

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

## TRAFFIC MONITORING SITE EQUIPMENT AND MATERIALS.

(REV 8-11-23)

SECTION 695 is deleted and the following substituted:

### 695-1 Description.

Furnish or furnish and install a complete, operable traffic monitoring site (TMS) as shown in the Plans and Standard Plans. The Department uses TMS to monitor the volume, speed, number of axles, weight of wheels, axles or vehicles, or vehicular axle classification types.

### 695-2 General.

#### 695-2.1 **Materials:** Meet the following requirements:

Poles.....	Section 646
Transformer Base*.....	Section 646
TMS Vehicle Non-Weight Axle Sensors*.....	Section 997
TMS Vehicle Microwave Radar Vehicle Sensors*.....	Section 997
TMS Vehicle Video Sensors*.....	Section 997
TMS Vehicle Strain Gauge Sensors*.....	Section 997
TMS Vehicle Quartz Piezoelectric Sensors*.....	Section 997
TMS Non-Motorized Axle Sensor*.....	Section 997
TMS Non-Motorized Infrared Sensor*.....	Section 997
TMS Non-Motorized Video Sensor*.....	Section 997
TMS Solar Power Unit For Vehicle Data Collection*...	Section 997
TMS Solar Power Unit For Non-Motorized Data*.....	Section 997
TMS System Communications Modem*.....	Section 997
TMS Modem Antenna*.....	Section 997
TMS Vehicle Speed/Classification Unit*.....	Section 997
TMS Vehicle Weigh-In-Motion (WIM) Unit*.....	Section 997
TMS Non-Motorized Data Collection Unit*.....	Section 997
Adhesive Bonding Agent*.....	Section 997
Loop Sealant*.....	Section 997
TMS Cabinets*.....	Section 997
TMS Suppression Devices (power, sensor)*.....	Section 997
TMS Managed Field Ethernet Switch*.....	Section 997
Patch Panel.....	Section 633

\*Use products listed on the Department's APL.

**695-1.2.2 Traffic Monitoring Site Component Approval:** Submit forms in accordance with 603-5. Any electronics unit or software submitted for approval must be compatible with or convert the data into a format compatible with the Department's polling and processing software. and be compatible with the existing and new equipment. Remove and replace any new equipment that fails the operational test at no cost to the Department. ~~Any substitute software modules submitted must be tested and approved.~~

~~**695-2.2 Marking of Approved Equipment:** All TMS equipment must be permanently marked with the manufacturer's name or trademark, part or model number and date of manufacture or serial number.~~

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

~~695-2.3 Notification:~~ Notify the Engineer 10 working days prior to beginning work in the area of the TMS to coordinate the removal of existing TMS equipment.

A TMS Inspector must be onsite during TMS installation. Notify the Engineer 10 working days prior to installation of the TMS to coordinate the scheduling of a TMS Inspector.

For the Weigh-In-Motion (WIM) electronics sensor and unit, notify the Engineer for final acceptance inspection after the completion of a 30 day operational period with no deficiencies. For all other equipment, notify the Engineer for final acceptance inspection after the completion of a 14 day operational period with no deficiencies.

**695-2.4 Poles ~~for Cabinets, Non-Intrusive Sensors and Solar Panels:~~**

~~695-2.4.1 Requirements:~~ Meet the requirements of Section 646 for aluminum poles.

~~695-2.4.2 Installation:~~ Use cabinets that meet the requirements of Section 676 and are listed on the Department's Approved Product List (APL). Install cabinets in accordance with Section 676. Install the weather head and ground the pole in accordance with Section 620 and Standard Plans, Index 695-001.

**695-2.5 Manufacturer's Warranty ~~Provisions:~~**

~~695-2.5.1 General:~~ Secure all warranties provided by the equipment manufacturer for the specific equipment included in the Contract. Ensure that all warranties are fully transferable from the Contractor to the Department. Transfer warranties upon final acceptance in accordance with 5-11. Document all warranties and warranty transfers and submit to the Engineer. ~~The Engineer will submit warranty forms received from the Contractor to the Transportation Data and Analytics Office (TDA) TMS Manager.~~

~~695-2.5.2 Terms and Conditions:~~ Ensure that the terms and conditions of warranties are documented by the manufacturer when submitting a request to the Department for certification and for equipment submittal for construction projects. Include terms for a specified service performance with provisions for repair parts and labor, or for replacement.

~~Ensure the terms and conditions define the equipment installation date as the date for such warranty to be in effect. The installation date for construction projects is the day the site is accepted by the TDA TMS Manager. For warehouse purchases, the installation date is the date of visual inspection approval, not to exceed ten days after delivery date.~~

~~Ensure warranties require the manufacturer to furnish replacements within 10 calendar days of notification for any part or equipment found to be defective during the manufacturer's warranty period at no cost to the Department.~~

~~Leave a copy of the warranty in the cabinet once it is installed and submit the warranty to the Engineer. The Engineer will submit warranty forms received from the Contractor to the TDA TMS Manager. Comply with the terms of the warranty. The Department may suspend the certification for non-compliance.~~

**695-3 Vehicle Sensor (Non-Weight) Applications.**

**695-3.1 General:** Install The vehicle classification site consists of axle sensors and inductive loop sensors. The axle sensor is described in 695-3.2. The inductive loop assembly is described in 695-10. Furnish and install TMS vehicle sensors of the type and at the location shown in the Plans. ~~Use vehicle sensors listed on the Department's APL meeting the requirements of Section 997 and compatible with the electronics unit to which they will be connected.~~

**695-3.2 Axle Sensor ~~(In-Roadway):~~**

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

**695-3.2.1 Installation:** Install sensors in accordance with the requirements of this Section and Standard Plans, Index 695-001. Ensure axle sensors are installed in the roadway and secured using an adhesive bonding ~~material listed on the APL~~ agent as listed on the APL.

Allow newly applied asphalt friction course to cure for a minimum of 30 days prior to the installation of in-road sensors.

Install axle sensors in the right-hand wheel-path midway between the leading and trailing loops as detailed in Standard Plans, Index 695-001. Install axle sensors in the left-hand wheel-path when no paved shoulder exists and sensor lead exit windows are installed at the right-hand edge of the roadway surface or in a lane which is to the left of and adjacent to an open lane of traffic.

Install the axle sensor such that the cable end is closest to the pull box to which the sensor lead cable will be routed. Install the end of the sensor mid-way into the edge line stripe or lane line stripe. Ensure that the axle sensor being installed has lead-in cables of sufficient length to reach the cabinet without splicing. Do not splice axle sensor lead-in cables.

Route the sensor leads to the pull box then to the TMS cabinet. Mark the sensor leads at the pull box and at termination in the cabinet. Submit lane numbering information as specified in Standard Plans, Index 695-001.

~~Allow newly applied asphalt to cure for a minimum of 30 days prior to the installation of in-road sensors. Use a chalk line or string and paint to layout the position of the sensor and lead-in cable slots.~~

~~Ensure saw cuts do not deviate more than 0.5 inches from the chalk line. Use a single blade or ganged blade saw wide enough to cut the axle sensor slot at full width in a single pass. Cutting two slots and chipping out roadway material between them is not allowed.~~

Cut the slot the length of the sensor plus an additional 3 to 4 inches. Ensure the depth and width of the slot is installed as recommended by the sensor manufacturer, typically 0.75 inches wide by 1.5 to 2 inches deep.

Use clips or jigs provided by the manufacturer to suspend the sensor at a uniform depth in the slot. Mix and apply the adhesive bonding agent ensuring the slot is completely full with no voids beneath the sensor.

**695-3.2.2 Test Requirements:** Perform the manufacturer's recommended on-site pre-installation test to determine the sensor's condition using an Inductive Capacitance Resistance meter. ~~Install only those~~ Replace any sensors that ~~pass~~ fail the pre-installation test.

Record all test results by lane on the warranty form provided by the manufacturer and leave a copy in the cabinet.

Repeat the test at the termination point in the cabinet after installation. Use an oscilloscope to view and record typical waveforms and signal intensity measurements for the axles of passenger cars and large trucks. Remove and replace any sensor that fails the test at no additional charge to the Department.

Perform an operational test to meet final acceptance requirements. The sensor shall operate without deficiencies for a minimum of 14 days prior to final acceptance. The sensor shall be operating without deficiencies at the time of final acceptance. Remove and replace any sensor that fails the operation test at no additional charge to the Department.

### **695-3.3 Non-Intrusive Vehicle Sensors (Off-Roadway):**

**695-3.3.1 General:** Install wireless motorized (radar, ~~or~~ microwave, or video) vehicle sensors on a pole as shown in the Plans and Standard Plans, Index 695-001. ~~Use vehicle~~

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

~~detection systems that meet the requirements of Section 997 and are listed on the Department's Approved Product List (APL).~~

**695-3.3.2 Installation Requirements:** Install the sensor on a pole perpendicular to the target lanes of traffic with room to perform horizontal and vertical aiming adjustments.

Ensure that the wireless vehicle sensor has sufficient cable length to reach the cabinet without splicing. Fasten the cable to the pole so wind does not move it, or route the cable within the pole cavity to the cabinet termination point. Provide 18 to 24 inches of slack in the cable at the connections to the sensor and in the cabinet to ensure the cable is stress-free. Include the appropriate mounting hardware, ~~contact closure signal that corresponds to vehicle presence~~ and the manufacturer's recommended surge suppression as a part of the installation.

Set up the lane detection zones using the manufacturer's instructions and software and verify that the sensor's orientation is perpendicular to the roadway.

Configure the wireless vehicle sensor for vehicle volume unless otherwise specified in the Plans.

**695-3.3.3 Test Requirements:** Conduct a visual test to determine that all detection zones are being counted accurately.

Connect a personal computer (PC) to the electronics unit and observe traffic in every lane, verifying that each vehicle is displayed on-screen. A minimum of 20 vehicles should be observed for each lane of traffic with all vehicles counted; assuming a clear line of sight between the sensor and the vehicle being observed is maintained.

If any vehicles are not counted, reconfigure the wireless vehicle sensor and repeat the visual observation test until all lanes count correctly. If the sensor fails to provide accurate counts after three test attempts, it must be replaced with a new unit at no expense to the Department.

~~Provide a time synchronized video of testing, if requested. Submit a 48 hour verification (class, speed and volume) report for all TMS to the Engineer. The Engineer will submit video received from the Contractor to the TDA TMS Manager. Submit all documents to the Engineer and leave a copy in the cabinet.~~

Perform an operational test to meet final acceptance requirements. The sensor shall operate without deficiencies for a minimum of 14 days prior to final acceptance. The sensor shall be operating without deficiencies at the time of final acceptance. Remove and replace any sensor that fails the operation test at no additional charge to the Department.

~~695-3.4 Method of Measurement. The Contract unit price for each vehicle sensor will include the vehicle sensor, lead-in cables, bonding agent, and all equipment, materials, testing and labor necessary for a complete and accepted installation.~~

~~695-3.5 Basis of Payment: Price and payment will be full compensation for all work specified in this Section.~~

~~Payment will be made under:~~

~~Item No. 695-1 TMS Vehicle Axle Sensor (In Roadway) Non Weight Applications each.~~

~~Item No. 695-2 TMS Vehicle Non Intrusive Non Weight Applications (Off Roadway) each.~~

#### **695-4 Vehicle Speed/Classification Unit.**

**695-4.1 General:** Furnish and install TMS vehicle speed/classification unit (electronics unit) in the TMS cabinet at the locations shown in the Plans.

#### 695-4.2 Materials:

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

~~695-4.2.1 General: Use a vehicle speed/classification unit listed on the Department's APL meeting the requirements of 997 and compatible with the other components installed at the TMS. Ensure that the vehicle speed/classification unit and equipment cables are compatible and constructed in accordance with the Standard Plans.~~

~~Ensure that the vehicle speed/classification unit is marked in accordance with 695-2.2 and the markings are visible after installation.~~

~~695-4.2.2 Vehicle Speed/Classification Unit Requirements: Provide an electronics unit that outputs data compatible with the Department's polling computer system or furnish a software module that converts the data into a format compatible with the Department's polling computer system.~~

~~The electronics unit operates in an unattended mode, accumulating data for later retrieval by downloading via the polling computer system. Ensure that the electronics unit is capable of downloading data through direct connection with a PC, without deleting or marking the files.~~

~~Submit complete operating procedures with all software.~~

~~695-4.2.2.1 Compatibility: Provide an electronics unit that is compatible with the weigh in motion sensors, embedded inductive loops, axle sensors, magnetometers and non-intrusive vehicle sensors in place at the TMS.~~

~~Ensure that each electronics unit is capable of determining the count and classification by type and speed of all vehicles for both directions of traffic on the roadway.~~

~~Provide real time polling software with each electronics unit, capable of operating on a PC using the Department recommended operating system and meeting the following requirements:~~

~~1. Capable of communicating with the traffic counter/classifier, and downloading data via cellular modem and producing reports of 15 minute, hourly, weekly, monthly and annual volume and classification data.~~

~~2. Capable of displaying and entering operating parameters into the vehicle class/counter, and allowing the display of real-time traffic volumes in addition to routine data collection activities.~~

~~3. Capable of processing and storing all vehicle data retrieved in routine mode, regardless of the selected parameters.~~

~~695-4.2.3 Functional Requirements: The electronics unit must be fully functional when receiving input from two 6 foot by 6 foot embedded inductive loops, spaced 12 to 24 feet apart, leading edge to leading edge, with a single axle sensor located between the loops, in each lane of a six lane (minimum) roadway. Ensure that each electronics unit is capable of collecting data from each of the lanes of traffic in any combination of counts, classification, speed, or direction.~~

~~Provide electrical components of solid state design, constructed so that they will not be damaged by jolts and vibrations encountered during shipping and everyday use.~~

~~Ensure that all electronics units are functionally identical and interchangeable except as follows:~~

~~1. The electronics unit may be constructed utilizing plug in modules; however, when plug in modules are used, each electronics unit must be identical except for the number and type of modules used. Ensure that modules of the same type are identical and interchangeable.~~

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

2. Should more than two electronics units be required in the same cabinet, ensure that each electronics unit has a unique, individual electronics unit number. The electronics unit number must reside in non-volatile memory, so that it is not changed when a "cold or warm boot" is performed or by a power interruption.

Provide an electronics unit having the capability of obtaining and providing the following:

1. Volume, speed, classification, and classification by speed data simultaneously.

2. Volume data by lane.

3. Speed data by lane in a minimum of 15 bins, programmable in 5 mph increments.

4. Classification by lane in vehicle type by axle class in 15 bins (minimum) in accordance with FHWA Classification Scheme "F" in Florida's Traffic Forecasting Handbook, Chapter 2, Figure 2.2 which can be accessed on the Department's website at the following URL address:

[https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/systems/systems-management/document-repository/traffic-analysis/2019-project-traffic-forecasting-handbook.pdf?sfvrsn=e105e71d\\_2](https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/systems/systems-management/document-repository/traffic-analysis/2019-project-traffic-forecasting-handbook.pdf?sfvrsn=e105e71d_2).

5. A minimum of 95% accuracy of vehicle class, speed and volume.

Ensure that each electronics unit has the capability of providing real-time monitoring of volume data by lane or direction in user selected intervals of as little as 15 minutes, when required, without disrupting the above selected programs.

Provide an electronics unit capable of communicating directly with a PC or through a modem at a minimum rate of 19,200 bps.

