The serrated area must start at the outside of the 2-inch hole and be at least 1/8 inch wide. The teeth must have a minimum depth of 3/64 inch between peaks and valleys, free from burrs or other imperfections, and provide positive locking with the grooves of mating sections, framework, and brackets. The serration on the top circular connection of a signal section must have a valley at the 0-degree position and the serration on the bottom circular connection must have a peak at the 0-degree position, both aligned perpendicular to the front of the section. Housings must include latch pads and manual stainless steel latching devices that are captive, or non-removable. Housings must have at least two latching points.

Reinforce all mounting points and adjacent housing material. The door enclosing the lens must be hinged and held securely to the housing. Provide a gasket meeting the requirements of ASTM D1056, Grade 2B2 between the housing and door and between the lens and door. If the fitting between the housing and door is weather-tight, the gasket may be omitted.

Provide a visor or egg-crate louver that eliminates sun phantom for each signal face. Visor must be three-sided and extend a minimum of 7 inches at the top from the face of the lens. The visor must be constructed of noncorrosive No. 18 gauge sheet metal, not less than 0.05 inch thick, or 0.1 inch thick polycarbonate.

All metal housings and visors must be powder-coat painted black in accordance with Military Standard MIL-PRF-24712A or AAMA-2603-02 with a reflectance value not exceeding 25 percent as measured by ASTM E97. For polycarbonate heads, the black color must be incorporated into the material before the molding process.

The housing must be constructed of a non-corrosive material. Cast metal parts must have a minimum tensile strength of 1 ksi (117 MPa) and sheet metal parts a minimum tensile strength of 27 ksi (186 MPa).

995-5.2.1 Die Castings: Meet the requirements in ASTM B85 for the physical characteristics and chemical content for alloys S12A, S12B, SC84A, SC84B, SG100A and SG100B.

995-5.2.2 Sand Castings: Meet the requirements in ASTM B26 for the physical characteristics and chemical content for alloys S5A and CS72A.

995-5.2.3 Permanent Mold Castings: Meet the requirements in ASTM B108 for the physical characteristics and chemical content for alloys S5A and CS72A.

995-5.2.4 Polycarbonate: Polycarbonate housing assemblies, doors and visors must be molded from ultraviolet stabilized polycarbonate plastic with a minimum thickness of 0.1 inches, plus or minus 0.01 inch, and provide the following physical properties:

Table 995-5
Polycarbonate Housing Assemblies, Doors, and Visors

Test	Minimum Requirement	Method
Specific Gravity	1.17	ASTM D792
Vicat Softening Temp.	305-325°F (152 – 163°C)	ASTM D1525
Brittleness Temp.	Below -200°F (-129°C)	ASTM D746
Flammability	Self-extinguishing	ASTM D635
Tensile Strength	Yield, 8500 psi (58 MPa)	ASTM D638
Elongation at yield	5.5 - 8.5%	ASTM D638
Shear Strength	Yield, 5500 psi (38 MPa)	ASTM D732
Izod impact strength	15ft-lb/in (800 J/m)	ASTM D256
Fatigue strength	950 psi (6.5MPa) at 2.5 mm cycles	ASTM D671

995-5.3 Light Emitting Diode (LED) Pedestrian Signal Optical Unit (State Standard): Provide a countdown pedestrian signal module meeting the requirements of the latest ITE LED Pedestrian Signal Specifications.

995-5.4 Electrical: Wiring and terminals must meet the size, insulation, length, and color-coding of the current ITE Pedestrian Traffic Control Signal Indicators LED specification. Wires must not have bare wiring exposed where wires are secured.

The pedestrian signal must include a terminal block containing a minimum of three circuits, each with two noncorrosive screw-type terminals. Each terminal must accommodate three No. 18 AWG conductors and be labeled for ease of identification. The terminal block must not be obstructed and be visible when the housing is open.

995-5.5 Hardware: All brackets used to mount pedestrian signals must be an aluminum alloy cast fitting, pipe, or equivalent material approved by the Department. Aluminum and aluminum alloy bars, rods, wires, profiles, and tubes must meet ASTM B221. Aluminum-alloy sand casting must meet ASTM B26. All mounting hardware must be painted black with a reflectance value not exceeding 25 percent as measured by ASTM E97.

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

EXPECTED IMPLEMENTATION (FY 2023-24)

DRAFT

995-6 Midblock Crosswalk Enhancement Assemblies.

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

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

In-roadway light assemblies can include a passive detector in addition to a pedestrian pushbutton. In-roadway light assemblies must be normally dark and initiate operation upon pedestrian actuation via a pedestrian pushbutton or a passive detector. The In-roadway light assembly will cease operation at a predetermined time after the pedestrian actuation. If a passive detector is used, the In-roadway 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 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): 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.

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 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 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 FED-STD-595-37038) 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, 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.

995-7 Mast Arm, Span Wire, and Pole Mounting Assemblies.

995-7.1 General: Fastening hardware such as bolts, nuts, washers, set screws, studs, u-bolts, cable and cable swags, must be provided by the mounting assembly manufacturer, must be SAE Type 316 or 304 stainless steel. Hardware (studs, bolts and u-bolts) must be a minimum of 5/16 inch diameter unless otherwise specified in this Section. SAE Grade 8 bolts and nuts are also acceptable. Metallic mounting assemblies must meet ASTM B117 for corrosion resistance.

Connections that provide an entrance to the interior of a traffic device must be weather-resistant.

All assemblies must be constructed to support the weight of any combination of signal indications with all accessories such as back plates and visors.

Connections between signal, disconnect and disconnect hanging hardware must be of the tri-stud design unless otherwise specified in this Section. Tri-stud washers must be a minimum 0.090 inches thick unless otherwise specified in this Section.

Connections must be designed to mate with a standard traffic signal's 2-inch I.D. opening and must be capable of providing positive positioning and alignment of the traffic device. Connection type may be a 72-tooth serrated edge or other connection type as long as all other specifications are met. For 72-tooth serrated edge connections, the teeth must be clean, sharp, and at least 1/8 inch wide and 3/64 inch deep. All connection types must be weather resistant.

