ORIGINATION FORM
Proposed Revisions to the Specifications
(Please provide all information - incomplete forms will be returned)

Date: 6/28/23

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Article/Subarticle: 695-2 through 695-15

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Associated Section(s) Revisions: 997

Will the proposed revision require changes to the following Publications:

Publication	Yes	No	Office Staff Contacted	Date
Standard Plans Index	●	○	Rick Jenkins/Darren Martin	6/1/23
Traffic Engineering Manual	○	●	Write-In	
FDOT Design Manual	○	●	Write-In	
Construction Project Administration Manual	●	○	Olivia Townsend/Taylor Calrquist	6/1/23
Basis of Estimate/Pay Items	●	○	Ryan Gray	6/5/23
Structures Design Guidelines	○	●	Write-In	
Approved Product List	●	○	Karen Byram/Melissa Hollis/Sarah Sr	6/5/23
Materials Manual	○	●	Write-In	
Maintenance Specs	○	●	Write-In	

Will this revision necessitate any of the following:

Design Bulletin ☐ **Construction (DCE Memo)** ☐ **Estimates Bulletin** ☐ **Materials Bulletin** ☐

Have all references to internal and external publications in this Section been verified for accuracy? YES

Synopsis: Summarize the changes:

Added Materials table. Moved warranty, terms and conditions information to 997. Removed duplicate installation language that is shown in Index 695-001. Moved Vehicle Speed/Classification Unit materials to 997. Removed Class I Axle sensors. Added new subarticle for Non-Motorized Sensors, Vehicle WIM Unit, Non-Motorized Data Unit, Managed

Justification: Why does the existing language need to be changed?

The Traffic Monitoring Site equipment will be shown on the Approved Products List (APL). Warranties are required for product acceptance into the APL. The vehicle speed/classification units will be listed on the APL. Class I Axle sensors are not being deployed. Non-Motorized detectors for bicycles and pedestrians will be deployed by the Department. Splicing loop wires to lead-in cables is a common failure issue.

Do the changes affect either of the following types of specifications (Hover over type to go to site.):

Special Provisions ☐ **Developmental Specifications** ☐

List Specifications Affected: (ex. SP3270301, Dev330TL, Dev334TL etc.)

Contact the State Specifications Office for assistance completing this form.

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1. Are changes in line with promoting and making meaningful progress on improving safety, enhancing mobility, inspiring innovation, and fostering talent; explain how?

To evaluate the performance of the shared use paths, the proposed changes addresses the techr

2. What financial impact does the change have; project costs, pay item structure, or consultant fees?

New pay items for the costs of furnishing and installing shared use path sensors. Contractors will

3. What impacts does the change have on production or construction schedules?

Contractors will include the procurement of TMS equipment in their schedules.

4. How does this change improve efficiency or quality?

Shifts the burden of equipment procurement from the Department to the Contractor.

5. Which FDOT offices does the change impact?

Transportation Data and Analytics.

6. What is the impact to districts with this change?

Districts will need to budget the cost of TMS equipment in their projects.

7. Does the change shift risk and to who?

Equipment procurement risks are shifted from the Department to the Contractor.

8. Provide summary and resolution of any outstanding comments from the districts or industry.

Comments and Responses are available on the Track the Status of Revisions hyperlink located on the Specifications landing page: https://www.fdot.gov/programmanagement/Specs.shtm

9. What is the communication plan?

Through the established specification revision process (e.g., Internal and Industry Review)

10. What is the schedule for implementation?

The Standard Specifications eBook and Workbook are effective July 1st every year.

TRAFFIC MONITORING SITE EQUIPMENT AND MATERIALS.
(REV 8-23-23)

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
Wire for Inductive Loop*	Section 997
Class II Piezoelectric Axle Sensor*	Section 997
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.~~

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 in accordance with Standard Plans, Index 695-001. ~~and g~~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.~~ Ensure that the terms and conditions of warranties are documented when submitting equipment submittal for approval. 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. 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.~~

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

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

695-3.1 General: ~~Install~~ The vehicle classification site consists of axle sensors and inductive loop sensors. 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)~~:

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 axles 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 inch~~es~~ 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 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.

~~**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:**~~

~~**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.~~

~~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.~~

~~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.~~

~~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_{DC} 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 140ºF.~~

~~The rate of change in ambient temperature must not exceed 63ºF 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 109ºF. Above 109ºF, 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.~~

~~Table 695-1~~
~~At 14.6 psi Barometric Pressure~~

~~Dry Bulb ºF~~	~~Relative Humidity (%)~~	~~Wet Bulb ºF~~
~~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.~~

~~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.

~~**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.

~~**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 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.~~

~~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~~

~~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.~~

~~**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~~7.~~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

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~~7.~~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,~~

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

695-~~5~~7.~~5~~4.~~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~~"~~ inch 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~~7.~~6~~ 5 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.~~

~~**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.

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

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~~9.~~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.

~~**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-~~7~~10.~~3~~ 2 Installation Requirements:~~Install inductive loop assembly components and materials in accordance with the Plans and the Standard Plans.~~

695-~~7~~10.~~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-~~7~~10.~~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-~~7~~10.~~3~~2.3 Loop Wire Twisted Pair Lead: For motorized vehicular loops, c~~C~~reate 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-~~7~~10.~~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-~~7~~10.~~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.

695-~~7~~10.~~4~~3.1 Motorized Vehicular Loop Resistance: Ensure new loops have a resistance reading of 3.0 Ω or less.

695-~~7~~10.~~4~~3.2 Motorized Vehicular Loop Inductance: Ensure new loops have a minimum inductance reading of 100 µH.~~MΩ~~

695-~~7~~10.~~4~~3.3 Motorized Vehicular Loop Insulation Resistance (Megging): Ensure new loops have a minimum reading of 200 MΩ at 500 V.

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

695-10.3.5 Non-Motorized Vehicular Loop Inductance: Ensure new loops have an inductance reading of 100 to 150 µH.

695-10.3.6 Non-Motorized Vehicular Loop Insulation Resistance (Megging): Ensure new loops have a minimum reading of 200 MΩ 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-~~8~~11.1 General: ~~Install~~ Furnish and install Type III, IV or V TMS cabinets in accordance with Section 676 and Standard Plans, Index 695-001.

695-~~8~~11.2 Materials:

695-~~8~~11.2.1 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-~~8~~11.2.2 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-~~8~~11.2.3 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-~~8~~11.3 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-~~8~~11.3.1 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.

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_{DC}.~~

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

~~**695-9**~~**12.~~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~~

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.

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.