Ensure that, at a minimum, the following parameters are programmable by direct connection to the electronics unit by Ethernet or via modem:

1. Six digit site number.

2. Number of lanes and directions.

3. Date and time.

4. Data operating and transmission parameters.

5. Sensor spacing.

6. Recording interval.

7. Vehicle parameter table with axle spacing ranges for each type of vehicle.

8. Number and range of speed categories, axle and length classifications, and headway.

Should an axle sensor or a loop in one or more lanes fail, the electronics unit must continue to provide the speed and volume from the remaining functioning sensors.

Ensure that the sensitivity level for each axle sensor is individually adjustable using software, by direct PC connection and remotely via telemetry.

Ensure that the loop detectors are internal and self-tuning. Ensure that the sensitivity level and any additional parameters necessary to prevent "loop crosstalk" for each embedded inductive loop can be adjusted individually using software, both by direct PC connection and remotely via telemetry.

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

Provide a means of introducing a time delay, or “de-bounce” value for ignoring spurious axle signals (ghost axles) in the electronics unit software.

**695-4.2.4 Power Requirements:** Provide an electronics unit that is field configurable to be powered 12 V<sub>DC</sub> and does not consume more than a total of 12 watts.

If an internal battery is required, it must be capable of being recharged and shall be furnished and included with the electronics unit at no extra cost.

**695-4.2.5 Mechanical Requirements:** Provide a modular electronics unit which is completely enclosed in a durable housing of sheet metal or cast aluminum with a durable finish. When configured for operation the electronics unit including all cables must fit into a Type IV cabinet.

**695-4.2.6 Environmental Requirements:** Provide an electronics unit which operates as specified when the ambient temperature and humidity inside the controller cabinet are within the following limits:

**695-4.2.6.1 Ambient Temperature:** The operating ambient temperature range must be between minus 0 to 140°F.

The rate of change in ambient temperature must not exceed 63°F per hour, during which the relative humidity must not exceed 90%.

**695-4.2.6.2 Humidity:** The relative humidity must not exceed 90% over the temperature range of 40 to 109°F. Above 109°F, constant absolute humidity must be maintained as seen in Table 695-1. The relative humidity range shown in Table 695-1 is for dynamic testing.

Dry Bulb °F	Relative Humidity (%)	Wet Bulb °F
40	75	37
50	80	46
60	83	57
70	86	66
80	87	77
90	89	88
100	89	97
109	90	108
120	70	109
130	50	109
140	38	109
150	28	109
160	21	109
165	18	109

**695-4.2.7 Cables and Connectors:** Furnish all cables and connectors for a complete and functional installation of each electronics unit in accordance with Standard Plans, Index 695-001.

Ensure that the cables are properly terminated for the prescribed use without further modification by the Department.

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

~~\_\_\_\_\_ Furnish one serial port cable for interconnecting each electronics unit with a PC.~~

**695-4.3-2 Installation Requirements:** ~~Install~~ Furnish and install the electronics unit and equipment cables in accordance with the manufacturer's recommended installation procedure, Standard Plans, Index 695-001, and the Contract Documents.

Ensure that the cables are properly terminated for the prescribed use without further modification by the Department.

~~\_\_\_\_\_ Furnish one serial port cable for interconnecting each electronics unit with a PC.~~

**695-4.3 Test Requirements:** The electronics unit must collect and distribute vehicle speed and classification data during the 14 day operational testing period and at final acceptance. Remove and replace any unit that fails the operation test at no additional charge to the Department.

~~\_\_\_\_\_ 695-4.4 Method of Measurement: The Contract unit price per assembly for electronics unit includes the electronics unit and equipment cable, all equipment, materials and labor necessary for a complete and accepted installation.~~

~~\_\_\_\_\_ 695-4.5 Basis of Payment: Prices and payments will be full compensation for all work specified in this Section.~~

~~\_\_\_\_\_ Payment will be made under:~~

~~Item No. 695-3 \_\_\_\_\_ TMS Vehicle Speed/Classification Unit \_\_\_\_\_ per assembly.~~

## **695-5 Weigh-In-Motion Electronic Unit Sensor.**

**695-5.1 General:** ~~Install Traffic Monitoring Site (TMS) Weigh In Motion Electronic Sensor in the configuration shown on the Standard Plans, Index 695-001, and meet the requirements in Section 997.~~ Furnish and install the vehicle weigh-in-motion (WIM) unit in the TMS cabinet at the locations shown in the Plans.

Ensure that the WIM unit and equipment cables are compatible and constructed in accordance with the Standard Plans.

Ensure that the WIM unit markings are visible after installation.

**695-5.2 Materials Installation Requirements:** ~~Use Weigh In Motion Electronic Sensors that meet the requirements of Section 997 and are listed on the Department's Approved Products List (APL).~~

~~Use bonding agents listed on the APL and which are compatible with the Weigh In Motion sensor being installed.~~ Furnish and install the electronics unit and equipment cables in accordance with the manufacturer's recommended installation procedure, Standard Plans, Index 695-001, and the Contract Documents.

Ensure that the cables are properly terminated for the prescribed use without further modification by the Department.

**695-5.3 Test Installation Requirements:** The electronics unit must collect and distribute weigh-in-motion data during the 30 day operational testing period and at final acceptance. Remove and replace any unit that fails the operation test at no additional charge to the Department.

~~\_\_\_\_\_ 695-5.3.1 General: The installer must have a valid certification from the manufacturer for installing the Weigh In Motion Electronics Sensors.~~

~~\_\_\_\_\_ All lead in cables shall have 3 feet of slack tied inside the pull box and 3 feet inside the cabinet.~~

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

————— To avoid delays during installation, compile and check all construction tools required for the installation before beginning.

————— **695-5.3.2 Saw Cuts:** Use a chalk line or equivalent method to outline the perimeter of the sensor on the pavement and routes for lead-in cables. Do not allow the saw cut in the pavement to deviate more than 1.0 inch from the chalk line. Ensure that all saw cuts are free of any dust, dirt, or other debris and completely dry prior to the installation.

————— **695-5.4 Bending Plate:** Install two weigh pads adjacent to each other or in each wheel path in a staggered array to cover a 12-foot lane in the roadway. Connect the weigh pads to an interface processor.

————— Install the bending plate (weigh pad) frames into concrete slabs of 6 inches or more without constructing a special foundation socket. The frames, including weigh pad embedded in it, have an average depth of 1.5 inches.

————— If the concrete slab is less than 6 inches or if the roadway material is asphaltic concrete, install a special foundation socket of concrete under the frame, just as wide as the frame. Bore 1-inch diameter anchors to a minimum of 8 inches into the base course.

————— Install a 2 to 4-inch diameter pipe from lower side of the foundation frame towards the slope into the drain water shaft. Ensure that water does not accumulate in the frame and properly drains the frame.

————— Install a temperature sensor in the roadway or paved shoulder to monitor pavement temperature. Ensure that the sensor provides data to the vehicle/speed classification unit to compensate for temperature variation.

————— Install the bending plate sensors in accordance with the manufacturer's installation procedures and in the presence of the manufacturer's representative. Ensure that the procedures are approved by the Engineer.

————— **695-5.5 Piezoelectric Weigh-In-Motion Axle Sensor:** Install piezoelectric sensors in concrete or asphaltic concrete roadways. Install two 6-foot piezoelectric Weigh-In-Motion sensors (Class I) in each pathway per lane, in a staggered array in accordance with Standard Plans, Index 695-001. Place the leading Piezoelectric Weigh-In-Motion sensor (Class I) onto the right side edge of the driving lane perpendicular to the flow of the traffic, covering half of the lane width (6 feet). Place the trailing Piezoelectric Weigh-In-Motion Sensor (Class I) onto the left side edge of the driving lane (6 feet). Orient all lead-in cables and connectors toward the nearest pull box, beyond the outside travel lanes. Ensure that the end of the sensor element or channel is centered on the lane stripe.

————— Install a temperature sensor in the roadway or paved shoulder to monitor pavement temperature to compensate for temperature variation.

————— Install piezoelectric Weigh-In-Motion axle sensors in accordance with the manufacturer's installation procedures and in the presence of the manufacturer's representative.

————— **695-5.5.1 Piezoelectric Weigh-In-Motion Axle Sensor (Class I):** Install the unencapsulated piezoelectric Weigh-In-Motion sensor (Class I) by sawing a slot into the pavement perpendicular to the flow of traffic, equal to the length of the sensor plus 4 inches, by 3/4 inch wide, and by 1 inch deep. Sawcut a 1-inch wide by 2 inches deep cable-run slot from the end of the sensor slot to the edge of the pavement shoulder.

————— Suspend the sensor within the slot with jigs. Prepare and apply bonding agent in accordance with the sensor manufacturer instructions, ensuring that there are no voids around the sensor. Ensure that the bonding agent is fully cured and ready for traffic within four hours of application. Remove the jigs after the bonding agent has cured.

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

Route the sensor lead-in cables to the pull box and through the conduit to the traffic monitoring site cabinet. Mark the sensor lead-in cables at the pull boxes and at the point of termination within the traffic monitoring site cabinet with an indelible marker, numbering the lanes as specified in the Plans and in accordance with the Standard Plans, Index 695-001.

**695-5.5.2 Quartz Piezoelectric Weigh-In-Motion Sensor:** Install the quartz piezoelectric sensor by sawing slots into the pavement perpendicular to the flow of traffic, equal to the length of the sensor plus 1 inch, by 2.875 inches wide, and by 2.125 inches deep. Sawcut a 1 inch wide by 2 inches deep cable run slot from the end of the sensor slot to the edge of the pavement shoulder.

Install the quartz piezoelectric sensor into the slot, properly aligned and positioned using specially constructed installation and leveling beams. Pour the manufacturer recommended epoxy grout into the cavity until it is at the proper height above the road surface and allow it to set. After the epoxy hardens, grind it to be level with the road surface. The top of the sensor must not deviate more than 1/24" above the height of the pavement surface over the length of the sensor.

Route the sensor lead-in cables to the pull box and through the conduit to the traffic monitoring site cabinet. Mark the sensor lead-in cables at the pull boxes and at the point of termination within the traffic monitoring site cabinet with an indelible marker, in accordance with Standard Plans, Index 695-001. Connect the cable to the interface card installed in the traffic monitoring cabinet.

**695-5.6 Weigh-In-Motion Electronics Sensor Test Requirements:** Perform the manufacturer's recommended on-site pre-installation test to determine the Weigh-In-Motion electronics sensor's condition. Install only those Weigh-In-Motion electronics sensors that pass the pre-installation test.

Repeat the test, following installation, at the lead-in point of connection in the traffic monitoring site cabinet. Remove and replace any Weigh-In-Motion electronics sensor which fails the test at no additional cost to the Department. Prior to post-installation acceptance, the Contractor shall demonstrate in the presence of the Engineer that the equipment supplied and installed for the system is in full compliance with the Plans and Specification herein.

The Department will operate the complete system for 30 consecutive days without failures prior to Final Acceptance. The Department will poll the site and statistically check data from historical data, field-collected data and field observations. In the event of failures, the Contractor shall correct the problem(s) and restart the 30-day test. Any equipment or labor that is found to be defective prior to Final Acceptance shall be replaced or corrected at no expense to the Department. Final Acceptance will be made upon the successful completion of the 30-day test.

Place a copy of the final test results, including the date of installation, manufacturer's name, model number for each Weigh-In-Motion electronics sensor, laboratory calibration sheet provided by the manufacturer, and type of bonding agent used in a waterproof package in the cabinet and furnish one copy to the Engineer.

**695-5.7 Guaranty Provisions:**

**695-5.7.1 Contractor's Responsibility:** Secure all guaranties that are customarily issued by the equipment manufacturers for the specific equipment included in the Contract. Ensure that the form in which such guaranties are delivered includes the provision that they are

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

subject to transfer to the Department and is accompanied by proper validation of such fact. Transfer guaranties at final acceptance of the work (or equipment) by the Department.

~~—————~~ **695-5.7.2 Terms:** Ensure that the manufacturers of the equipment stipulate the terms of guaranties when submitting a request to the Department for certification and for equipment submittal for construction projects. Include terms for a specified service performance with provisions for repair parts and labor, or for replacement. Provisions shall define the equipment "installation date" as the date for such guaranty to be in effect. For construction projects, the "installation date" is the first day of equipment "burn-in". For warehouse purchases, the "installation date" is the date of visual inspection approval, not to exceed ten days after delivery date.

~~—————~~ **695-5.7.3 Conditions:** When guaranty is available, ensure that a written and signed guaranty accompanies the manufacturer's billing invoice. The Engineer will sign and retain the original and provide a copy to the manufacturer. If the Contractor does not comply with the terms of the guaranty, the Department may suspend the certification. Comply with additional terms and conditions as stated in purchasing agreements.

~~—————~~ **695-5.8 Method of Measurement:**

~~—————~~ The Contract unit price for each Weigh In Motion Electronics Sensor, furnished and installed, will consist of the Weigh In Motion sensor, temperature sensor, lead-in cable(s); Manufacturers' recommended bonding agent, all equipment, materials, and labor necessary for a complete and accepted installation.

~~—————~~ **695-5.9 Basis of Payment:**

~~—————~~ Price and payment will be full compensation for all work specified in this Section. Payment will be made under:

~~Item No. 695-9 ——— TMS Weigh In Motion Electronics sensor — each.~~

## **695-6 Solar Power Unit Non-Motorized Data Collection Unit.**

~~695-6.1 General:~~ Install TMS solar power units at the locations and as shown in the Plans and Standard Plans. Solar power units are used to power TMS that collect vehicular data on a continuous basis. The solar power unit consists of the following components: solar panel(s) and mounting hardware; 12 V storage battery; and voltage regulator with wiring and associated mounting hardware. Furnish and install the non-motorized data collection unit in the TMS cabinet at the locations shown in the Plans.

Ensure that the non-motorized data collection unit and equipment cables are compatible and constructed in accordance with the Standard Plans.

Ensure that the data collection unit markings are visible after installation.

~~695-6.2 Materials Installation Requirements:~~ Use solar power unit components listed on the Department's APL meeting the requirements of Section 997 and compatible with the other components installed at the location. Ensure that the solar power unit is marked in accordance with Section 997 and the markings are visible after installation. Furnish and install the electronics unit and equipment cables in accordance with the manufacturer's recommended installation procedure, Standard Plans, Index 695-001, and the Contract Documents.

Ensure that the cables are properly terminated for the prescribed use without further modification by the Department.

~~695-6.3 Installation Test Requirements:~~ Install the solar power units in accordance with the manufacturer's recommended installation procedure, Standard Plans, Index 695-001 and the Contract Documents.

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

~~695-6.3.1 Pole Placement:~~ Ensure that the pole is placed to allow for the proper placement of the solar panels.

~~695-6.3.2 Solar Panel Orientation:~~ Mount and orient the solar panels to the south. Angle the solar panels in accordance with Standard Plans, Index 695-001.

~~Install a weather head and route the wires in accordance with Standard Plans, Index 695-001. The electronics unit must collect and distribute non-motorized data during the 14 day operational testing period and at final acceptance. Remove and replace any unit that fails the operation test at no additional charge to the Department.~~

~~695-6.4 Testing Requirements:~~ Solar panels must have 20% efficiency rating and must be tested by setting the multi-meter to volts setting and connecting the positive lead to the solar panel's positive wire. Then connect the multi-meter's negative lead to the solar panel's negative wire. The volt reading on the multi-meter should be no less than 20 volts. If the volts are less, then there is a problem with the solar panel output. Go back and check all connections of the solar panel and check for cracks in the solar cells. Next test the solar panel for amperage by setting the multi-meter to amps setting and follow the above mentioned steps. The amp reading should be no less than 4.25 amps. If the amperage is less, then there is a problem with the solar panel output. Go back and check all the connections of the solar panel and check for cracks in the solar cells.