All mounting assemblies must be capable of providing adjustment in multiple directions for proper alignment of the attached traffic device and to prevent rotation around the vertical axis or misalignment after installation.

Use studs that are either cast directly into the aluminum during the casting process or tapped and locked with a locking material. In each case, a pull-out force must be provided. Messenger wire clamps must be extruded aluminum six inches long or cast U-bolt type.

Torque specifications must be included for all fastening hardware with the assembly installation instructions.

995-7.2 Product Identification: Mounting assemblies must be permanently marked in accordance with 995-1. Identification must be cast into, or metal-marked on, the assembly in a legible manner. When the assembly is made up of multiple components, each component must be identified with the manufacturer’s name or trademark.

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 3359 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.

995-7.4 Mast Arm Mounting Assemblies: Mast arm mounting assemblies must include the following components: mast arm saddle, swivel, attachment cables (with cable clamp mechanism) or bands. Unless the assembly uses a free-swinging mounting method, mast arm mounting assemblies must include the support tube, and top and bottom support arms. Mast arm mounting assemblies must be designed to be attached to a mast arm by cables or bands. All connections must be designed to prevent movement when 250 pounds of downward force is applied to the completed vehicular traffic signal assembly.

995-7.4.1 Saddle: Saddles must be aluminum or stainless steel and must have a minimum yield strength of 16 ksi and a minimum ultimate tensile strength of 23 ksi in accordance with ASTM B26, ASTM B108, ASTM B85 or ASTM A240.

995-7.4.2 Swivel: Swivels must be aluminum or stainless steel and must have a minimum yield strength of 16 ksi and a minimum ultimate tensile strength of 23 ksi in accordance with ASTM B26, ASTM B108, ASTM B85 or ASTM A240. The swivel must provide at least two connection devices to secure the support tube to the swivel and be configured to permit the support tube to provide adjustment in multiple directions in a plane parallel to the mast arm. Any castings used to attach the support tube to the swivel must be manufactured from the same alloy as the swivel.

995-7.4.3 Saddle Attachment Cables and Bands: Mast arm saddle attachment cables must be 3/16-inch minimum diameter, Type 316 or 304 stainless steel aircraft type wire strand cable. The swage at the ends of the cable (used to tighten the cable against the saddle) must be Type 316 or 304 stainless steel with a minimum 3/8-inch diameter thread. The swage must permit use of a wrench to prevent rotation while tightening the nut at the end of the swage. If the attachment cable does not have swaged clamp screws at each end (double-ended), the unclamped end of the cable must be sintered, welded, or otherwise secured without adhesives to prevent unraveling of the cable. Banding must use two Type 304 or 201 series stainless steel 3/4 inch wide bands and Type 316 stainless steel buckles (clamp screws). De-burr the edges of the bands.

995-7.4.4 Cable Clamp Mechanism: Mast arm mount components used to secure the cable to the saddle must be aluminum or stainless steel and must have a minimum yield strength of 23 ksi and a minimum ultimate tensile strength of 30 ksi in accordance with ASTM B26, ASTM B221, ASTM B85 or ASTM A240.

995-7.4.5 Support Tube: Support tubes used in mast arm mounting assemblies must be aluminum or stainless steel and must have a minimum yield strength of 25 ksi and a minimum ultimate tensile strength of 30 ksi in accordance with ASTM B221 or ASTM A240. A gusseted hollow design may be used to provide for the routing of necessary wiring. The tube cross-sectional area's principal moments of inertia must average; at a minimum, that of a 1.5-inch standard aluminum Schedule 40 pipe and the cross-sectional metal area must not be less than that of a 1.5-inch Schedule 40 pipe. The bottom portion of the tube that supports the vertical load of the hanging device must be threaded using National Pipe Thread Taper (NPT), National Pipe Thread Straight (NPS), non-threaded U-bolt secured, or a continuous arm support tube. Threaded support tubes that are fully slotted must have an aluminum insert in the 3/4-inch slot extending a minimum of 1/2-inch beyond the

threaded section. To provide easy installation of wiring, the tube must have a minimum 0.562-inch wire entrance slot running the full length of the tube, or either stopping a minimum of 8 inches above the threaded or U-bolt secured end. Edges of slot must be supported with internal gusseting. The tube interior and slot must be free of sharp edges that may damage wiring. Provide an easily installed and removable UV stabilized seal to completely fill the wire entrance slot after installation.

995-7.4.6 Top Support Arm: The top support arm of the mounting assembly must be of one-piece solid construction, or continuous arm with support tube, and capable of holding the signal head firmly in place. Top support arms must be aluminum with a minimum ultimate tensile strength of 30 ksi and minimum yield strength of 18 ksi in accordance with ASTM B26, or be die cast with a minimum ultimate tensile strength of 27 ksi and a minimum yield strength of 24 ksi.

A one or two piece top arm is acceptable. For a one-piece top arm, use at least two 1/4-inch minimum diameter Type 316 or 304 stainless steel set screws to secure its position on the support tube. When a two-piece top arm is used, hardware required to connect components of the top arm must be 3/8-inch minimum diameter, Type 316 or 304 stainless steel.

The top support arm must have three 1/4 inch - 20 UNC-2B threaded holes to accept bolts for a tri-stud washer and gasket, or at least one imbedded or tapped and locked 5/16 inch - 18 threaded stud within the industry's standard 72-tooth serrated circular design that facilitates 5 degree increment positioning. Provide 0.090-inch thick (minimum) Type 316 or 304 stainless steel washers, nuts, and lock washers for attaching signal heads. A rubber washer, with dimensions similar to the large stainless-steel washer, must be provided for traffic signals. When mast arm clamps are used to support illuminated signs with tri-stud arrangements, a rubber washer with dimensions similar to the steel washer must also be used.

995-7.4.7 Bottom Support Arm: The bottom support arm, when not continuous arm with support tube, must be hollow to allow the routing and enclosing of all signal wiring. Bottom support arms must be aluminum with a minimum ultimate tensile strength of 30 ksi and minimum yield strength of 18 ksi in accordance with ASTM B26, or be die cast with a minimum ultimate tensile strength of 27 ksi and a minimum yield strength of 24 ksi. Plastic bottom arm covers must be constructed of ABS with a UV inhibitor and be strong enough to contain the signal cable in the bottom arm cavity without bending during installation and warping over time.

The end of the bottom support arm that attaches to the support tube must have a 1.5-inch steel coupling imbedded and cast directly into the part during the solidification of the aluminum, or a 1-1/2 inch NPT or NPS pipe thread cut directly into the casting. For non-threaded versions, the arm must allow the support tube to sit a minimum of 2 inches into an arm pocket and be secured to the arm with minimum 5/16-inch full U-shape U-bolt to distribute the load evenly to the lower arm casting.

The end of the bottom support arm that connects to the signal must have either three equally spaced and plumb imbedded 5/16-inch Type 316 or 304 stainless steel threaded studs located in the center of the 72-tooth serrated circular design, or three 1/4 inch – 20 UNC-2B tapped holes to accept bolts for a tri-stud washer.

995-7.4.7.1 Arms with Steel Coupling: If a threaded steel coupling is imbedded into the casting, the bottom arm must be aluminum alloy 535.0-F in accordance

with ASTM B26, with a minimum ultimate tensile strength of 23 ksi, meeting all standards listed in ASTM B26, including chemical composition listed in Table 1 and material mechanical properties listed in Table 2. The end of the bottom support arm must have at least two 1/4-inch diameter Type 316 or 304 stainless steel set screws to secure its position on the support tube.

995-7.4.7.2 Threaded Arms: If threads are cut directly into the casting, the bottom arm must be aluminum alloy 535.0-F in accordance with ASTM B26, with a minimum ultimate tensile strength of 35 ksi and elongation of 9.0% in a 2-inch section, meeting all standards listed in ASTM B26, including chemical composition listed in Table 1 and material mechanical properties listed in Table 2. As an alternative, the arm can be die cast in aluminum with a minimum ultimate tensile strength of 27 ksi and a minimum yield strength of 24 ksi. The end of the bottom arm must have at least two 1/4-inch minimum diameter Type 316 or 304 stainless steel set screws to secure its position on the support tube.

995-7.4.7.3 Non-threaded Arms: Lower arm must be aluminum 356 having a minimum ultimate tensile strength of 30 ksi and meeting all standards listed in ASTM B26, including chemical composition listed in Table 1 and material mechanical properties listed in Table 2. The arm must have a locator tab to receive the support tube and be secured by a U-bolt.

995-7.4.7.4 Continuous Arm Support Tube: The continuous arm support tube must be of single form construction to support the weight of any combination of signal indicators with all accessories such as backplates and visors. Continuous support tubes must be Type 316 or 304 stainless steel with a minimum ultimate tensile strength of 75 ksi and a minimum yield strength of 30 ksi in accordance with ASTM A554, or aluminum with a minimum yield strength of 25 ksi and a minimum ultimate tensile strength of 30 ksi in accordance with ASTM B221.

The continuous arm support tube attachment to the signal head must have a minimum of two 5/16-18 Type 316 or 304 stainless steel bolts, nuts and washers. A rubber seal must be provided between the support tube and signal head.

995-7.5 Span Wire Mounting Assemblies: Span wire mounting assemblies must include a span wire clamp, a hanging device such as a drop pipe, adjustable hanger, or adjustable pivotal hanger with extension bar, messenger clamp, disconnect hanger, and multi-brackets.

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, ASTM B108, ASTM B85, or ASTM A240.

995-7.5.2 Drop Pipe: Drop pipe hangers must be galvanized 1.5-inch steel aluminum having a minimum yield strength of 35 ksi and a minimum ultimate tensile strength of 42 ksi in accordance with ASTM B221 and have NPT on each end for assembly.

995-7.5.3 Aluminum Adjustable Hanger: Aluminum adjustable hangers must be aluminum alloy 535.0-F in accordance with ASTM B26 with a minimum ultimate tensile strength of 35 ksi and elongation of 9.0% in a two-inch section, meeting the chemical composition listed in Table 1 and material mechanical properties listed in Table 2 in ASTM B26.

995-7.5.4 Stainless Steel Adjustable Hanger: Stainless steel adjustable hangers must be Type 316 or 304 stainless steel with a minimum ultimate tensile strength of 75 ksi and a minimum yield strength of 30 ksi in accordance with ASTM A276.

995-7.5.5 Aluminum Adjustable Pivotal Hanger: Aluminum pivotal hangers must be aluminum alloy 535.0-F in accordance with ASTM B26 with a minimum ultimate tensile strength of 35 ksi and elongation of 9.0% in a two-inch section, meeting the chemical composition listed in Table 1 and material mechanical properties listed in Table 2 in ASTM B26.

995-7.5.6 Stainless Steel Adjustable Pivotal Hanger: Stainless steel pivotal hangers must be either Type 316 or 304 stainless steel with a minimum ultimate tensile strength of 75 ksi and a minimum yield strength of 30 ksi in accordance with ASTM A276.

995-7.5.7 Aluminum Extension Bar: Extension bars used to extend the length of the adjustable hanger must be T6061-T6 extrusion aluminum having a minimum yield strength of 35 ksi and a minimum ultimate tensile strength of 42 ksi in accordance with ASTM B221.

995-7.5.8 Stainless Steel Extension Bar: Stainless steel extension bar used to extend the length of adjustable hangers must be Type 316 or 304 stainless steel with a minimum ultimate tensile strength of 75 ksi and a minimum yield strength of 30 ksi in accordance with ASTM A276.

995-7.5.9 Disconnect Hanger: The disconnect hanger must be supplied with the following as a minimum:

1. Wired screw type/compression terminal block and wiring rated at 600 V_{AC} Root Mean Square (rms) with 12 or 18 circuits. The terminal block must be easily accessible for connection of the field wiring. Attach the terminal block to the disconnect with Type 316 or 304 stainless steel or brass fastening hardware.
2. Weather resistant grommets in each signal cable entrance of the disconnect hanger to prevent insect and animal access and to protect the signal cable from chafing.
3. A 2-inch opening in the top of the disconnect hanger with an integral serrated area (or 1.5-inch NPT threaded top section) to interface with the hanger method employed above it.
4. A securable door that allows access to all areas of the interior. The door securing device must be Type 316 or 304 stainless steel and captive. Hinge or groove pins for the door must be Type 316, 304, 303, or 302 stainless steel.