~~695-6.5 Method of Measurement:~~ The Contract unit price for each solar power unit includes the solar power unit as specified in the Contract Documents, all equipment, materials, and labor necessary for a complete and accepted installation.

~~695-6.6 Basis of Payment:~~ Price and payment will be full compensation for all work specified in this Section.

~~Payment will be made under:~~

~~Item No. 695-6 TMS Solar Power Unit each.~~

### **695-5.7 Weigh-In-Motion Electronic Sensor.**

~~695-5.7.1 General:~~ The weigh-in-motion (WIM) lane consists of WIM sensors and inductive loops sensors. The first type of WIM sensor, strain gauge sensor, is described in 695-7.3. The second type of WIM sensor, quartz piezoelectric weigh-in-motion sensor, is described in 695-7.4. The inductive loop assembly is described in 695-10. ~~Install~~ Furnish and install the Traffic Monitoring Site (TMS) Weigh-In-Motion Electronic Sensor in the configuration shown on the Standard Plans, Index 695-001, ~~and meet the requirements in Section 997.~~ Install in accordance with Manufacturer's instructions.

~~695-5.2 Materials:~~ Use Weigh-In-Motion Electronic Sensors that meet the requirements of Section 997 and are listed on the Department's Approved Products List (APL). Use bonding agents listed on the APL and which are compatible with the Weigh-In-Motion sensor being installed.

#### ~~695-5.3.2 Installation Requirements:~~

~~695-5.3.1 General:~~ The installer must have a valid certification from the manufacturer for installing the Weigh-In-Motion Electronics Sensors.

~~All lead in cables shall have 3 feet of slack tied inside the pull box and 3 feet inside the cabinet.~~

~~To avoid delays during installation, compile and check all construction tools required for the installation before beginning.~~

~~695-5.3.2 Saw Cuts:~~ Use a chalk line or equivalent method to outline the perimeter of the sensor on the pavement and routes for lead-in cables. Do not allow the saw cut

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in the pavement to deviate more than 1.0 inch from the chalk line. Ensure that all saw cuts are free of any dust, dirt, or other debris and completely dry prior to the installation.

**695-57.4.3 Bending Plate Strain Gauge Sensor:** Install two ~~weigh pads~~ strain gauge sensors ~~adjacent to~~ in line with each other ~~or~~ in each wheel path ~~in a staggered array~~ to cover a 12-foot lane in the roadway. Connect the ~~weigh pads~~ strain gauge sensors to an interface processor.

Install the ~~bending plate~~ strain gauge sensor (weigh pad) frames into concrete slabs of 6 inches or more without constructing a special foundation socket. The frames, including ~~weigh pad~~ strain gauge sensor embedded in it, have an average depth of 1.5 inches.

If the concrete slab is less than 6 inches or if the roadway material is asphaltic concrete, install a special foundation socket of concrete under the frame, just as wide as the frame. Bore 1-inch diameter anchors to a minimum of 8 inches into the base course.

Install a 2 to 4 inch diameter pipe from lower side of the foundation frame towards the slope into the drain water shaft. Ensure that water does not accumulate in the frame and properly drains the frame.

~~Install a temperature sensor in the roadway or paved shoulder to monitor pavement temperature. Ensure that the sensor provides data to the vehicle/speed classification unit to compensate for temperature variation.~~

Install the ~~bending plate~~ strain gauge sensors in accordance with the manufacturer's installation procedures and in the presence of the manufacturer's representative. Ensure that the procedures are approved by the Engineer.

~~**695-5.5 Piezoelectric Weigh-In-Motion Axle Sensor:** Install piezoelectric sensors in concrete or asphaltic concrete roadways. Install two 6-foot piezoelectric Weigh-In-Motion sensors (Class I) in each pathway per lane, in a staggered array in accordance with Standard Plans, Index 695-001. Place the leading Piezoelectric Weigh-In-Motion sensor (Class I) onto the right side edge of the driving lane perpendicular to the flow of the traffic, covering half of the lane width (6 feet). Place the trailing Piezoelectric Weigh-In-Motion Sensor (Class I) onto the left side edge of the driving lane (6 feet). Orient all lead-in cables and connectors toward the nearest pull box, beyond the outside travel lanes. Ensure that the end of the sensor element or channel is centered on the lane stripe.~~

~~Install a temperature sensor in the roadway or paved shoulder to monitor pavement temperature to compensate for temperature variation.~~

~~Install piezoelectric Weigh-In-Motion axle sensors in accordance with the manufacturer's installation procedures and in the presence of the manufacturer's representative.~~

~~**695-5.5.1 Piezoelectric Weigh-In-Motion Axle Sensor (Class I):** Install the unencapsulated piezoelectric Weigh-In-Motion sensor (Class I) by sawing a slot into the pavement perpendicular to the flow of traffic, equal to the length of the sensor plus 4 inches, by 3/4 inch wide, and by 1 inch deep. Sawcut a 1 inch wide by 2 inches deep cable run slot from the end of the sensor slot to the edge of the pavement shoulder.~~

~~Suspend the sensor within the slot with jigs. Prepare and apply bonding agent in accordance with the sensor manufacturer instructions, ensuring that there are no voids around the sensor. Ensure that the bonding agent is fully cured and ready for traffic within four hours of application. Remove the jigs after the bonding agent has cured.~~

~~Route the sensor lead-in cables to the pull box and through the conduit to the traffic monitoring site cabinet. Mark the sensor lead-in cables at the pull boxes and at the point of termination within the traffic monitoring site cabinet with an indelible marker,~~

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~~numbering the lanes as specified in the Plans and in accordance with the Standard Plans, Index 695-001.~~

~~—————~~ **695-57.54.2 Quartz Piezoelectric Weigh-In-Motion Sensor:** Install two quartz piezoelectric sensors in line with each other in each wheel path to cover a 12-foot lane in the roadway.

Install the quartz piezoelectric sensor by sawing slots into the pavement perpendicular to the flow of traffic, equal to the length of the sensor plus 1 inch, by 2.875 inches wide, and by 2.125 inches deep. Sawcut a 1 inch wide by 2 inches deep cable run slot from the end of the sensor slot to the edge of the pavement shoulder.

————— Install the quartz piezoelectric sensor into the slot, properly aligned and positioned using specially constructed installation and leveling beams. Pour the manufacturer recommended ~~epoxy grout~~ adhesive bonding agent into the cavity until it is at the proper height above the road surface and allow it to set. After the ~~epoxy~~ adhesive bonding agent hardens, grind it to be level with the road surface. The top of the sensor must not deviate more than 1/24" above the height of the pavement surface over the length of the sensor.

————— Route the sensor lead-in cables to the pull box and through the conduit to the traffic monitoring site cabinet. Mark the sensor lead-in cables at the pull boxes and at the point of termination within the traffic monitoring site cabinet ~~with an indelible marker~~, in accordance with Standard Plans, Index 695-001. Connect the cable to the interface card installed in the traffic monitoring cabinet.

**695-57.65 Weigh-In-Motion Electronics Sensor Test Requirements:** Perform the manufacturer's recommended on-site pre-installation test to determine the Weigh-In-Motion electronics sensor's condition. Install only those Weigh-In-Motion electronics sensors that pass the pre-installation test.

Repeat the test, following installation, at the lead-in point of connection in the traffic monitoring site cabinet. Remove and replace any Weigh-In-Motion electronics sensor which fails the test at no additional cost to the Department. Prior to post-installation acceptance, the Contractor shall demonstrate in the presence of the Engineer that the equipment supplied and installed for the system is in full compliance with the Plans and Specification herein.

The Department will operate the complete system for 30 consecutive days without failures prior to Final Acceptance. The Department will poll the site and statistically check data from historical data, field collected data and field observations. In the event of failures, the Contractor shall correct the problem(s) and restart the 30-day test. Any equipment or labor that is found to be defective during the operation test and prior to Final Acceptance shall be replaced or corrected at no expense to the Department. Final Acceptance will be made upon the successful completion of the 30-day test.

Place a copy of the final test results, including the date of installation, manufacturer's name, model number for each Weigh-In-Motion electronics sensor, laboratory calibration sheet provided by the manufacturer, and type of adhesive bonding agent used in a waterproof package in the cabinet and furnish one copy to the Engineer.

~~—————~~ **695-5.7 Guaranty Provisions:**

~~—————~~ **695-5.7.1 Contractor's Responsibility:** ~~Secure all guaranties that are customarily issued by the equipment manufacturers for the specific equipment included in the Contract. Ensure that the form in which such guaranties are delivered includes the provision that they are subject to transfer to the Department and is accompanied by proper validation of such fact. Transfer guaranties at final acceptance of the work (or equipment) by the Department.~~

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~~695-5.7.2 Terms: Ensure that the manufacturers of the equipment stipulate the terms of guaranties when submitting a request to the Department for certification and for equipment submittal for construction projects. Include terms for a specified service performance with provisions for repair parts and labor, or for replacement. Provisions shall define the equipment "installation date" as the date for such guaranty to be in effect. For construction projects, the "installation date" is the first day of equipment "burn-in". For warehouse purchases, the "installation date" is the date of visual inspection approval, not to exceed ten days after delivery date.~~

~~695-5.7.3 Conditions: When guaranty is available, ensure that a written and signed guaranty accompanies the manufacturer's billing invoice. The Engineer will sign and retain the original and provide a copy to the manufacturer. If the Contractor does not comply with the terms of the guaranty, the Department may suspend the certification. Comply with additional terms and conditions as stated in purchasing agreements.~~

~~695-5.8 Method of Measurement:~~

~~The Contract unit price for each Weigh In Motion Electronics Sensor, furnished and installed, will consist of the Weigh In Motion sensor, temperature sensor, lead-in cable(s), Manufacturers' recommended bonding agent, all equipment, materials, and labor necessary for a complete and accepted installation.~~

~~695-5.9 Basis of Payment:~~

~~Price and payment will be full compensation for all work specified in this Section. Payment will be made under:~~

~~Item No. 695-9 TMS Weigh In Motion Electronics sensor each.~~

**695-8 Non-Motorized Sensor Applications.**

**695-8.1 General:** The non-motorized site uses axle sensors, inductive loops sensors, and infrared sensors. The inductive loop assembly is described in 695-10. Furnish and install TMS non-motorized sensors of the type and at the location shown in the Plans and Index 695-001.

**695-8.2 Non-motorized Axle Sensor:**

**695-8.2.1 Installation Requirements:** Allow newly applied friction course to cure for a minimum of 30 days prior to the installation of in-path sensors.

Ensure axle sensors are installed in the pathway and secured using an adhesive bonding agent as listed on the APL.

Cut the slot the length of the axle sensor plus an additional 3 to 4 inches. Ensure the depth and width of the slot is installed as recommended by the sensor manufacturer. Ensure that all saw cuts are free of any dust, dirt, or other debris and completely dry prior to the installation.

Use clips or jigs provided by the manufacturer to suspend the sensor at a uniform depth in the slot. Mix and apply the adhesive bonding agent ensuring the slot is completely full with no voids beneath the sensor. Once cured, grind down excess adhesive bonding agent to be level with the road surface, sidewalk, side path, or shared-use path.

**695-8.2.2 Test Requirements:** Perform the manufacturer's recommended on-site pre-installation test to determine the sensor's condition using an Inductive Capacitance Resistance meter. Install only those sensors that pass the pre-installation test. Record all test results on the warranty form provided by the manufacturer and leave a copy in the cabinet.

Repeat the test at the termination point in the cabinet after installation. Use an oscilloscope to view and record typical waveforms and signal intensity measurements for the axles of non-motorized vehicles.

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

Connect a personal computer (PC) to the electronics unit and observe bicycles and pedestrians in the pathway, verifying the detection of each non-motorized vehicle on-screen. A minimum of 20 non-motorized vehicles shall be observed with all non-motorized vehicle manually counted.

If any non-motorized vehicles are not counted by the sensor, reconfigure the sensor and repeat the visual observation test until all are counted correctly. If the sensor fails to provide accurate counts after 3 test attempts, it must be replaced with a new unit at no expense to the Department.

The sensor shall operate without any deficiencies for two weeks after installation and at final acceptance. Remove and replace any sensor that fails the 14 day operation test at no additional charge to the Department.

Submit all documents to the Engineer and leave a copy of the report in the cabinet.

### **695-8.3 Infrared Sensors:**

**695-8.3.1 Installation Requirements:** For grade level applications, install the sensor perpendicular to the pathway and pointed parallel to the ground. The sensor shall not point towards the vehicular traffic lane, reflective surfaces, direct sunlight exposure, or moving infrastructure. Ensure that the sensor has sufficient cable length to reach the cabinet without splicing.

For overhead applications, route the cable within the pole cavity or conduit to the cabinet termination point. Provide 18 to 24 inches of slack in the cable at the connections to the sensor and in the cabinet to ensure the cable is stress-free. Include the appropriate mounting hardware as a part of the installation.

Set up the detection zones using the manufacturer's instructions and software and verify that the sensor's orientation is perpendicular to the pathway.

Configure the sensor for pedestrian and bicycle traffic.

**695-8.3.2 Test Requirements:** Conduct a visual test to determine that all detection zones are being counted accurately.

Connect a personal computer (PC) to the electronics unit and observe traffic in the pathway, verifying that each non-motorized vehicle or pedestrian is displayed on-screen. A minimum of 20 non-motorized vehicles and 20 pedestrians shall be observed with all non-motorized vehicles and pedestrians counted.

If any non-motorized vehicles or pedestrians are not counted, reconfigure the infrared sensor and repeat the visual observation test until all are counted correctly. If the sensor fails to provide accurate counts after 3 test attempts, it must be replaced with a new unit at no expense to the Department.

The sensor shall operate without any deficiencies for two weeks after installation and at final acceptance. Remove and replace any sensor that fails the 14 day operation test at no additional charge to the Department.

Submit all documents to the Engineer and leave a copy of the report in the cabinet.

### **695-6-9 TMS Solar Power Unit.**

**695-6-9.1 General:** ~~Install~~ Furnish and install TMS solar power units at the locations and as shown in the Plans and Standard Plans. Solar power units are used to power TMS that collect vehicular data and non-motorized data on a continuous basis. The solar power unit consists of the

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following components: solar panel(s) and mounting hardware; 12 V storage battery; and voltage regulator with wiring and associated mounting hardware.

~~695-6.2 Materials: Use solar power unit components listed on the Department's APL meeting the requirements of Section 997 and compatible with the other components installed at the location. Ensure that the solar power unit is marked in accordance with Section 997 and the markings are visible after installation.~~

~~695-6.3 Installation Requirements: Install the solar power units in accordance with the manufacturer's recommended installation procedure, Standard Plans, Index 695-001 and the Contract Documents.~~

~~695-6.3.1 Pole Placement: Ensure that the pole is placed to allow for the proper placement of the solar panels.~~

~~695-6.3.2 Solar Panel Orientation: Mount and orient the solar panels to the south. Angle the solar panels in accordance with Standard Plans, Index 695-001.~~

~~Install a weather head and route the wires in accordance with Standard Plans, Index 695-001.~~

**695-6.4.2 Testing Requirements:** Solar panels ~~must have 20% efficiency rating and~~ must be tested by setting the multi-meter to volts setting and connecting the positive lead to the solar panel's positive wire. Then connect the multi-meter's negative lead to the solar panel's negative wire. The volt reading on the multi-meter should be no less than 20 volts. If the volts are less, then there is a problem with the solar panel output. Go back and check all connections of the solar panel and check for cracks in the solar cells. Next test the solar panel for amperage by setting the multi-meter to amps setting and follow the above-mentioned steps. The amp reading should be no less than 4.25 amps. If the amperage is less, then there is a problem with the solar panel output. Go back and check all the connections of the solar panel and check for cracks in the solar cells.