995-7.5.10 Multi-Brackets: Top and bottom (multi) brackets used in the assembly of span wire mounted multi-directional signals must be constructed of aluminum having a minimum yield strength of 13 ksi and a minimum ultimate tensile strength of 23 ksi per ASTM B26.

Top brackets must be of one-piece hollow design, with a cross-sectional diameter of at least 1-1/2 inch I.D. for receiving signal wires. The wall thickness must be at least 3/16 inch. Each top bracket (2-way, 3-way, and 4-way) must have a two-inch diameter hole (with integral serrated boss as specified above) in the top side of the bracket for receiving a 1-1/2 inch entrance fitting. The underside of the top bracket must have a covered hole of at least three inches in diameter for the installation of the signal wires.

Bottom brackets must be of one-piece solid construction and must hold the signal heads firmly in place.

For the five-section cluster configuration, provide 3/8-inch-thick Type 316 or 304 stainless steel tri-stud washers and nylock nuts with lock washers to secure the top and lower signal sections of the cluster to the top multi bracket. Washer distortion must not occur after assembly of the five-section cluster. Multi-brackets must include all fastening hardware necessary to attach to the signal.

995-7.6 Pole (Pedestal and Post) Mounting Assemblies: All trunnions, brackets, and suspensions used in mounting vehicular and pedestrian signals to concrete, steel, aluminum, or wood poles must be an aluminum alloy cast fitting, pipe or equivalent as approved by the Engineer. The aluminum alloy must have a minimum ultimate tensile strength of 35 ksi in accordance with ASTM B221, ASTM B85, or ASTM B26.

Pole side-mount brackets used for pedestrian signals may be constructed of polycarbonate material.

995-7.7 Mounting Assemblies for Signs, Cameras, Detectors, and Other Traffic Control Devices: Mounting assemblies or assembly components used for signs, cameras, detectors, and other traffic control devices must be constructed of the same material and meet the same mechanical and chemical properties as mounting assemblies for signals.

995-7.8 Miscellaneous Mounting Components: Miscellaneous mast arm, span wire, and pole mounting components and accessories included with assemblies must meet the mechanical properties for its associated main assembly components or be listed separately on the APL. Mounting assemblies not approved with a specific primary device (such as a camera, detector, etc.), must be approved and listed separately on the APL.

995-8 Signal Priority and Preemption Systems.

995-8.1 General:

Signal priority and preemption system equipment may utilize optical, GPS, and radio frequency technologies.

995-8.2 Functional Requirements: Ensure that in-vehicle equipment operates without requiring any action from the vehicle operator or occupants once power is applied.

995-8.2.1 Security: The system must include features that secure the system and restrict its configuration and operation to authorized users and vehicles only.

995-8.2.2 Vehicle Identification: The system must be able to assign a unique identifier for each authorized vehicle. The system must be able to associate the identifier with vehicle information such as vehicle classification (e.g., fire, police, rescue, transit), owner/operator, and priority level.

995-8.2.3 Configuration and Management: The system must allow authorized local and remote users to set and read all user-programmable features and retrieve data collected by the system. The manufacturer must provide computer software required to configure, operate, and maintain the system at no additional cost to the Department.

995-8.2.4 Logging: The system installed in the field cabinet must store a record of events, including time, vehicle ID, class, priority level, and approaching direction for all vehicles detected. The log must operate on a first-in, first out (FIFO) principle with a minimum capacity of 5,000 events.

995-8.2.5 Detection Range and Accuracy: The priority and preemption system must be capable of detecting and identifying multiple authorized vehicles at various ranges up to 2,500 feet. The system must be able to determine the approaching direction of authorized vehicles. The detection range and programming of emergency (high priority) and transit signal (low priority) preemption shall be adjustable from within the traffic signal cabinet. High priority calls must override low priority calls.

The system must service preemption calls having equal priority on a first-come, first-served basis.

995-8.3 Preemption System Cabinet Electronics: The priority and preemption system must be compatible with NEMA TS 1, NEMA TS 2, Type 170, and Type 2070 traffic signal controllers and their respective cabinets.

The system must be able to provide calls to the controller via input file and detector rack. The system must include two channel or four channel detector card units compatible with NEMA TS 2-2003 v02.06. The system must include a shelf mount option.

The system must be able to provide emergency preemption (high priority) and transit signal (low priority) preemption calls to the controller. Detectors must include programmable timers that allow the operator to configure detector call extension as well as limit the length of channel output calls.

Channel outputs must deliver a constant signal while emergency vehicles are detected for high priority preemption activation. Channel outputs must deliver a pulsed output for low priority preemption activation. Inputs and outputs must be optically isolated.

995-8.3.1 Serial Interface: Ensure that the serial ports support data rates up to 115 kbps; error detection procedures utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2). Serial interface ports may utilize RJ-45 connectors, D-sub connectors, or screw terminals.

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 requirements.

995-8.4 Optical Preemption Detectors: Optical preemption detectors must respond to light impulses generated from a visible or infrared light source.

995-8.5 Intersection Radio/GPS Modules: Radio/GPS preemption systems must include radio/GPS modules that transmit a beacon signal and receive data transmitted by Radio/GPS vehicle equipment.

995-8.6 Mechanical Specifications: Ensure that every conductive contact surface or pin is gold-plated or made of a noncorrosive, conductive metal. Do not use self-tapping screws on the exterior of the assembly.

All external parts must be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

Detector cards must include indicators for power and vehicle detection. Detector cards must include a test switch that can be used to manually generate detector calls that the system provides during normal operations.

995-8.7 Electrical Specifications: Provide equipment that operates on a nominal voltage of 120 volts V_{AC}. If the device requires operating voltages of less than 120 V_{AC}, supply the appropriate voltage converter.

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.

995-9 Pedestrian Detection System.

995-9.1 General: The components of the pedestrian detection system include pushbuttons, pedestrian actuation signs, electronics, wiring, and mounting hardware.

995-9.2 Standard Pedestrian Pushbutton Detector: Pushbuttons must be raised from or flush with their housings and be a minimum of 2 inches in the smallest dimension. The pushbutton must require no more than 5 pounds of force to activate. The detector must be weather-tight and tamper resistant.

995-9.2.1 Housing: The housing must be a two-piece unit consisting of a base housing and a removable cover. The housing must be cast aluminum meeting the physical characteristics and chemical content established in ASTM B26 for alloys S5A and CS72A.

The housing or adapter (saddle) must conform to the shape of a pole and provide a flush, secure fit. Saddles must be of the same material and construction as the housing. Pushbuttons for wood pole mounting must have threaded holes for 1/2-inch conduit provided in the housing top or bottom. A 3/4-inch hole with an insulated bushing shall be provided through the back of the housing. Unused openings shall be closed with a weatherproof closure and painted to match the housing.

The housing must have a powder-coat finish and painted in accordance with Military Standard MIL-PRF-24712A.

995-9.2.2 Pushbutton: The pushbutton must include a normally open, mechanical phenolic enclosed, positive-acting, spring-loaded, audible (i.e., click) snap-action switch with single pole, single throw contacts, or a Piezo driven solid state switch rated for a minimum of 50 V. The Piezo driven solid state switch, when activated, must give an audible (i.e., two-tone chirp) indication of actuation. A visual indication of actuation is optional. The visual indication must remain illuminated until the pedestrian's WALKING PERSON (symbolizing WALK) signal indication is displayed. Switch connections inside the housing must allow wiring and installation without binding. The switch must have a design life of one million operations (minimum) at rated load.

995-9.2.3 Electrical Requirements: The wiring must be No. 18 AWG stranded (minimum) with 600 V outdoor insulation rating.

995-9.3 Accessible (Audible/Tactile) Pedestrian Pushbutton Detector: The accessible pedestrian pushbutton detector must consist of all electronic control equipment, wiring, mounting hardware, pushbuttons, and pedestrian actuation signs designed to provide both a pushbutton with a raised, vibrating tactile arrow on the button as well as a variety of audible indications for differing pedestrian signal functions.

995-9.3.1 Electronic Control Equipment: The accessible pedestrian pushbutton detector must include electronic control equipment that is programmable and adjustable using a laptop computer or vendor supplied programmer. Electronic control equipment must be able to be installed within a traffic controller cabinet or within a pedestrian signal housing. Electronic control equipment installed within a traffic controller

cabinet must allow the use of up to 16 pushbuttons (4 maximum per channel) with a single traffic controller cabinet. The accessible pedestrian pushbutton detector must receive timing from Walk and Don't Walk signals.

995-9.3.1.1 Audible Messages: Audible messages must be programmable. All audible messages and tones must emanate from the accessible pedestrian pushbutton housing. The accessible pedestrian pushbutton detector must utilize digital audio technology. The system shall have, at a minimum, three programmable locator tones. The accessible pedestrian pushbutton detector must have independent minimum and maximum volume limits for the Locator Tone, Walk, and Audible Beaconing features. The Wait message must only annunciate once per actuation.

995-9.3.1.2 Pushbutton locator tone: The accessible pedestrian pushbutton detector must provide independent ambient sound adjustment for the locator tone feature. The accessible pedestrian pushbutton detector must allow the locator tone to be deactivated.

995-9.3.1.3 Vibrating Pushbutton (VPB): The accessible pedestrian pushbutton detector must include a Vibrating Pushbutton (VPB). The VPB must be a single assembly containing an ADA compliant, vibro-tactile, directional arrow button, weatherproof audible speaker, and pedestrian actuation sign with optional placard Braille messages. The VPB tactile arrow must be 2 inches in length, be field adjustable to two directions, and require no more than 5 pounds of applied force to activate.

995-9.3.1.4 Conflict Monitoring: The accessible pedestrian pushbutton detector must monitor the Walk condition for conflict operation. The accessible pedestrian detector system must disable the Walk functionality if a conflict is detected.

995-9.3.1.5 Cabinet Control Unit (CCU): The accessible pedestrian pushbutton detector may include a CCU for interfacing and connecting the system. The CCU shall have labeled LED indicators for each channel operation. The CCU must reset upon loss of internal communication.

995-9.3.2 Inputs and Outputs: All inputs and outputs must use Mil-Spec Multi-pin connectors.

995-9.3.2.1 Inputs: Walk and Don’t Walk inputs must be optically isolated 80-150 volts AC/DC, 5mA max. General purpose inputs must be optically isolated 10-36 volts AC/DC, 10mA max.

995-9.3.2.2 Outputs: Outputs must be optically isolated 36 volts AC/DC peak, 300mA solid state fused contact closures. CCUs must include a normally open relay contact fault output.

995-9.3.3 Communication: The CCU must include an Ethernet interface. The CCU must have an integral web server that provides information on audible/tactile pedestrian-pushbutton detector status, access to event logs, and provides for remote Configuration of accessible pedestrian pushbutton detector system options. VPBs must include an Ethernet, serial, USB, or Bluetooth programming interface.

995-9.4 Passive Detectors: The passive detector must consist of all electronic control equipment, wiring, and mounting hardware.

995-9.4.1 General: A passive detector system uses one or more sensors and analytics hardware and software to detect the presence and direction of pedestrians and activate the traffic control device without any required action by the pedestrian.

995-9.4.2 Configuration and Management: Ensure that the passive detector is provided with software that allows local and remote configuration and monitoring. Ensure that the system can display detection zones and detection activations overlaid on live passive detector inputs. Ensure that the passive detector allows a user to edit previously defined configuration parameters, including size, placement, and sensitivity of detection zones.

Ensure that the passive detector retains its programming in nonvolatile memory. Ensure that the detection system configuration data can be saved to a computer and restored from a saved file. Ensure that all communication addresses are user programmable.

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

995-9.4.4: Electrical Requirements: Ensure the system operates using a nominal input voltage of 120 V_{AC}. Ensure that the system will operate with an input voltage ranging from 89 to 135 V_{AC}. If a system device requires operating voltages other than 120 V_{AC}, supply a voltage converter.