The panels shall operate without any deficiencies for two weeks after installation and at final acceptance. Remove and replace any panels that fail the 14 day operation test at no additional charge to the Department.

Submit all documents to the Engineer and leave a copy of the report in the cabinet. ~~695-6.5 Method of Measurement: The Contract unit price for each solar power unit includes the solar power unit as specified in the Contract Documents, all equipment, materials, and labor necessary for a complete and accepted installation.~~

~~695-6.6 Basis of Payment: Price and payment will be full compensation for all work specified in this Section.~~

~~Payment will be made under:  
Item No. 695-6 TMS Solar Power Unit each.~~

## **695-7.10 Inductive Loop Assembly.**

**695-7.10.1 General:** Install TMS motorized inductive loop assembly and non-motorized inductive loop assembly at the locations shown in the Plans ~~meeting the requirements of this specification~~. Ensure that all materials furnished, assembled, or installed are new products.

~~695-7.2 Materials: Furnish and install inductive loop assembly components listed on the Department's APL that are compatible with the other components installed at the location.~~

~~695-7.2.1 Loop Wire: Use~~ Install loop wire in accordance with Standard Plans, Index 695-001. Install the inductive loops such that the loop leads reach the cabinet. Do not splice loop leads.

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~~695-7.2.2 Shielded Lead-In Cable: Use shielded lead-in cable in accordance with Standard Plans, Index 695-001.~~

~~695-7.2.3 Splicing: No splicing loop wire less than 150 feet.~~

~~695-710.3.2 Installation Requirements: Install inductive loop assembly components and materials in accordance with the Plans and the Standard Plans.~~

~~695-710.3.2.1 Saw Cuts: Loop layout will be as shown in Standard Plans, Index 695-001.~~

Perform saw cuts across concrete pavement expansion joints as detailed in Standard Plans, Index 695-001.

For pavement thickness less greater than or equal to 3-2 inches deep, make saw cuts deep enough to allow 1 to 1-1/2 inch of sealant cover over the installed loop wire.

For pavement thickness less than 2 inches, make the saw cut depth to 1 inch.

**695-710.3.2.2 Loop Wire:** Ensure that all motorized vehicular loops have four complete turns of wire and all non-motorized vehicle loops have eight complete turns of No. 14 AWG stranded copper wire that meet the requirements of International Municipal Signal Association (IMSA) 51-7, wound in a clockwise manner. Do not damage the insulation.

~~Ensure~~ For roadways, ensure that the hold down material is non-metallic; placed in the saw slot using segments 1 to 2 inches long, spaced 12 inches apart; and the distance from the top of the hold down material to the final roadway surface is not less than 1-1/2 inches.

For sidewalks, side paths, or shared use paths, the distance from the top of the non-metallic hold down material to final surface elevation must be 1/2 inch or greater. Install inductive loops in the pathway and secure using loop sealant listed on the APL. Avoid installation of inductive loops in areas that have electromagnetic interference from power lines (overhead or underground), or buried telecommunication equipment or in the proximity of other inductive loops.

**695-710.3.2.3 Loop Wire Twisted Pair Lead:** For motorized vehicular loops, ~~c~~ Create a loop wire twisted pair lead by twisting the loop wire pair a minimum of 8 to 16 twists per foot from the edge of the loop to the termination point in the cabinet. Provide a minimum of 3 feet of twisted loop wire pair lead in the pull box located adjacent to the roadway.

For non-motorized vehicle loops, create a loop wire twisted pair lead by twisting the loop wire pair 10 twists per foot from the edge of the loop to the termination point. Splicing of the loop wire is not permitted.

**695-710.3.2.4 Loop Sealant:** Use loop sealant in accordance with Section ~~660~~997. Prepare and apply the sealant in accordance with the manufacturer's instructions. Remove excess sealant from the roadway surface. Ensure that the loop sealant has cured completely before allowing vehicular traffic to travel over the sealant.

~~695-7.3.5 Shielded Lead-In Cable: Install the shielded lead-in cable and perform all splices in accordance with Standard Plans, Index 695-001.~~

~~Ensure that the shielded lead-in cable is of sufficient length to extend through the conduits to the cabinet without additional splicing.~~

**695-710.4.3 Testing:** Conduct all testing with the leads disconnected from the backplane. The loops shall operate without any deficiencies for two weeks after installation. Remove and replace any loop that fails the 14 day operation test at no additional charge to the Department. Submit all documents to the Engineer and leave a copy of the report in the cabinet.

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**695-710.43.1 Motorized Vehicular Loop Resistance:** Ensure new loops have a resistance reading of 3.0  $\Omega$  or less.

**695-710.43.2 Motorized Vehicular Loop Inductance:** Ensure new loops have a minimum inductance reading of 100  $\mu\text{H}$ . ~~M $\Omega$~~

**695-710.43.3 Motorized Vehicular Loop Insulation Resistance (Megging):** Ensure new loops have a minimum reading of 200 M $\Omega$  at 500 V.

**695-10.3.4 Non-Motorized Vehicular Loop Resistance:** Ensure new loops have a resistance reading of 3.0  $\Omega$  or less.

**695-10.3.5 Non-Motorized Vehicular Loop Inductance:** Ensure new loops have an inductance reading of 100 to 150  $\mu\text{H}$ .

**695-10.3.6 Non-Motorized Vehicular Loop Insulation Resistance (Megging):** Ensure new loops have a minimum reading of 200 M $\Omega$  at 500 V.

~~695-7.5 Method of Measurement: The Contract unit price for each inductive loop assembly includes loop wire, loop sealant and shielded lead in cable, all equipment, materials, and labor necessary for a complete and accepted installation.~~

~~695-7.6 Basis of Payment: Prices and payments will be full compensation for all work specified in this Section, except conduit and pull and junction boxes.~~

~~Conduit will be paid for as specified in Section 630 and pull and junction boxes will be paid for as specified in Section 635.~~

~~Payment will be made under:~~

~~Item No. 695-6 TMS Inductive Loop Assembly each.~~

### **695-8-11 Site TMS Cabinet.**

**695-811.1 General:** ~~Install~~ Furnish and install Type III, IV or V TMS cabinets in accordance with Section 676 and Standard Plans, Index 695-001.

#### **695-811.2 Materials:**

**695-811.2.1 General:** Only use TMS cabinets and components currently listed on the Department's APL. Ensure that the cabinet and components are compatible with the other components installed at the location.

**695-811.2.2 Shelf:** Ensure that the cabinet has an adjustable shelf, constructed of 0.08 inch thick aluminum, that is adjustable to within 15 inches of the top of the cabinet and to within 26 inches of the bottom of the cabinet in 2 inch increments.

**695-811.2.3 Backplane and Cabinet Cable:** Furnish and install as specified in the Standard Plans, Index 695-001.

**695-11.2.4 Suppression Devices:** Furnish and install suppression devices per manufacturers recommendation.

**695-811.3 Installation Requirements:** Install the TMS cabinet in accordance with the Plans, Standard Plans and manufacturer's recommended installation procedure. Ensure that all conduit entrance holes or field drilled holes are reamed and free of burrs. Use clear silicone rubber sealant to make all conduit connections to the cabinet watertight. Perform all excavation and backfill in accordance with 125-4 and 125-8.2.

**695-811.3.1 Pole Mounted Traffic Monitoring Site Cabinets (Types III and IV):** Install pole mounted traffic monitoring site cabinets in accordance with Standard Plans, Index 676-001 and 695-001.

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

**695-811.3.2 Base Mounted (Type IV and V) and Pedestal Mounted (Type III) Traffic Monitoring Site Cabinets:** Install base and pedestal mounted traffic monitoring site cabinets in accordance with Standard Plans, Index 676-001 and 695-001.

Ensure that the end of the conduit riser is a minimum of 2 inches above the finished surface of the concrete base.

~~695-8.4 Method of Measurement:~~ The Contract unit price for each TMS cabinet includes the TMS cabinet, shelf, and backplane components as specified in the Contract Documents, all equipment, materials, and labor necessary for a complete and accepted installation.

~~The cost of the base or pedestal, as shown in the Standard Plans, is included in the cost of the cabinet. The cost of the pole for pole mounts will be paid in accordance with Section 646.~~

~~695-8.5 Basis of Payment:~~ Price and payment will be full compensation for all work specified in this Section.

~~Payment will be made under:  
Item No. 695-7 TMS Cabinet each.~~

**695-9-12 Site TMS System Communications Modem.**

**695-912.1 General:** ~~Install~~ Furnish and install the TMS modem and antenna in the cabinet at the TMS location shown in the Plans.

**695-9.2 Materials:**

~~695-9.2.1 General:~~ Use a TMS modem listed on the Department's APL meeting the requirements of Section 997 and compatible with the other components installed at the location.

~~695-9.2.2 Modem:~~ Furnish and install all cables required to connect the modem to the electronics unit. Furnish and install all including the antenna cables.

~~The device shall be field-configurable to be powered from 12 V<sub>DC</sub>.~~

~~695-9.2.3 Antenna:~~ Use the furnished antenna that meets the requirements in Section 997.

~~695-912.3-2 Commercial Software Registration:~~ Ensure that the Department is registered as the end-user of software installed on the system communications.

**695-912.4-3 Installation Requirements:** Install the TMS modem and antenna in accordance with the manufacturer's recommended installation procedure, ~~unless otherwise specified in the Contract Documents.~~

695-12.4 Test Requirements: The modem and antenna shall operate without any deficiencies for two weeks after installation. The modem and antenna must transmit and receive TMS data during the 14 day operational testing period and at final acceptance. Remove and replace any modem and antenna that fails the operation test at no additional charge to the Department. Submit all documents to the Engineer and leave a copy of the report in the cabinet.

~~695-9.5 Method of Measurement:~~ The Contract unit price for each TMS modem will include the antenna and all equipment, materials, and labor necessary for a complete and accepted installation.

~~695-9.6 Basis of Payment:~~ Price and payment will be full compensation for all work specified in this Section.

~~Payment will be made under:  
Item No. 695-8 TMS System Communications Modem per each~~

Associated with STD 695-001 and Spec 9970000 Note: Numerous moves of original language

### **695-13 TMS Managed Field Ethernet Switch.**

**695-13.1 General:** Furnish and install the Managed Field Ethernet Switch (MFES) in the cabinet at the TMS location shown in the Plans. Furnish and install all cables required to connect the MFES to the cabinet equipment. Furnish and install all fiber optic jumpers required to connect the MFES to the patch panel.

**695-13.2 Installation Requirements:** Install the MFES in accordance with the manufacturer's recommended installation procedure.

**695-13.3 Test Requirements:** The MFES must transmit and receive TMS data over the Department's fiber network. The MFES shall communicate with the TMS central data repository. The MFES must operate within the TMS solar site power and battery backup system constraints. All MFES functions shall be operational during the operational testing period and at final acceptance.

The MFES shall operate without any deficiencies for two weeks after installation. The MFES must transmit and receive TMS data during the 14 day operational testing period and at final acceptance. Remove and replace any MFES that fails the operation test at no additional charge to the Department. Submit all documents to the Engineer and leave a copy of the report in the cabinet.

### **695-14 Method of Measurement.**

The Contract unit price for each vehicle axle sensor will include the vehicle sensor, lead-in cables, adhesive bonding agent; and all equipment, materials, testing and labor necessary for a complete and accepted installation.

The Contract unit price for each non-intrusive vehicle sensor will include the vehicle sensor, cables, conduit, conduit accessories such as the weatherhead and couplings; and all equipment, materials, testing and labor necessary for a complete and accepted installation.

The Contract unit price per assembly for the vehicle speed/classification unit includes the electronics unit and equipment cable, all equipment, materials and labor necessary for a complete and accepted installation.

The Contract unit price per assembly for the weigh-in-motion unit includes the electronics unit and equipment cable, all equipment, materials and labor necessary for a complete and accepted installation.

The Contract unit price per assembly for the non-motorized data collection unit includes the electronics unit and equipment cable, all equipment, materials and labor necessary for a complete and accepted installation.

The Contract unit price for each Weigh-In-Motion Electronics Sensor, furnished and installed, will consist of the Weigh-In-Motion sensor, lead-in cable(s), adhesive bonding agent, loop sealant, all equipment, materials, and labor necessary for a complete and accepted installation.

The Contract unit price for each non-motorized axle sensor will include the sensor, lead-in cables, adhesive bonding agent, loop sealant; and all equipment, materials, testing and labor necessary for a complete and accepted installation.

The Contract unit price for each non-motorized infrared sensor will include the infrared sensor, mounting hardware, cabling; and all equipment, materials, testing and labor necessary for a complete and accepted installation.

The Contract unit price for each solar power unit includes the solar power unit as specified in the Contract Documents, all equipment, materials (weatherhead, conduit, conduit accessories), and labor necessary for a complete and accepted installation.

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The Contract unit price for each inductive loop assembly includes loop wire, loop sealant, all equipment, materials, testing, and labor necessary for a complete and accepted installation.

The Contract unit price for each TMS cabinet includes the TMS cabinet, shelf, suppression device, and backplane components as specified in the Contract Documents, all equipment, materials, and labor necessary for a complete and accepted installation. The cost of the base or pedestal, as shown in the Standard Plans, is included in the cost of the cabinet. The cost of the pole for pole mounts will be paid in accordance with Section 646.

The Contract unit price for each TMS modem will include the modem and all equipment, materials, and labor necessary for a complete and accepted installation.

The Contract unit price for each TMS antenna will include the antenna and all equipment, materials, and labor necessary for a complete and accepted installation.

The Contract unit price for each TMS Managed Field Ethernet Switch (MFES) will include the MFES and all equipment, materials, and labor necessary for a complete and accepted installation.

### **695-15 Basis of Payment.**

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

- Item No. 695- 1- TMS Vehicle Axle Sensor - Non-Weight Applications- each.
- Item No. 695- 2- TMS Vehicle Non-Intrusive – Non-Weight Applications – each.
- Item No. 695- 3- TMS Vehicle Speed/Classification Unit - per assembly.
- Item No. 695- 5- TMS Solar Power Unit - each.
- Item No. 695- 6- TMS Inductive Loop Assembly – each.
- Item No. 695- 7- TMS Cabinet - each.
- Item No. 695- 8- TMS System Communications Modem -- each.
- Item No. 695- 9- TMS Weigh-In-Motion Axle Sensor -- each.
- Item No. 695- 10- TMS Weigh-In-Motion Unit – per assembly.
- Item No. 695- 11- TMS Non-Motorized Data Collection Unit – per assembly.
- Item No. 695- 12- TMS Non-Motorized Axle Sensor – each.
- Item No. 695- 13- TMS Non-Motorized Infrared Sensor – each.
- Item No. 695- 14- TMS Non-Motorized Inductive Loop Assembly – each.
- Item No. 695- 15- TMS Non-Motorized Solar Power Unit – each.
- Item No. 695- 16- TMS Surge Suppressor – each.
- Item No. 695- 17- TMS Patch Panel – each.
- Item No. 695- 18- TMS Managed Field Ethernet Switch – each.

# **Specification 9970000**

Traffic Monitoring Site Materials

Note: This revision has numerous instances of original language moved to various Articles.

## TRAFFIC MONITORING SITE MATERIALS.

(REV 6-30-23)

SECTION 997 is deleted and the following substituted:

### 997-1 Description.

This Section governs the requirements for all traffic monitoring site (TMS) material as shown in the Plans and Standard Plans.

Provide products compatible with all other TMS APL equipment. Any electronics unit or software submitted for approval must be compatible with or convert the data into a format compatible with the Department's polling and processing software. Any substitute software modules submitted must be tested and approved by the Department.

Provide products constructed of corrosion-resistant materials, such as 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 any equipment fails during the operational testing period prior to final acceptance, remove the defective equipment and replace with new equipment.

Provide warranties that are fully transferrable to the Department. Ensure that the terms and conditions of warranties are documented by the manufacturer when submitting a request to the Department for certification and for equipment submittal for construction projects. Include terms for a specified service performance with provisions for repair parts and labor, or for replacement.

Ensure the terms and conditions define the equipment installation date as the date for such warranty to be in effect. The installation date for construction projects is the day the site is accepted by the TDA TMS Manager. For warehouse purchases, the installation date is the date of visual inspection approval, not to exceed ten days after delivery date.

Ensure warranties require the manufacturer to furnish replacements within 10 calendar days of notification for any part or equipment found to be defective during the manufacturer's warranty period at no cost to the Department.

**997-1.1 Approved Product List Submittal Requirements:** All products shall be listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of their product for inclusion on the APL shall submit an application in accordance with Section 6 including documentation identified in Table 997-1 and this section. Documentation must demonstrate that the product meets the requirements of this Section.

Documentation	Requirements
Technical Data Sheets	Provide information as required in this Section.
Product Label <u>Photo</u>	Provide equipment permanently marked with manufacturer name or trademark, part number, and date of manufacture or serial number.
Product Sample	When requested, submit a product sample.

Note: This revision has numerous instances of original language moved to various Articles.

Table 997-1	
Documentation	Requirements
Installation <del>Instructions</del> <u>Manual</u>	<del>Required</del> <u>Instructions describing mounting, cabling, and configuration.</u>
Product Photo	Display significant features of the products.

**997-2 TMS Vehicle Sensors (Non-Weight).**

**997-2.1** Non-weight vehicle sensors include inductive loops, Class II piezoelectric axle sensors, microwave radar, and ~~non-motorized sensors~~ video data collection technologies.

**997-2.2 Inductive Loops:** Materials used in the creation of the inductive loops must meet the material specification of No. 14 AWG International Municipal Signal Association (IMSA) 51-7 wire.

**997-2.2-3 Class II Piezoelectric Axle Sensor and Non-Motorized Sensor:** In-Roadway Class II piezoelectric axle sensors shall meet the physical characteristics in Table 997-2.

Table 997-2 Physical Characteristics, <u>Class II Piezoelectric</u> Axle Sensor		
Property	Documentation	Requirements
Sensor Element Dimensions	Technical Data Sheet	Approximately 6 ft. to 10 ft. in length, 3/16 in. to 3/8 in. in diameter (varies by manufacturer)
Sensor Element Material	Technical Data Sheet	Pressure sensing piezoelectric
Pavement Operating Temperature Range	Technical Data Sheet	Minimum 0°F to +150°F
Output Signal	Technical Data Sheet	Minimum +200mV or produce a charge signal for <del>passenger car/pickup truck axle @ 70°F with less than 10% negative signal for non-WIM axle sensors</del> <u>a FHWA Class 2 Vehicle.</u>
Environmental Requirements	Technical Data Sheet	NEMA TS-2- <del>2016</del> , Section <del>32</del> .

**997-2.4 Microwave Radar Sensor:** Sensors shall meet the physical characteristics in Table 997-3.

Table 997-3 Physical Characteristics, <u>Microwave Radar Sensor</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirement</u>
<u>Detection Range</u>	<u>Technical Data Sheet</u>	<u>A minimum of 8 distinguishable lanes within a minimum 200 feet of detection zone.</u>
<u>Direction</u>	<u>Technical Data Sheet</u>	<u>Bidirectional</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Table 997-3</u> <u>Physical Characteristics, Microwave Radar Sensor</u>		
<u>Operating Temperature Range</u>	<u>Technical Data Sheet</u>	<u>Ambient temperature of 0°F to 140°F</u>
<u>Enclosure Dimensions</u>	<u>Technical Data Sheet</u>	<u>Weatherproof aluminum, stainless steel, or polycarbonate housing. Typically, up to 15" X 12" X 6"</u> <u>Weight typically &lt;10 lbs.</u>
<u>Operating Frequency</u>	<u>Technical Data Sheet</u>	<u>Wireless transmission in FCC approved band or unlicensed RF range.</u>
<u>Communications</u>	<u>Technical Data Sheet</u>	<u>RS-232/RS-485 ports, supports minimum 19,200 baud rate.</u>
<u>Data Interface Compatibility</u>	<u>Department Testing</u>	<u>Compatible with the vehicle speed/classification unit and the Department's traffic polling system.</u>

**997-2.5 Video Sensor:** Sensors shall meet the physical characteristics in Table 997-4. Cameras 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>.

<u>Table 997-4</u> <u>Performance Characteristics, Video Sensor</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Configuration</u>	<u>Technical Data Sheet</u>	<u>Displays detection zones, activations, overlaid on live video inputs.</u>
<u>Configuration</u>	<u>Technical Data Sheet</u>	<u>Editable detection zone size, placement, and sensitivity. Parameters stored in and retrieved from nonvolatile memory.</u>
<u>Processor</u>	<u>Technical Data Sheet</u>	<u>Video analysis, presence detection, data collection, storage and reporting of detection data.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Table 997-4</u> <u>Performance Characteristics, Video Sensor</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Communications</u>	<u>Technical Data Sheet or Department Testing</u>	<u>TIA-232, 10/100 Base TX, FCC certified secure wireless, or cellular compatible with Agency's carrier. Department must approve carrier.</u>
<u>Communications</u>	<u>Technical Data Sheet</u>	<u>CDMA compatible</u>
<u>Solid State Detection Output</u>	<u>Technical Data Sheet</u>	<u>NEMA TS2, 6.5.2.26</u>
<u>Environmental Requirements</u>	<u>Technical Data Sheet</u>	<u>NEMA TS-2, Section 2.</u>

**997-3 ~~Weight Sensors (In-Roadway)~~ TMS Non-Motorized Sensors.**

**997-3.1 General:** ~~Weight sensors include bending plates, Class I piezoelectric sensors, and quartz piezoelectric sensors.~~ Non-Motorized sensors include inductive loops, axle sensors, infrared, and video data collection technologies. Non-intrusive non-motorized sensors detect non-motorized vehicles and pedestrians using passive detection.

**997-3.2 ~~Bending Plate~~ Inductive Loops for Non-Motorized Data Collection:** ~~Provide bending Plate Weigh In Motion systems that utilize plates with strain gauges bonded to the underside. The weigh pads shall meet the physical characteristics in Table 997-4.~~ Materials used in the creation of the inductive loops must meet the material specification of No. 14 AWG International Municipal Signal Association (IMSA) 51-7 wire or manufacturer's required inductive loop wire.

<u>Table 997-4</u> <u>Physical Characteristics, Bending Plate, Weigh Pad</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Sensor Size</u>	<u>Technical Data Sheet</u>	<u>20 in. wide x 70 in. or 50 in. long</u>
<u>Operating Temperature Range</u>	<u>Technical Data Sheet</u>	<u>-50°F to 176°F</u>
<u>Scale Capacity</u>	<u>Technical Data Sheet</u>	<u>45000 pounds per axle and overload protected to 80000 pounds per axle</u>
<u>Environmental Requirements</u>	<u>Technical Data Sheet</u>	<u>NEMA TS-2-2016, Section 3.</u>

**997-3.3 ~~Piezoelectric Axle Sensor (Class I)~~ Axle Sensor for Non-Motorized Data Collection:** ~~Class I sensors collect Weigh In Motion data. The vehicle sensor shall meet the physical characteristics in Table 997-5. Non-motorized Class I or II axle sensors shall meet the physical characteristics in Table 997-5. In Sidewalk and Shared Use Path non-motorized sensors shall meet the physical characteristics in Table 997-3.~~

<u>Table 997-<del>3</del>5</u> <u>Physical Characteristics, Non-Motorized <u>Axle</u> Sensor</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Sensor Element Dimensions</u>	<u>Technical Data Sheet</u>	<u>Approximately 3 ft. in length, 3/16 in. to 3/8 in. in diameter (varies by manufacturer)</u>

Note: This revision has numerous instances of original language moved to various Articles.

Sensor Element Material	Technical Data Sheet	Pressure sensing piezoelectric
Pavement Operating Temperature Range	Technical Data Sheet	Minimum 0°F to +150°F
Output Signal Range	Technical Data Sheet	Minimum +34 mV (front axle) and +65mV (rear axle), 220 lbs. Passenger bicycle, at 7.3 MPH
Environmental Requirements	Technical Data Sheet	NEMA TS-2-2016, Section 3.

**997-3.4 ~~Quartz Piezoelectric Sensor~~ Infrared for Non-Motorized Sensor Data Collection:** ~~The quartz piezoelectric sensors collect Weigh-In-Motion data. The quartz~~ Non-motorized infrared sensors shall meet the physical characteristics in Table 997-6.

<u>Table 997-6</u> <u>Physical Characteristics, Quartz Piezoelectric Sensor</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Measuring Range wheel load (At a referenced tire contact area)</u>	<u>Technical Data Sheet</u>	<u>0 to 34000 pounds (8 in. by 12.6 in.)</u>
<u>Overload (twin wheel)</u>	<u>Technical Data Sheet</u>	<u>55000 pounds</u>
<u>Sensitivity—Nominal</u>	<u>Technical Data Sheet</u>	<u>7.6 ± 12% pC/lbf</u>
<u>Sensitivity shift over sensor length</u>	<u>Technical Data Sheet</u>	<u>≤ ± 3%</u>
<u>Threshold</u>	<u>Technical Data Sheet</u>	<u>&lt; 0.1 lbf</u>
<u>Linearity</u>	<u>Technical Data Sheet</u>	<u>≤ ± 2% Full Scale Output</u>
<u>Hysteresis</u>	<u>Technical Data Sheet</u>	<u>≤ 2% Full Scale Output</u>
<u>Natural Frequency</u>	<u>Technical Data Sheet</u>	<u>&gt; 5 kHz</u>
<u>Operating Temperature range</u>	<u>Technical Data Sheet</u>	<u>-40°F to 176°F</u>
<u>Temperature coefficient of sensitivity</u>	<u>Technical Data Sheet</u>	<u>-0.04%/°F</u>
<u>Operating Speed</u>	<u>Technical Data Sheet</u>	<u>5 MPH to 100 MPH</u>
<u>Insulation resistance</u>	<u>Technical Data Sheet</u>	<u>&gt; 100 giga ohms</u>
<u>Capacitance with 130 ft. cable</u>	<u>Technical Data Sheet</u>	<u>8 to 12 nano farad</u>
<u>Environmental Requirements</u>	<u>Technical Data Sheet</u>	<u>NEMA TS-2-2016, Section 3.</u>

<u>Table 997-6</u> <u>Physical Characteristics, Non-Motorized Infrared Sensor</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirement</u>
<u>Temperature Sensitivity</u>	<u>Technical Data Sheet</u>	<u>2°F from ambient temp.</u>
<u>Detection Range</u>	<u>Technical Data Sheet</u>	<u>3 ft. to 18 ft.</u>
<u>Direction</u>	<u>Technical Data Sheet</u>	<u>Bidirectional</u>
<u>Operating Temperature Range</u>	<u>Technical Data Sheet</u>	<u>-13°F to 120°F</u>

**997-3.5. Video Sensor:** Sensors shall meet the physical characteristics in Table 997-7. Cameras shall be compliant with the Code of Federal Regulations Section 200.216 Prohibition

Note: This revision has numerous instances of original language moved to various Articles.

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>.

<u>Table 997-7</u> <u>Performance Characteristics, Video Sensor</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Configuration</u>	<u>Technical Data Sheet</u>	<u>Displays detection zones, activations, overlaid on live video inputs.</u>
<u>Configuration</u>	<u>Technical Data Sheet</u>	<u>Editable detection zone size, placement, and sensitivity. Parameters stored in and retrieved from nonvolatile memory.</u>
<u>Processor</u>	<u>Technical Data Sheet</u>	<u>Video analysis, presence detection, data collection, storage and reporting of detection data.</u>
<u>Communications</u>	<u>Technical Data Sheet or Department Testing</u>	<u>TIA-232, 10/100 Base TX, FCC certified secure wireless, or cellular compatible with Agency's carrier. Department must approve carrier.</u>
<u>Solid State Detection Output</u>	<u>Technical Data Sheet</u>	<u>NEMA TS2-2021, 6.5.2.26</u>
<u>Environmental Requirements</u>	<u>Technical Data Sheet</u>	<u>NEMA TS-2, Section 2.</u>

**997-3.4 TMS Weight Vehicle Sensors (In-Roadway Weight for Motorized Vehicle Data Collection).**

**997-3.4.1 General:** Weight sensor arrays include bending plates, Class I piezoelectric inductive loops with strain gauge sensors, and or quartz piezoelectric sensors.

**997-4.2 Inductive Loop:** Materials used in the creation of the inductive loops must meet the material specification of No. 14 AWG International Municipal Signal Association (IMSA) 51-7 wire.

**997-3.4.2.3 Bending Plate Strain Gauge Sensor:** Provide bending Plate Weigh-In-Motion (WIM) systems that utilize plates with strain gauges bonded to the underside or one-piece gauge strip scale. The weigh pad strain gauge sensors shall meet the physical characteristics in Table 997-48.

Note: This revision has numerous instances of original language moved to various Articles.

Property	Documentation	Requirements
Sensor Size	Technical Data Sheet	<del>.5 in. to 20 in. wide x 70 in. or 50 in. to 80 in. long</del>
Operating Temperature Range	Technical Data Sheet	-50°F to 176°F
Scale Capacity	Technical Data Sheet	45,000 pounds per axle and overload protected to 80000 pounds per axle
Environmental Requirements	Technical Data Sheet	NEMA TS-2- <del>2016</del> , Section <del>23</del> .

~~997-3.3 Piezoelectric Axle Sensor (Class I): Class I sensors collect Weigh-In-Motion data. The vehicle sensor shall meet the physical characteristics in Table 997-5.~~

Property	Documentation	Requirements
<del>Sensor Size</del>	<del>Technical Data Sheet</del>	<del>6 ft. to 8 ft. Flat Element 0.26 in. wide x 0.063 in. thick</del>
<del>Operating Temperature Range</del>	<del>Technical Data Sheet</del>	<del>-40°F to 160°F</del>
<del>Temperature sensitivity</del>	<del>Technical Data Sheet</del>	<del>0.2%/°F</del>
<del>Output Uniformity</del>	<del>Technical Data Sheet</del>	<del>5% to 7%</del>
<del>Output Signal</del>	<del>Technical Data Sheet</del>	<del>250 mV for 400-pound wheel load at 70 F° and 55 mph [250 mV for 181 kg wheel load at 21 C° and 88 kph] Minimum</del>
<del>Insulation Resistance</del>	<del>Technical Data Sheet</del>	<del>&gt; 500 MΩ</del>
<del>Passive Signal Cable</del>	<del>Technical Data Sheet</del>	<del>RG-58 C/U with High Density Polyethylene Outer Jacket 0.187" [4.75 mm] OD</del>
<del>Center Core</del>	<del>Technical Data Sheet</del>	<del>16-gauge, flat braided, silver plated copper wire</del>
<del>Piezoelectric Material</del>	<del>Technical Data Sheet</del>	<del>Spiral Wrapped PVDF piezoelectric film</del>
<del>Cable Capacitance</del>	<del>Technical Data Sheet</del>	<del>27 pF/ft [89 pF/m]</del>
<del>Piezoelectric Coefficient</del>	<del>Technical Data Sheet</del>	<del>34 pC/N—nominal</del>
<del>Life</del>	<del>Technical Data Sheet</del>	<del>40 Million ESAL's [Minimum]</del>
<del>Environmental Requirements</del>	<del>Technical Data Sheet</del>	<del>NEMA TS-2-2016, Section 3.</del>

~~997-3.4 Quartz Piezoelectric Sensor: The quartz piezoelectric sensors use one piece quartz crystal sensors to collect Weigh-In-Motion data. The quartz sensor shall meet the physical characteristics in Table 997-69.~~

Note: This revision has numerous instances of original language moved to various Articles.