995-9.5 Electrical: All wiring must meet applicable NEC requirements. The accessible pedestrian pushbutton detector must operate using a nominal input voltage of 120 V_{AC}. If any device requires nominal input voltage of less than 120 V_{AC}, furnish the appropriate voltage converter.

Accessible pedestrian pushbutton detector control electronics that are mounted in a pedestrian signal head must be able to receive power from the Walk and Don't Walk circuits of the signal head. Control electronics shall not require more than four wires for each pushbutton connection, and no more than two wires for each controller pedestrian input. Voltage at the pushbutton shall not exceed 24 V_{AC}.

995-9.6 Mechanical: Do not use self-tapping screws on the exterior of the assembly.

Ensure that all parts are made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal. Ensure that all assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8-inch in diameter, are Type 304 or 316 passivated stainless steel. Stainless steel bolts, screws and studs must meet ASTM F593. Nuts must meet ASTM F594. All assembly hardware greater than or equal to 5/8-inch in diameter must be galvanized. Bolts, studs, and threaded rod must meet ASTM A307. Structural bolts must meet ASTM F3125, Grade A325.

Enclosures must have a NEMA 4X rating. Pushbutton housings for intersections must be black.

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.

SECTION 995 is expanded by the following new Articles:

995-10 Traffic Controllers.

Traffic controllers must meet the industry standards in Table 995-6.

Table 995-6 Traffic Controller Standards	
Device	Standard

EXPECTED IMPLEMENTATION (FY 2023-24)

DRAFT

NEMA TS2 Controller	NEMA TS2-2021
Model 2070 Controller	CALTRANS TEES, 2020
Note: All controllers must meet AASHTO/ITE/NEMA ATC 5201, v06.25.	

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

All controllers must:

1.Capture all mandatory event-based data elements listed in supplemental requirement SR-671-2, 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 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 2016-03.

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

995-11 Traffic Cabinets.

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 TS-2-2016, 7.7.2.

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 TS-1-1989
NEMA TS2 Controller Cabinet	NEMA TS 2 2016

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 three 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.

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

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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) 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)Peak Surge Current

2 kA (8 by 20 µs)

Occurrences at peak current: 100 (typical)

(c) Response Time: 5-30 ns

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

(e) Clamp Voltage: 30V

(f) 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) The SPD must be a 3 terminal device

(b) Peak Surge Current

2000A (8 b 20 µs)

Occurrences at peak current: 25 (minimum)

(c) Response Time: less than 200 ns

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

995-11.3.7 Model 210 Conflict Monitor with Absence of Red Monitoring: The conflict monitor must be a Model 210 "PLUS" conflict monitor capable of detecting fault sequencing of signals on a per channel basis (i.e., short or absence of yellow interval and/or simultaneous dual indications). All integrated circuits having 14 pins or more must be socket mounted.

995-11.3.7.1 Absence of Red Monitoring: The conflict monitor must be capable of monitoring for the absence of voltage on all of the inputs of a channel (defined here as red, yellow, and green). If an output is not present on at least one input of a channel at all times, the unit shall begin timing the duration of this condition. If this condition exists for less than 700 milliseconds, the unit shall not trigger. If this condition exists for more than 1000 milliseconds, the unit shall trigger as if a conflict had occurred, causing the intersection to transfer immediately into a flashing mode, and "stop-time" to be applied to the controller. A red signal shall require the presence of a minimum of 60 $V_{AC,}$ plus or minus 10 $V_{AC,}$ to satisfy the requirements of a red indication. The red input signals shall be brought into the conflict monitor through an auxiliary connector on the monitor's front panel. Provide a similar connector on the output file, with a removable harness connecting the two. Provide an

indicator on the front panel of the monitor to identify the triggering of the monitor in response to the absence of red condition.

995-11.3.7.2 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.

995-11.3.7.3 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.

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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:

a) TBS1 - Terminal Block, Deadfront type, 3 position, No. 4 to No. 14 AWG wire range, 70A, 600V.

b) 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.

c) 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.

d) 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 inches 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.

995-11.4 Controller Cabinet Flashing Operation: When a non-emergency flashing operation is required, the selected operation shall be performed by the UCF format. The following shall utilize UCF format:

a) Flash Switch located on the cabinet service panel
b) Time Base Coordination Flash
c) Time Switch

When flashing operation is initiated, the controller assembly shall transfer from normal operation to flashing operation only at the end of the common major street red interval, the common minor street yellow interval, or the all red interval.

UCF shall be an internal function of the controller unit and must not be inhibited by the hold command. External logic will not be allowed to provide this function.

In the event of an emergency when flashing operation is required, the controller assembly shall immediately place the intersection on flash. Emergency flash may be initiated by the following:

a) Auto/Flash Switch - A switch located on the cabinet police panel
b) Conflict-Voltage Monitor senses a conflicting indication or system error

The transfer of the controller assembly from flashing operation to normal operation shall cause the controller unit to revert to its start-up sequence unless the conflict-voltage monitor has transferred the controller assembly to flashing operation. If transferred to flashing operation by the conflict-voltage monitor, the controller assembly shall remain in flashing operation until the monitor unit is reset and automatic operation can be implemented through the normal start-up sequence.

995-11.5 Intelligent Transportation System Cabinets: The cabinet shell must conform to NEMA 3R requirements, be constructed of unpainted sheet aluminum alloy 5052-H32 with a minimum thickness of 0.125 inch and have a smooth, uniform natural aluminum finish without rivet holes, visible scratches or gouges on the outer surface. Other finishes are acceptable if approved.

The dimensions for cabinets are listed below.