Table 997- <del>69</del> Physical Characteristics, Quartz Piezoelectric Sensor		
Property	Documentation	Requirements
Measuring Range wheel load (At a referenced tire contact area)	Technical Data Sheet	0 to 34000 pounds (8 in. by 12.6 in.)
Overload (twin wheel)	Technical Data Sheet	55000 pounds
Sensitivity – Nominal	Technical Data Sheet	7.6 ± 12% pC/lbf
Sensitivity shift over sensor length	Technical Data Sheet	<± 3%
Threshold	Technical Data Sheet	<0.1 lbf
Linearity	Technical Data Sheet	<± 2% Full Scale Output
Hysteresis	Technical Data Sheet	≤ 2% Full Scale Output
Natural Frequency	Technical Data Sheet	> 5 kHz
Operating Temperature range	Technical Data Sheet	-40°F to 176°F
Temperature coefficient of sensitivity	Technical Data Sheet	-0.04%/°F
Operating Speed	Technical Data Sheet	5 MPH to 100 MPH
Insulation resistance	Technical Data Sheet	> 100 <del>giga-ohms</del> <b>GΩ</b>
Capacitance with 130 ft. cable	Technical Data Sheet	8 to 12 <del>nano-farad</del> <b>nF</b>
Environmental Requirements	Technical Data Sheet	NEMA TS-2- <del>2016</del> , Section <del>32</del>

#### **997-4.5 TMS Solar Power Unit for Motorized Data Collection.**

**997-45.1 General:** ~~Provide s~~ Solar power unit ~~consisting~~ consists of the following components: solar panel(s) and mounting hardware; 12 V storage battery; and voltage regulator with wiring and associated mounting hardware.

**997-45.2 Solar Panel Configured for Nominal 12 V<sub>DC</sub>:** Solar panels cannot have internal voltage regulators and must be capable of multiple arrays and series or parallel wiring configurations. Meet the physical characteristics in Table 997-~~710~~:

Table 997- <del>710</del> Physical Characteristics, Solar Panel		
Property	Documentation	Requirements
Peak power range	Technical Data Sheet	<del>80-85</del> to <del>130-300</del> watts
Voltage	Technical Data Sheet	Maximum power greater than 16.5 V at 77°F
Current	Technical Data Sheet	Maximum power greater than 2.85 A at 77°F
Photovoltaic modules construction	Technical Data Sheet	Mono or poly-crystalline cells
<u>Efficiency Rating</u>	<u>Technical Data Sheet</u>	<u>Minimum 20%</u>
<del>App</del> Frame construction	Technical Data Sheet	Anodized aluminum
Mounting hardware construction	Technical Data Sheet	Anodized, galvanized or stainless-steel

**997-45.3 Battery 12 V:** Meet the physical characteristics in Table 997-~~811~~:

Note: This revision has numerous instances of original language moved to various Articles.

Table 997- <del>811</del> <u>11</u> Physical Characteristics, Battery 12 V		
Property	Documentation	Requirements
		<del>Rechargeable for photovoltaic application.</del>
<u>Battery Chemistry</u>	<u>Technical Data Sheet</u>	<del>Rechargeable</del> valve regulated lead-calcium gelled electrolyte or absorbed glass mat <u>for photovoltaic applications</u>
Case Construction	Technical Data Sheet	ABS Plastic or Polypropylene
Current discharge rate	Technical Data Sheet	Minimum of 100 hours at 0.9 amperes
Dimensions	Technical Data Sheet	<del>Approximately</del> <u>Maximum of</u> 12 inches by <del>7</del> <u>8</u> inches by <del>9</del> <u>10</u> inches

**997-~~45.4~~4 Voltage Regulator Configured for Nominal 12 V<sub>DC</sub>:** Meet the physical characteristics in Table 997-~~912~~12:

Table 997- <del>912</del> <u>12</u> Physical Characteristics, Voltage Regulator		
Property	Documentation	Requirements
Voltage for battery charging.	Technical Data Sheet	Minimum of 13.5 V <sub>DC</sub>
<u>Begin Charging-Battery Voltage</u>	<u>Technical Data Sheet</u>	<del>Begin charging when battery voltage is</del> 13.3 V or less
<u>End Charging-Battery Voltage</u>	<u>Technical Data Sheet</u>	<del>Discontinue charging when battery voltage is</del> <u>Maximum of</u> 14.5 V
Quiescent current	Technical Data Sheet	Maximum 15 mA
<u>Charge rating</u>	<u>Technical Data Sheet</u>	<u>Minimum of 20 A.</u>
Operating Temperature range	Technical Data Sheet	<u>Range:</u> 0 to 122°F
Dimensions	Technical Data Sheet	Approximately 2 inches by 5 inches by 1 inch.

**997-6 TMS Solar Power Unit for Non-Motorized Data Collection.**

**997-6.1 General:** Solar power unit consists of the following components: solar panel(s) and mounting hardware; 12 V storage battery; and voltage regulator with wiring and associated mounting hardware.

**997-6.2 Solar Panel Configured for Nominal 12 V<sub>DC</sub>:** Solar panels cannot have internal voltage regulators and must be capable of multiple arrays and series or parallel wiring configurations. Meet the physical characteristics in Table 997-13.

Note: This revision has numerous instances of original language moved to various Articles.

<u>Table 997-13</u> <u>Physical Characteristics, Solar Panel</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Peak power range</u>	<u>Technical Data Sheet</u>	<u>65 to 300 watts</u>
<u>Voltage</u>	<u>Technical Data Sheet</u>	<u>Maximum power greater than 16.5 V at 77°F</u>
<u>Current</u>	<u>Technical Data Sheet</u>	<u>Maximum power greater than 2.85 A at 77°F</u>
<u>Photovoltaic modules construction</u>	<u>Technical Data Sheet</u>	<u>Mono or poly-crystalline cells</u>
<u>Efficiency Rating</u>	<u>Technical Data Sheet</u>	<u>Minimum 20%</u>
<u>Frame construction</u>	<u>Technical Data Sheet</u>	<u>Anodized aluminum</u>
<u>Mounting hardware construction</u>	<u>Technical Data Sheet</u>	<u>Anodized, galvanized, or stainless steel</u>

**997-6.3 Battery 12 V:** Meet the physical characteristics in Table 997-14.

<u>Table 997-14</u> <u>Physical Characteristics, Battery 12 V</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Battery Chemistry</u>	<u>Technical Data Sheet</u>	<u>Rechargeable valve regulated lead-calcium gelled electrolyte or absorbed glass mat for photovoltaic applications</u>
<u>Case Construction</u>	<u>Technical Data Sheet</u>	<u>ABS Plastic or Polypropylene.</u>
<u>Current discharge rate</u>	<u>Technical Data Sheet</u>	<u>Minimum of 21 to 100 hours at 0.9 amperes</u>
<u>Dimensions</u>	<u>Technical Data Sheet</u>	<u>Maximum of 12 inches by 8 inches by 10 inches</u>

**997-6.4 Voltage Regulator Configured for Nominal 12 VDC:** Meet the physical characteristics in Table 997-15.

<u>Table 997-15</u> <u>Physical Characteristics, Voltage Regulator</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Charging Voltage</u>	<u>Technical Data Sheet</u>	<u>Minimum of 13.5 V<sub>DC</sub></u>
<u>Begin Charging- Battery Voltage</u>	<u>Technical Data Sheet</u>	<u>13.3 V or less</u>
<u>End Charging- Battery Voltage</u>	<u>Technical Data Sheet</u>	<u>Maximum of 14.5 V</u>
<u>Quiescent current</u>	<u>Technical Data Sheet</u>	<u>Maximum 15 mA</u>
<u>Charge rating</u>	<u>Technical Data Sheet</u>	<u>Minimum of 20 amps</u>
<u>Operating Temperature range</u>	<u>Technical Data Sheet</u>	<u>Range: 0 to 122°F</u>
<u>Dimensions</u>	<u>Technical Data Sheet</u>	<u>Approximately 2 inches by 5 inches by 1 inch</u>

Note: This revision has numerous instances of original language moved to various Articles.

**997-5-7 Site-TMS System Communications Modem** Meet the physical characteristics in Table 997-~~10~~16. Modems 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>.

Table 997- <del>10</del> 16 Physical Characteristics, <u>Site-TMS</u> Modem		
Property	Documentation	Requirements
Configuration	Technical Data Sheet	<ol style="list-style-type: none"> <li>1.The device shall be field configurable to be powered from 12 VDC.</li> <li>2.The device shall have the ability and be configured to utilize a network service that shall be at a minimum 4G LTE with fallback to 3G EV-DO.</li> </ol>
Protocols: The device shall have the ability to utilize, at a minimum, the following protocols:	Technical Data Sheet	<ol style="list-style-type: none"> <li>1. Network: TCP/IP, UDP/IP, Domain Name System (DNS)</li> <li>2. Routing: Network Address Translation (NAT), Host Port Routing, DHCP, Point-to-Point Protocol over Ethernet (PPPoE), VLAN, Virtual Router Redundancy Protocol (VRRP), Reliable Static Route.</li> <li>3. Application: Short Message Service (SMS), Telnet/SSH, Reverse Telnet, Simple Mail Transfer Protocol (SMTP), SNMP, SNTP, Reliable Static Route</li> <li>4. Serial: TCP/UDP Packet Assembly Disassembly (PAD) Mode, Modbus (ASCII, RTU, Variable), Point-to-Point Protocol (PPP)</li> </ol>
<u>Communication Transmission</u>	<u>Technical Data Sheet</u>	<u>Code Division Multiple Access (CDMA) capable.</u>
Event Reporting: The device shall have the capability to record and report, at a minimum, the following events in plain text:	Technical Data Sheet	<ol style="list-style-type: none"> <li>1. Network parameters</li> <li>2. Data usage</li> <li>3. Power</li> <li>4. Device temperature</li> <li>5. Digital input</li> <li>6. Global Positioning</li> <li>7. System/Automatic</li> <li>8. Vehicle Locator (GPS/AVL)</li> <li>9. Timer</li> </ol>
Security: The device shall have the following security provisions:	Technical Data Sheet	<ol style="list-style-type: none"> <li>1. Ability to establish VPN tunnels.</li> <li>2. IPsec, Secure Sockets Layer (SSL), and Generic Routing Encapsulation (GRE) VPN client</li> </ol>

Note: This revision has numerous instances of original language moved to various Articles.

		<ul style="list-style-type: none"> <li>3. Port forwarding and Demilitarized Zone (DMZ)</li> <li>4. Port filtering</li> <li>5. Trusted IP</li> <li>6. MAC address filtering</li> </ul>
Operating Temperature range	Technical Data Sheet	Minimum 0 to 158°F
<del>Antenna: Use an antenna that meets the following requirements:</del>	<del>Technical Data Sheet</del>	<ul style="list-style-type: none"> <li><del>1. Dual diversity</del></li> <li><del>2. Minimum NEMA rating of NEMA 3</del></li> <li><del>3. Frequencies: F<sub>1</sub>= 824 to 896 MHz, F<sub>2</sub>= 1850 to 1990 MHz, F<sub>3</sub>= 1850 to 1955 MHz, F<sub>4</sub>= 1710 to 1770 MHz, F<sub>5</sub>= 2110 to 2170 MHz</del></li> <li><del>4. Voltage Standing Wave Ratio (VSWR) of 1.5:1 or less at resonant point</del></li> <li><del>5. 50 Ω nominal impedance</del></li> <li><del>6. Gain of 3.0 dB to 5.15 dB</del></li> <li><del>7. Omni-directional radiation pattern</del></li> <li><del>8. Vertical polarization</del></li> <li><del>9. Glass-filled polypropylene radome</del></li> <li><del>10. Adhesive mounting or Bolt mount</del></li> <li><del>11. SMA male plug connectors 10 ft. (minimum) coaxial length</del></li> </ul>

### **997-8 TMS Modem Antenna.**

Meet the physical characteristics in Table 997-17.

<u>Table 997-17</u>		
<u>Physical Characteristics, TMS Modem Antenna</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Antenna Requirements</u>	<u>Technical Data Sheet</u>	<ul style="list-style-type: none"> <li><u>1. Dual diversity</u></li> <li><u>2. Minimum NEMA rating of NEMA 3</u></li> <li><u>3. Frequencies: F<sub>1</sub> = 824 to 896 MHz, F<sub>2</sub> = 1850 to 1990 MHz, F<sub>3</sub> = 1850 to 1955 MHz, F<sub>4</sub> = 1710 to 1770 MHz, F<sub>5</sub> = 2110 to 2170 MHz</u></li> <li><u>4. Voltage Standing Wave Ratio (VSWR) of 1.5:1 or less at resonant point</u></li> <li><u>5. 50 Ω nominal impedance</u></li> <li><u>6. Gain of 3.0 dB to 5.15 dB</u></li> <li><u>7. Omni-directional radiation pattern</u></li> <li><u>8. Vertical polarization</u></li> </ul>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Table 997-17</u> <u>Physical Characteristics, TMS Modem Antenna</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
		<u>9. Glass-filled polypropylene radome</u> <u>10. Adhesive mounting or Bolt mount</u> <u>11. SMA male plug connectors</u> <u>10 ft. (minimum) coaxial length</u>

**997-9 TMS Vehicle Speed/Classification Unit.**

Vehicle speed/classification units must meet the physical characteristics in Tables 997-18 and 997-19. Polling software must meet the requirements in Table 997-20.