Table 995-7 Cabinet Dimensions in Inches			
Cabinet Type	Height	Width	Depth
340	66” - 68”	44” - 46”	26” - 28”
336	36” - 39”	24” - 26”	20’ - 22”
336S	46” - 48”	24” - 26”	22” - 24”
334	66” - 68”	24” - 26”	30” - 32”
332D	66” - 68”	48” - 50”	30” - 32”
P44	55” - 59”	44” - 46”	26” - 29”

The cabinet must be weather resistant and constructed with a crowned top to prevent standing water. All exterior cabinet welds must be gas tungsten arc (TIG) welds and all interior cabinet welds must be gas metal arc (MIG) or TIG welds. All exterior cabinet and door seams must be continuously welded and smooth and all inside and outside edges of the cabinet must be free of burrs, rounded and smoothed for safety. All welds must be neatly formed and free of cracks, blow holes and other irregularities. Use ER5356 aluminum alloy bare welding electrodes conforming to AWS A5.10 requirements for welding on aluminum. Procedures, welders and welding operators must conform to AWS requirements as contained in AWS B3.0 and C5.6 for aluminum.

The cabinet must have a lifting eye plate on both sides of the top of the cabinet for lifting and positioning it. Each lifting eye must be secured with a minimum of two bolts to the cabinet body and have a lift point opening diameter of 0.75 inch and capable of supporting a weight load of 1,000 pounds. All external bolt heads must be tamperproof.

Ground-mount cabinets must include a removable base plate and two aluminum plates, welded inside, for anchoring the cabinet. Fabricate the plates from aluminum alloy 5052-H32 a minimum of 4 inches wide by 0.125 inch thick. Provide the cabinet with four 1 inch diameter holes for anchoring.

995-11.5.1 Doors: Provide cabinets with front and rear doors, each equipped with a lock and handle. Doors must be full size, matching the height and width dimensions of the cabinet enclosure, with no fewer than three Type 4 or larger stainless steel hinges or; alternately, one full-length “piano” hinge. Hinges must be constructed of 14 gauge stainless steel with stainless steel hinge pins that are spot-welded at the top. Mount the hinges so that they cannot be removed from the door or cabinet without first opening the door. Brace the door and hinges to withstand 100 pounds per vertical foot of door height load applied to the outer edge of the door when standing open. Ensure there is no permanent deformation or impairment of any part of the door or cabinet body when the load is removed.

Door opening must provide a flange that allows the door gasket to mate with a flat surface. Include a gasket made of closed-cell material resistant to UV, weathering, elevated temperatures, and permanent deformation that is permanently bonded to the inside of each door forming a weather-tight seal when the door is closed.

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.

995-11.5.3 Rails: Provide the cabinet with four cabinet rails that form a cage for mounting miscellaneous wiring panels and various mounting brackets. Use rails constructed of either 0.1345 inch thick plated steel or 0.105 inch thick stainless steel that extend the length of the cabinet's sides, starting from the bottom of the enclosure. Rails must be keyhole designed with slots 2 inches on center with a top opening of 5/8 inch in diameter to allow the insertion of a 5/8 inch by 1 inch carriage bolt. Rails must be 1-1/2 to 2 inches wide by 1/2 inch deep, drilled and tapped for 10-32 screws or rack screws with EIA universal spacing. Do not use unistruts or other rail types.

995-11.5.4 Racks: The cabinet must include a standard 19-inch EIA/TIA equipment rack centered in the cabinet for mounting devices to be installed inside. Clearance in the rack between the rails must be 17-3/4 inches.

995-11.5.5 Shelf: Provide a level, rollout internal shelf with a minimum work area measuring 10 inches by 10 inches. The shelf must be capable of sustaining a constant 20 pound load and the shelf position must be adjustable.

995-11.5.6 Sunshield: Sunshields must be mounted with tamper resistant hardware to standoffs that provide an air gap of at least one inch between the exterior cabinet walls and the sunshields. Sunshield standoffs located on the roof of the cabinet must be welded to the cabinet body. Construct sunshields of 0.125 inch thick 5052-H32 aluminum sheet with corners that are rounded and smoothed for safety.

995-11.5.7 Ventilation: Provide ventilation through the use of a louvered vent at the bottom of the door. Vent depth must not exceed 0.25 inch. Provide an air filter a minimum of 192 square inches and 1 inch thick behind the vent. The filter must be removable and held firmly in place so that all intake air is filtered.

Provide a bottom trough and a spring-loaded upper clamp to hold the filter in place. The bottom trough must drain any accumulated moisture to the outside of the field cabinet.

ITS field cabinets must have dual thermostatically controlled fans, with one thermostat per fan, rated for continuous duty with a service life of at least three 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. Use UL listed exhaust fans having a minimum air flow rating of 100 cubic feet per minute. Electric fan motors must have ball or roller bearings. Vent the exhaust air from openings in the roof of the field cabinet.

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.

995-11.5.8.1 Service Panel Assembly: Provide a service panel assembly to function as the entry point for AC power to the cabinet and the location for power filtering, transient suppression and equipment grounding. Provide branch circuits, SPDs, and grounding as required for the load served by the cabinet, including ventilation fans, internal lights, electrical receptacles, etc.

995-11.5.8.2 Terminal Blocks: Terminate electrical inputs and outputs on terminal blocks. The voltage and current rating of the terminal block must be greater than the voltage and current rating of the wire fastened to it.

Terminate conductors on terminal blocks using insulated terminal lugs large enough to accommodate the conductor to be terminated. When two or more conductors are terminated on field wiring terminal block screws, use a terminal ring lug for termination of those conductors. Number all terminal block circuits and cover the blocks with a clear insulating material to prevent inadvertent contact.

995-11.5.8.3 Ground BusBar: Fabricate ground busbars of 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 the ground busbar on the side of the cabinet wall adjacent to the service panel assembly for the connection of AC neutral wires and chassis ground wires. If more than one ground busbar is used in a cabinet, use a minimum of a No. 10 AWG copper wire to interconnect them. Connect the equipment rack to the ground busbar in the cabinet to maintain electrical continuity throughout the cabinet.

Follow the PANI recommendations of USDA-RUS-1751 for connections to the ground busbar. Producer (P) or electrical power and sources of stroke current connections shall be on the left end of the busbar. Absorbing (A) or grounding wires shall be connected immediately right of the P connections. Non-isolated (N) connections such as doors and vents shall be connected to the right of the A connections. Isolated (I) equipment grounds from equipment in the cabinet shall be connected on the right end of the busbar.

995-11.5.8.4 Power Distribution Assembly: Furnish a power distribution assembly that fits in the EIA 19-inch rack and provides for protection and distribution of 120 V_{AC} power.