<u>Table 997-18</u> <u>Performance Characteristics, Vehicle Speed/Classification Unit</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Operations</u>	<u>Technical Data Sheet</u>	<u>Operates in an unattended mode, accumulating data for real time and later retrieval by downloading via the polling computer system. Capable of downloading through direct connection with a PC, without deleting or marking the files.</u>
<u>Operations</u>	<u>Operations Manual</u>	<u>Vehicle speed/classification unit operating procedures.</u>
<u>Compatibility with software</u>	<u>Technical Data Sheet</u>	<u>Outputs data compatible with the Department's polling computer system. If non-compatible, then furnish a software module that converts the data into a format compatible with the Department's polling computer system.</u>
<u>Compatibility with sensors</u>	<u>Technical Data Sheet</u>	<u>Compatible with the weigh-in-motion sensors, embedded inductive loops, axle sensors, magnetometers and non-intrusive vehicle sensors in place at the Traffic Monitoring Site.</u>
<u>Count and Classification</u>	<u>Technical Data Sheet</u>	<u>Capable of determining the count and classification by type and speed of all vehicles for both directions of traffic on the roadway.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Functional Requirements</u>	<u>Technical Data Sheet</u>	<u>Capable of receiving input from two 6-foot by 6-foot embedded inductive loops, spaced 12 to 24 feet apart, leading edge to leading edge, with a single axle sensor located between the loops, in each lane of a six lane (minimum) roadway.</u>
<u>Functional Requirements</u>	<u>Technical Data Sheet</u>	<u>Capable of collecting data from each of the lanes of traffic in any combination of counts, classification, speed, or direction.</u>
<u>Electrical Components</u>	<u>Technical Data Sheet</u>	<u>Electrical components are designed to be solid-state so that they will not be damaged by jolts and vibrations encountered during shipping and everyday use.</u>
<u>Plug-In Modules</u>	<u>Technical Data Sheet</u>	<u>The vehicle speed/classification unit may be constructed utilizing plug in modules; however, when plug in modules are used, each vehicle speed/classification unit must be identical except for the number and type of modules used. Ensure that modules of the same type are identical and interchangeable.</u>
<u>Multiple Vehicle Speed/Classification Units in One Cabinet</u>	<u>Technical Data Sheet</u>	<u>Ensure that each vehicle speed/classification unit has a unique, individual unit number. The unit number must reside in non-volatile memory, so that it is not changed when a "cold or warm boot" is performed or by a power interruption.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing volume, speed, classification, and classification by speed data simultaneously.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing volume data by lane.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing speed data by lane in a minimum of 15 bins, programmable in 5 mph increments.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing Classification by lane in vehicle type by axle class in 15 bins (minimum) in accordance with FHWA Classification Scheme “F” in Florida’s Traffic Forecasting Handbook, Chapter 2, Figure 2.2 which can be accessed on the Department’s website at the following URL address: <a href="https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/systems/systems-management/document-repository/traffic-analysis/2019-project-traffic-forecasting-handbook.pdf?sfvrsn=e105e71d_2">https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/systems/systems-management/document-repository/traffic-analysis/2019-project-traffic-forecasting-handbook.pdf?sfvrsn=e105e71d_2</a>.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing a minimum of 95% accuracy of vehicle class, speed and volume.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of providing real-time monitoring of volume data by lane or direction in user selected intervals of as little as 15 minutes, when required, without disrupting the above selected programs</u>
<u>Communications</u>	<u>Technical Data Sheet</u>	<u>Capable of communicating directly with a PC or through a modem at a minimum rate of 19,200 bps.</u>
<u>Configuration</u>	<u>Technical Data Sheet</u>	<u>At a minimum, the following parameters are programmable by direct connection to the vehicle speed/classification unit by Ethernet or via modem:</u> <u>1. Six-digit site number.</u> <u>2. Number of lanes and directions.</u> <u>3. Date and time.</u> <u>4. Data operating and transmission parameters.</u> <u>5. Sensor spacing.</u> <u>6. Recording interval.</u> <u>7. Vehicle parameter table with axle spacing ranges for each type of vehicle.</u>
<u>Sensor Failure</u>	<u>Technical Data Sheet</u>	<u>The vehicle speed/classification unit must continue to provide the speed and/or volume from the remaining functioning sensors.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Sensitivity</u>	<u>Technical Data Sheet</u>	<u>The sensitivity level for each axle sensor must be individually adjustable using software, by direct PC connection and remotely via telemetry.</u>
<u>Loop Detector</u>	<u>Technical Data Sheet</u>	<u>Loop detectors must be internal and self-tuning. The sensitivity level and any additional parameters necessary to prevent "loop crosstalk" for each embedded inductive loop must be individually adjustable using software, both by direct PC connection and remotely via telemetry.</u>
<u>Time Delay</u>	<u>Technical Data Sheet</u>	<u>A time delay, or "de-bounce" value for ignoring spurious axle signals (ghost axles) in the vehicle speed/classification unit software must be provided.</u>
<u>Power</u>	<u>Technical Data Sheet</u>	<u>Provide a vehicle speed/classification unit that is field configurable to be powered 12 VDC and does not consume more than a total of 12 watts. If an internal battery is required, it must be capable of being recharged and shall be furnished and included with the vehicle speed/classification unit at no extra cost.</u>
<u>Mechanical</u>	<u>Technical Data Sheet</u>	<u>Provide a modular electronics unit which is completely enclosed in a durable housing of sheet metal or cast aluminum with a durable finish. When configured for operation the vehicle speed/classification unit including all cables must fit into a Type III cabinet.</u>
<u>Environmental</u>	<u>Technical Data Sheet</u>	<u>Provide an electronics unit which operates as specified when the ambient temperature and humidity inside the controller cabinet are within the following limits: The operating ambient temperature range must be between minus 0 to 140°F. The rate of change in ambient temperature must not exceed 63°F per hour, during which the relative humidity must not exceed 90%.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Environmental</u>	<u>Technical Data Sheet</u>	<p><u>Provide an electronics unit which operates as specified when the ambient temperature and humidity inside the controller cabinet are within the following limits:</u></p> <p><u>The relative humidity must not exceed 90% over the temperature range of 40 to 109°F. Above 109°F, constant absolute humidity must be maintained as seen in Table 997-19. The relative humidity range shown in Table 997-19 is for dynamic testing.</u></p>
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<u>Table 997-19</u>		
<u>At 14.6 psi Barometric Pressure</u>		
<u>Dry Bulb °F</u>	<u>Relative Humidity (%)</u>	<u>Wet Bulb °F</u>
<u>40</u>	<u>75</u>	<u>37</u>
<u>50</u>	<u>80</u>	<u>46</u>
<u>60</u>	<u>83</u>	<u>57</u>
<u>70</u>	<u>86</u>	<u>66</u>
<u>80</u>	<u>87</u>	<u>77</u>
<u>90</u>	<u>89</u>	<u>88</u>
<u>100</u>	<u>89</u>	<u>97</u>
<u>109</u>	<u>90</u>	<u>108</u>
<u>120</u>	<u>70</u>	<u>109</u>
<u>130</u>	<u>50</u>	<u>109</u>
<u>140</u>	<u>38</u>	<u>109</u>
<u>150</u>	<u>28</u>	<u>109</u>
<u>160</u>	<u>21</u>	<u>109</u>
<u>165</u>	<u>18</u>	<u>109</u>

<u>Table 997-20</u>		
<u>Performance Characteristics, Vehicle Speed/Classification Unit Polling Software</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Operations</u>	<u>Department Testing</u>	<u>Real time polling software operates on a PC using the Department's recommended operating system.</u>
<u>Operations</u>	<u>Operations Manual</u>	<u>Software operating procedures.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Table 997-20</u>		
<u>Performance Characteristics, Vehicle Speed/Classification Unit Polling Software</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Communications</u>	<u>Technical Data Sheet</u>	<u>Capable of communicating with the traffic counter/classifier and downloading data via cellular modem and producing reports of 15 minute, hourly, weekly, monthly and annual volume and classification data.</u>
<u>Configuration</u>	<u>Technical Data Sheet</u>	<u>Capable of displaying and entering operating parameters into the vehicle class/counter and allowing the display of real-time traffic volumes in addition to routine data collection activities.</u>
<u>Data Storage</u>	<u>Technical Data Sheet</u>	<u>Capable of processing and storing all vehicle data retrieved in routine mode, regardless of the selected parameters.</u>

#### **997-10 TMS Vehicle Weigh in Motion Unit.**

Weigh in Motion Unit must meet the physical characteristics in Tables 997-21 and 997-22. Polling software must meet the requirements in Table 997-23.

<u>Table 997-21</u>		
<u>Performance Characteristics, Vehicle Weigh in Motion Unit</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Operations</u>	<u>Technical Data Sheet</u>	<u>Operates in an unattended mode, accumulating data for real time and later retrieval by downloading via the polling computer system. Capable of downloading through direct connection with a PC, without deleting or marking the files.</u>
<u>Operations</u>	<u>Operations Manual</u>	<u>Weigh in Motion unit operating procedures.</u>
<u>Compatibility with software</u>	<u>Technical Data Sheet</u>	<u>Outputs data compatible with the Department's polling computer system. If non-compatible, then furnish a software module that converts the data into a format compatible with the Department's polling computer system.</u>
<u>Compatibility with sensors</u>	<u>Technical Data Sheet</u>	<u>Compatible with the weigh-in-motion sensors, embedded inductive loops, axle sensors, and non-intrusive vehicle sensors in place at the Traffic Monitoring Site.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Count and Classification</u>	<u>Technical Data Sheet</u>	<u>Capable of determining the count and classification by type and speed of all vehicles for both directions of traffic on the roadway.</u>
<u>Functional Requirements</u>	<u>Technical Data Sheet</u>	<u>Capable of receiving input from a 6-foot by 6-foot (or 6-foot by 8-foot) embedded inductive loop, with four single WIM axle sensors located outside the loop, in each WIM lane of a six lane (minimum) roadway.</u>
<u>Functional Requirements</u>	<u>Technical Data Sheet</u>	<u>Capable of collecting data from each of the lanes of traffic in any combination of Weight, counts, classification, speed, or direction.</u>
<u>Electrical Components</u>	<u>Technical Data Sheet</u>	<u>Electrical components are designed to be solid-state so that they will not be damaged by jolts and vibrations encountered during shipping and everyday use.</u>
<u>Plug-In Modules</u>	<u>Technical Data Sheet</u>	<u>The vehicle Weigh in Motion unit may be constructed utilizing plug-in modules; however, when plug in modules are used, each vehicle Weigh in Motion unit must be identical except for the number and type of modules used. Ensure that modules of the same type are identical and interchangeable.</u>
<u>Multiple Vehicle Speed/Classification Units in One Cabinet</u>	<u>Technical Data Sheet</u>	<u>Ensure that each vehicle Weigh in Motion unit has a unique, individual unit number. The unit number must reside in non-volatile memory, so that it is not changed when a “cold or warm boot” is performed or by a power interruption.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing Weight, volume, speed, classification, and classification by speed data simultaneously.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing volume data by lane.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing speed data by lane in a minimum of 15 bins, programmable in 5 mph increments.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing Classification by lane in vehicle type by axle class in 15 bins (minimum) in accordance with FHWA Classification Scheme “F” in Florida’s Traffic Forecasting Handbook, Chapter 2, Figure 2.2 which can be accessed on the Department’s website at the following URL address: <a href="https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/systems/systems-management/document-repository/traffic-analysis/2019-project-traffic-forecasting-handbook.pdf?sfvrsn=e105e71d_2">https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/systems/systems-management/document-repository/traffic-analysis/2019-project-traffic-forecasting-handbook.pdf?sfvrsn=e105e71d_2</a>.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing a minimum of 95% accuracy of vehicle weight, class, speed, and volume.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of providing real-time monitoring of volume data by lane or direction in user selected intervals of as little as 15 minutes, when required, without disrupting the above selected programs</u>
<u>Communications</u>	<u>Technical Data Sheet</u>	<u>Capable of communicating directly with a PC or through a modem at a minimum rate of 19,200 bps.</u>
<u>Configuration</u>	<u>Technical Data Sheet</u>	<u>At a minimum, the following parameters are programmable by direct connection to the Weigh in Motion unit by Ethernet or via modem: 1. Six-digit site number. 2. Number of lanes and directions. 3. Date and time. 4. Data operating and transmission parameters. 5. Sensor spacing. 6. Recording interval. 7. Vehicle parameter table with axle spacing ranges for each type of vehicle. 8. Number and range of speed categories, axle and length classifications, and headway.</u>
<u>Sensor Failure</u>	<u>Technical Data Sheet</u>	<u>The Weigh in Motion unit must continue to provide the speed and/or volume from the remaining functioning sensors.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Sensitivity</u>	<u>Technical Data Sheet</u>	<u>The sensitivity level for each axle sensor must be individually adjustable using software, by direct PC connection and remotely via telemetry.</u>
<u>Loop Detector</u>	<u>Technical Data Sheet</u>	<u>Loop detectors must be internal and self-tuning. The sensitivity level and any additional parameters necessary to prevent “loop crosstalk” for each embedded inductive loop must be individually adjustable using software, both by direct PC connection and remotely via telemetry.</u>
<u>Time Delay</u>	<u>Technical Data Sheet</u>	<u>A time delay, or “de-bounce” value for ignoring spurious axle signals (ghost axles) in the vehicle speed/classification unit software must be provided.</u>
<u>Power</u>	<u>Technical Data Sheet</u>	<u>Provide a vehicle Weigh in Motion unit that is field configurable to be powered 12 VDC and does not consume more than a total of 12 watts. If an internal battery is required, it must be capable of being recharged and shall be furnished and included with the vehicle Weigh in Motion unit at no extra cost.</u>
<u>Mechanical</u>	<u>Technical Data Sheet</u>	<u>Provide a modular electronics unit which is completely enclosed in a durable housing of sheet metal or cast aluminum with a durable finish. When configured for operation the Weigh in Motion unit including all cables must fit into a Type III cabinet.</u>
<u>Environmental</u>	<u>Technical Data Sheet</u>	<u>Provide a Weigh in Motion unit which operates as specified when the ambient temperature and humidity inside the controller cabinet are within the following limits: The operating ambient temperature range must be between minus 0 to 140°F. The rate of change in ambient temperature must not exceed 63°F per hour, during which the relative humidity must not exceed 90%.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Environmental</u>	<u>Technical Data Sheet</u>	<p><u>Provide a Weigh in Motion unit which operates as specified when the ambient temperature and humidity inside the controller cabinet are within the following limits:</u></p> <p><u>The relative humidity must not exceed 90% over the temperature range of 40 to 109°F. Above 109°F, constant absolute humidity must be maintained as seen in Table 997-22.</u></p> <p><u>The relative humidity range shown in Table 997-22 is for dynamic testing.</u></p>
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<u>Table 997-22</u>		
<u>At 14.6 psi Barometric Pressure</u>		
<u>Dry Bulb °F</u>	<u>Relative Humidity (%)</u>	<u>Wet Bulb °F</u>
<u>40</u>	<u>75</u>	<u>37</u>
<u>50</u>	<u>80</u>	<u>46</u>
<u>60</u>	<u>83</u>	<u>57</u>
<u>70</u>	<u>86</u>	<u>66</u>
<u>80</u>	<u>87</u>	<u>77</u>
<u>90</u>	<u>89</u>	<u>88</u>
<u>100</u>	<u>89</u>	<u>97</u>
<u>109</u>	<u>90</u>	<u>108</u>
<u>120</u>	<u>70</u>	<u>109</u>
<u>130</u>	<u>50</u>	<u>109</u>
<u>140</u>	<u>38</u>	<u>109</u>
<u>150</u>	<u>28</u>	<u>109</u>
<u>160</u>	<u>21</u>	<u>109</u>
<u>165</u>	<u>18</u>	<u>109</u>

<u>Table 997-23</u>		
<u>Performance Characteristics, Weigh in Motion Unit Polling Software</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Operations</u>	<u>Department Testing</u>	<u>Real time polling software operates on a PC using the Department's recommended operating system.</u>
<u>Operations</u>	<u>Operations Manual</u>	<u>Software operating procedures.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Table 997-23</u>		
<u>Performance Characteristics, Weigh in Motion Unit Polling Software</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Communications</u>	<u>Technical Data Sheet</u>	<u>Capable of communicating with the Weigh in Motion unit and downloading data via cellular modem and producing reports of 15 minute, hourly, weekly, monthly, and annual volume, weight, and classification data.</u>
<u>Configuration</u>	<u>Technical Data Sheet</u>	<u>Capable of displaying and entering operating parameters into the vehicle Weigh in Motion unit and allowing the display of real-time traffic volumes in addition to routine data collection activities.</u>
<u>Data Storage</u>	<u>Technical Data Sheet</u>	<u>Capable of processing and storing all vehicle data retrieved in routine mode, regardless of the selected parameters.</u>

#### **997-11 TMS Non-Motorized Data Collection Units.**

Non-Motorized data collection units must meet the physical characteristics in Tables 997-24. Polling software must meet the requirements in Table 997-25.

<u>Table 997-24</u>		
<u>Performance Characteristics, Classification Unit</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Operations</u>	<u>Technical Data Sheet</u>	<u>Operates in an unattended mode, accumulating data for later retrieval by downloading via the polling computer system. Capable of downloading through direct connection with a PC, without deleting or marking the files.</u>
<u>Operations</u>	<u>Operations Manual</u>	<u>Non-motorized unit operating procedures.</u>
<u>Compatibility with software</u>	<u>Technical Data Sheet</u>	<u>Outputs data compatible with the Department's polling computer system. If non-compatible, then furnish a software module that converts the data into a format compatible with the Department's polling computer system.</u>
<u>Compatibility with sensors</u>	<u>Technical Data Sheet</u>	<u>Compatible with the embedded inductive loops, axle sensors, and non-intrusive vehicle sensors in place at the Traffic Monitoring Site.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Count, Speed and Classification</u>	<u>Technical Data Sheet</u>	<u>Capable of determining the count and classification (bicycle and pedestrian) by type for all directions of traffic on the sidewalk, side path, bicycle lane, and shared use path.</u>
<u>Functional Requirements</u>	<u>Technical Data Sheet</u>	<u>Capable of receiving input from embedded inductive loops, axle sensors, and non-intrusive sensors on the sidewalk, side path, bicycle lane, and shared use path.</u>
<u>Functional Requirements</u>	<u>Technical Data Sheet</u>	<u>Capable of collecting data from each direction of bicycle and pedestrian traffic in any combination of counts, classification, or direction.</u>
<u>Electrical Components</u>	<u>Technical Data Sheet</u>	<u>Electrical components are designed to be solid-state so that they will not be damaged by jolts and vibrations encountered during shipping and everyday use.</u>
<u>Plug-In Modules</u>	<u>Technical Data Sheet</u>	<u>The non-motorized data collection unit may be constructed utilizing plug-in modules; however, when plug in modules are used, each non-motorized data collection must be identical except for the number and type of modules used. Ensure that modules of the same type are identical and interchangeable.</u>
<u>Multiple Classification Units in One Cabinet</u>	<u>Technical Data Sheet</u>	<u>Ensure that each non-motorized data collection has a unique, individual unit number. The unit number must reside in non-volatile memory, so that it is not changed when a “cold or warm boot” is performed or by a power interruption.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing volume and classification data simultaneously.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing volume data by direction.</u>
<u>Data Collection Requirement</u>	<u>Technical Data Sheet</u>	<u>Capable of obtaining and providing a minimum of 80% accuracy of non-motorized classification and volume.</u>
<u>Communications</u>	<u>Technical Data Sheet</u>	<u>Capable of communicating directly with a PC or through a modem at a minimum rate of 115,200 bps.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Configuration</u>	<u>Technical Data Sheet</u>	<u>At a minimum, the following parameters are programmable by direct connection to the classification unit by Ethernet or via modem:</u> <u>1. Six-digit alphanumeric site number.</u> <u>2. Bicycle and pedestrian direction of travel.</u> <u>3. Date and time.</u> <u>4. Data operating and transmission parameters.</u>
<u>Sensor Failure</u>	<u>Technical Data Sheet</u>	<u>The non-motorized data collection unit must continue to provide the volume from the remaining functioning sensors.</u>
<u>Piezo Sensitivity</u>	<u>Technical Data Sheet</u>	<u>The sensitivity level for each axle sensor must be individually adjustable using software, by direct PC connection and remotely via telemetry.</u>
<u>Loop Detector</u>	<u>Technical Data Sheet</u>	<u>Loop detectors must be internal and self-tuning. The sensitivity level and any additional parameters necessary to prevent "loop crosstalk" for each embedded inductive loop must be individually adjustable using software, both by direct PC connection and remotely via telemetry.</u>
<u>Time Delay</u>	<u>Technical Data Sheet</u>	<u>A time delay, or "de-bounce" value for ignoring spurious axle signals (ghost axles) in the classification unit software must be provided.</u>
<u>Power</u>	<u>Technical Data Sheet</u>	<u>Provide a non-motorized data collection unit that is field configurable to be powered by 12 VDC and does not consume more than a total of 12 watts. If an internal battery is required, it must be capable of being recharged and shall be furnished and included with the non-motorized data collection unit at no extra cost.</u>
<u>Mechanical</u>	<u>Technical Data Sheet</u>	<u>Provide a modular electronics unit which is completely enclosed in a durable housing with a durable finish. When configured for operation the classification unit including all cables must fit into a Type III cabinet or self-contained in the manufacture's housing.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Environmental</u>	<u>Technical Data Sheet</u>	<u>Provide an electronics unit which operates as specified when the ambient temperature and humidity inside the controller cabinet are within the following limits: The operating ambient temperature range must be between minus 0 to 140°F.</u>
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<u>Table 997-25</u>		
<u>Performance Characteristics of Non-Motorized Data Collection Polling Software</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Operations</u>	<u>Department Testing</u>	<u>Polling software operates on a PC using the Department's recommended operating system.</u>
<u>Operations</u>	<u>Operations Manual</u>	<u>Software operating procedures.</u>
<u>Communications</u>	<u>Technical Data Sheet</u>	<u>Capable of communicating with the non-motorized data collection unit and downloading data via cellular modem and producing reports of hourly, weekly, monthly and annual volume and classification data.</u>
<u>Configuration</u>	<u>Technical Data Sheet</u>	<u>Capable of displaying and entering operating parameters into the non-motorized data collection unit and allowing the display of traffic volumes in addition to routine data collection activities.</u>
<u>Data Storage</u>	<u>Technical Data Sheet</u>	<u>Capable of processing and storing all non-motorized data retrieved in routine mode, regardless of the selected parameters.</u>

### **997-12 Adhesive Bonding Agent.**

Meet the requirements in Table 997-26.

<u>Table 997-26</u>		
<u>Physical Characteristics, Adhesive Bonding Agent</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Agent</u>	<u>Technical Data Sheet</u>	<u>Flowable mortar-based methyl methacrylate resin</u>
<u>Application</u>	<u>Technical Data Sheet</u>	<u>Per manufacturer's instruction.</u>
<u>Curing Time</u>	<u>Technical Data Sheet</u>	<u>Less than 60 minutes.</u>

### **997-13 Loop Sealant.**

Meet the requirements in Table 997-27.

Note: This revision has numerous instances of original language moved to various Articles.

<u>Table 997-27</u> <u>Physical Characteristics, Loop Sealant</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Agent</u>	<u>Technical Data Sheet</u>	<u>2-part unsaturated polyester resin utilizing a liquid methyl ethyl ketone peroxide (MEKP) hardener</u>
<u>Application</u>	<u>Technical Data Sheet</u>	<u>Per manufacturer's instruction. Hardener component amounts may be adjusted according to temperature and an accelerator is available for use in colder climates to further reduce drying time. Improper mixing may cause poor results.</u>
<u>Curing Time</u>	<u>Technical Data Sheet</u>	<u>Less than 60 minutes.</u>

#### 997-14 TMS Cabinets.

Meet the requirements of Tables 997-28 and 997-29.

<u>Table 997-28</u> <u>Physical Characteristics, TMS Cabinet</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Cabinet Shell Material</u>	<u>Technical Data Sheet</u>	<u>0.125-inch-thick sheet aluminum Type 5052-H32</u>
<u>Workmanship</u>	<u>Letter of Conformance</u>	<u>Exterior seams are continuously welded, smooth, free of cracks, blow holes or other irregularities and the inside and outside edges are free of burrs.</u>
<u>Cabinet Finish</u>	<u>Technical Data Sheet</u>	<u>Outside surface of the cabinet has a smooth, uniform, and natural finish and the cabinet top has a sloped surface to prevent accumulation of water.</u>
<u>Cabinet Vent</u>	<u>Technical Data Sheet</u>	<u>Vent between the top of the door and the top of the cabinet, covered by screen material with a maximum opening of 0.125 inches.</u>
<u>Cabinet Door Hinge</u>	<u>Technical Data Sheet</u>	<u>Continuously hinged door constructed of 14-gauge stainless steel or 0.125 inches aluminum that occupies 80% of the front surface area of the cabinet and is rain and dust tight; hinged on the right side of the cabinet; hinge pin is stainless steel and capped at the top and bottom to deter tampering.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Cabinet Door</u>	<u>Technical Data Sheet</u>	<u>Double flanged on all four sides and equip it with a restraint that will hold the door open in the 90 degree and 120-degree position.</u>
<u>Cabinet Door Lock</u>	<u>Technical Data Sheet</u>	<u>Three point latching system, consisting of the following latch points: (1) Center of the cabinet - latching handle with provisions for a padlock in the center position (2) Top of the cabinet - controlled by the door handle (3) Bottom of the cabinet - controlled by the door handle Ensure that latching points (2) and (3) remain in the locked position until the latching handle is rotated to the unlocked position.</u>
<u>Cabinet Door Vent</u>	<u>Technical Data Sheet</u>	<u>Louvered vents meeting the NEMA rod entry test for 3R enclosures. The louvers are covered by a replaceable air filter mounted inside the cabinet door with either brackets or clamps that will allow easy removal and replacement.</u>
<u>Cabinet Shelf</u>	<u>Technical Data Sheet</u>	<u>Adjustable shelf, constructed of 0.08 inches thick aluminum, that is adjustable to within 15 inches of the top of the cabinet and to within 26 inches of the bottom of the cabinet in 2 inches increments.</u>

Table 997-29  
TMS Cabinet Dimensions

		<u>Cabinet Dimensions in Inches</u>		
<u>Cabinet Type</u>	<u>Documentation</u>	<u>Height</u>	<u>Width</u>	<u>Depth</u>
<u>Type III</u>	<u>Technical Data Sheet</u>	<u>38"</u>	<u>23"</u>	<u>18"</u>
<u>Type IV</u>	<u>Technical Data Sheet</u>	<u>48"</u>	<u>30"</u>	<u>16"</u>
<u>Type V</u>	<u>Technical Data Sheet</u>	<u>56"</u>	<u>38"</u>	<u>27"</u>

### 997-15 TMS Suppression Devices.

997-15.1 Power Suppression Devices: Meet the requirements of Table 997-30.

<u>Table 997-30</u> <u>Physical Characteristics, Power Suppression Devices</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Connector Type</u>	<u>Technical Data Sheet</u>	<u>Terminal Strip - plug in or screw type</u>
<u>Voltage</u>	<u>Technical Data Sheet</u>	<u>12 – 24 V<sub>DC</sub></u>

997-15.2 Sensor Suppression Devices: Meet the requirements of Table 997-31.

Note: This revision has numerous instances of original language moved to various Articles.

<u>Table 997-31</u> <u>Physical Characteristics, Sensor Suppression Devices</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Connector Type</u>	<u>Technical Data Sheet</u>	<u>Terminal Strip - plug in or screw type</u>
<u>Voltage</u>	<u>Technical Data Sheet</u>	<u>6 V<sub>DC</sub></u>

### **997-16 TMS Managed Field Ethernet Switch.**

Meet the requirements of Table 997-32 and 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>.

<u>Table 997-32</u> <u>Performance Characteristics, Managed Field Ethernet Switch</u>		
<u>Property</u>	<u>Documentation</u>	<u>Requirements</u>
<u>Layer 2+ Capability</u>	<u>Technical Data Sheet</u>	<u>QoS, IGMP, rate limiting, security filtering</u>
<u>Transmission</u>	<u>Technical Data Sheet</u>	<u>Full Duplex, Half Duplex Ethernet communications</u>
<u>Error-free Operation</u>	<u>Technical Data Sheet</u>	<u>99.999%</u>
<u>Mean Time Between Failures</u>	<u>Technical Data Sheet</u>	<u>10 years or 87,600 hours, using Bellcore/Telcordia SR-332 standards</u>
<u>Networking Standards</u>	<u>Technical Data Sheet</u>	<u>IEEE 802.1Q, IEEE 802.1P, IEEE 802.3, IEEE 802.3u, IEEE 802.3x,</u>
<u>Optical Ports</u>	<u>Technical Data Sheet</u>	<u>Single Mode: 1,310 or 1,550 nanometers. Type ST or LC.</u>
<u>Optical Ports</u>	<u>Technical Data Sheet</u>	<u>1000 Base FX, with optical budget of at least 15dB. Minimum of four ports designed for use with two pair of fibers, two strands transmit, the other two strands receive.</u>
<u>Copper Ports</u>	<u>Technical Data Sheet</u>	<u>Minimum of four copper ports, Type RJ-45, auto-negotiate (10/100 Base), full duplex. IEEE 802.3 standard pinouts.</u>
<u>Operational Indicators</u>	<u>Technical Data Sheet</u>	<u>LEDs showing link, transmit, receive, and power.</u>
<u>Management Capability</u>	<u>Technical Data Sheet</u>	<u>Port-based VLAN, VLAN tagging, IEEE 802.1Q, 4-kilobit VLAN address table.</u>
<u>Management Capability</u>	<u>Technical Data Sheet</u>	<u>Forwarding/filtering rate at a minimum 14,880 packets per second for 10 megabits per second, and 148,800 packets per second for 100 megabits per second.</u>

Note: This revision has numerous instances of original language moved to various Articles.

<u>Management Capability</u>	<u>Technical Data Sheet</u>	<u>Minimum 4 kilobit MAC address table.</u>
<u>Management Capability</u>	<u>Technical Data Sheet</u>	<u>Support of, at a minimum, Version 2 of the Internet Group Management Protocol (IGMP).</u>
<u>Management Capability</u>	<u>Technical Data Sheet</u>	<u>Support of Secure Shell (SSH) and secure Web-based GUI.</u>
<u>Management Capability</u>	<u>Technical Data Sheet</u>	<u>Support of the Simple Network Management Protocol (SNMP) version 1/2/3. Accessible using the EIA-232 management port or telecommunication network.</u>
<u>Management Capability</u>	<u>Technical Data Sheet</u>	<u>Support of Remote Authentication Dial-In User Service (RADIUS) or Terminal Access Controller Access-Control System Plus (TACACS+).</u>
<u>Management Capability</u>	<u>Technical Data Sheet</u>	<u>Support of remote monitoring (RMON) of the Ethernet agent and the ability to switch monitoring (SMON).</u>
<u>Management Capability</u>	<u>Technical Data Sheet</u>	<u>Support of Secure Copy (SCP) or Secure File Transfer Protocol (SFTP) and either Network Time Protocol (NTP) or Simple Network Time Protocol (SNTP).</u>
<u>Management Capability</u>	<u>Technical Data Sheet</u>	<u>Supports port mirroring when combined with a network analyzer.</u>
<u>Power Requirements</u>	<u>Technical Data Sheet</u>	<u>Compatible with the solar requirements in 997-5.</u>
<u>Power Requirements</u>	<u>Technical Data Sheet</u>	<u>Fiber port fail open feature.</u>
<u>Environmental Requirements</u>	<u>Technical Data Sheet</u>	<u>NEMA TS 2 2021, Sections 2.2.7, 2.2.8., and 2.2.9.</u>
<u>Data Interface Compatibility</u>	<u>Department Testing</u>	<u>Compatible with the Vehicle Speed/Classification Unit, Weigh-In-Motion Unit, and Non-motorized Data Collection Unit.</u>
<u>Data Interface Compatibility</u>	<u>Department Testing</u>	<u>Compatible with the Department's polling software (TPAS).</u>