995-11.5.8.5 Interior Lighting: Provide one or more light fixtures that illuminate the entire interior of the cabinet. All light fixtures must automatically turn on when the main cabinet door is opened and turn off when the door is closed.

995-11.5.9 Adapter Bracket: Provide an adapter bracket for pole mounted cabinets that is slotted or otherwise designed to allow banding straps to be installed to avoid pole handholes.

995-11.6 Generator and Auxiliary Power Connection: Traffic signal controller cabinets and ITS cabinets must include a generator and auxiliary power connection.

Cabinets with generator and auxiliary power connection must include provisions for the connection of an external power source, such as a portable generator, through a weatherproof, secure interface. This feature must allow authorized personnel to access, connect, and secure an external power source to the cabinet in order to restore power

within five minutes of arrival time at the cabinet. A 10 AWG, 600V UL rated cable, fabricated with L5-30 connectors, a minimum of 12 feet in length, must be supplied with cabinet assemblies for field connection between generator and cabinet. The generator access door and cable entrance must include means to prevent access to insects when cable is not present.

995-11.6.1 Automatic Transfer Switch: The transfer switch must meet UL 1008 and be rated equal to or higher than the design load of the cabinet's main breaker and the generator input twist-lock connector rating. The transfer switch must provide a means of switching between normal utility power and auxiliary backup generator power. Switching time cannot exceed 250 milliseconds. Ensure that the transfer switch does not allow simultaneous active power from more than one source and does not allow generator backflow into normal utility AC circuits.

995-11.6.2 Generator Access Panel: Include a generator connection panel consisting of, at a minimum, the automatic transfer switch with a three-prong, 30 amp L5-30P twist-lock connector with recessed male contacts for generator hookup. Locate the access panel as close as possible to the main AC circuit breaker with the bottom of the access panel no less than 24 inches above the bottom of the cabinet. Do not place the generator access panel on the main cabinet door or back door. Locate and label the transfer switch and twist lock connector on a panel easily accessible behind a weatherproof lockable exterior access door equipped with a tamper-resistant hinge. Label this access door "Generator Access Door". Provide the access door with a No. 2 lock.

The access door and cable entrance must include means to prevent access to insects when cable is not present. The generator hookup compartment must be recessed no more than six inches into the cabinet but be deep enough to allow closing and locking of the access door when the generator cable is connected. Avoid blocking access to any other equipment in the cabinet.

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 UL 508A listed, be rated 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 inches 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.

995-12 Traffic Controller Accessories.

995-12.1 General: Traffic controller accessories must meet the industry standards in Table 995-8.

Table 995-8
Traffic Controller Accessory Standards

Device	Standard
Conflict Monitor	NEMA TS1-1989, Section 6
Malfunction Management Unit	NEMA TS2-2021, Section 4
Power Supply	NEMA TS2-2021, Section 5.3.5
Load Switch	NEMA TS2-2021, Section 6.2
Flasher	NEMA TS2-2021, Section 6.3
Bus Interface Unit	NEMA TS2-2021, Section 8
Model 206L Power Supply Unit	CALTRANS TEES, 2020, 3.4
Model 208 Monitor Unit	CALTRANS TEES, 2020, 3.5
Model 210 Monitor Unit	CALTRANS TEES, 2020, 3.6
Power Distribution Assembly	CALTRANS TEES, 2020, 6.4.3
Input File	CALTRANS TEES, 2020, 6.4.4

995-12.2 Time Switch: Ensure the time switch is a 24-hour timer which controls the daily switching operation of circuit contacts at preselected times.

Type 1 time switches must contain a single circuit contact and a solid state timer with at least 48 programmable on and off times.

Type 2 time switches must contain two circuit contacts and a solid state timer with at least three independently programmable on and off times per circuit.

Type 3 time switches must contain three circuit contacts and a solid state timer with at least three independently programmable on and off times per circuit.

995-12.2.1 Timing: Solid state timing must be accomplished by digital circuits utilizing the power line 60 Hz frequency as the normal timing reference or GPS Time Sync. Time-of-day must be settable and displayed in maximum increments of one minute.

995-12.2.2 Programming: Programming for selection of contact openings or closures must be provided in maximum increments of one minute for Types 1 through 3 time switches.

A day omit device or circuit must be provided with Types 1 through 3 time switches to omit the programmed switching operation for any combination of up to three days of the week. A positive means of indicating the day of the week must be provided with Types 1 through 3 time switches.

995-12.2.3 Reserve Power: Type 1, Type 2, and Type 3 solid state time switches must be provided with a battery backup circuit which maintains time during a power

failure of up to 10 hours. The timing accuracy of battery backup circuits during a power failure must be plus or minus 0.5 seconds.

995-12.2.4 Output Circuit Contacts: Each output circuit contact must be rated for a 3A, 115 V_{AC} load. The output circuit contact must have 115 V_{AC} present when the timer turns the circuit on.

995-12.2.5 Time Switch Housing: Time switches must be enclosed in durable sheet aluminum or approved alternate housing. A terminal strip or screws must be provided with the time switch for AC power and all output circuit contacts.

995-13 System Control Equipment.

995-13.1 Adaptive Signal Control System: Adaptive signal control systems external to the traffic controller place detector calls to the traffic signal controller to adjust signalization timing based on measured traffic conditions independently of the traffic signal controller's preconfigured timings.

The system must interface with the traffic controller using either the Synchronous Data Link Control (SDLC) Port 1 interface and protocol or 24 V_{DC} inputs/outputs available in the traffic controller cabinet. Dynamically modifying controller configuration settings through serial communications is not allowed.

The system must include a user interface that allows the configuration of subcomponents, such as detectors and cameras, and includes remote monitoring and reporting.

The system must include the option of incorporating existing vehicle detection in addition to the primary detection used by the adaptive signal control system.

The system must not affect the normal operation of the traffic signal controller upon any failure of communication, detection, or system component.

Ensure adaptive signal control system hardware is permanently marked with manufacturer name or trademark as well as part number and serial number. Ensure that the markings are visible after installation.

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, 2.2.7, 2.2.8, and 2.2.9.