

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
PAVEMENT SENSOR

MET:RDM

1 of 7

APPR:EG:MS:04-12-21

a. Description. This work consists of furnishing, installing, integrating, calibrating, testing, and providing manufacturer warranty of a pavement sensor and all ancillary components, as a part of an environmental sensor station (ESS) as shown on the plans. Ensure this work is done in accordance with the standard specifications, except as modified herein. The plans will indicate the type of device, invasive or non-invasive, quantity, location, and components required for each site, communications medium, and power for each device location.

This special provision provides a modular framework for the specification of the device with functions and capabilities which can be selected to meet site specific needs and conditions.

1. General.

A. Furnish, install, integrate, calibrate, test, and provide manufacturer warranty for all equipment and components necessary to provide complete functionality without additional expense to the contract.

B. Ensure final equipment selection, procurement, and installation is approved and coordinated with the Engineer.

C. Different configurations of sensors and/or equipment may be specified at various ESS sites. Ensure same function and range sensor and/or equipment is identical when used at each site.

2. Functional and Performance Requirements.

A. General.

(1) Integrate the pavement sensors with the remote processing unit (RPU) located in the field cabinet as designated on the plans.

(2) Ensure the pavement sensors allow for interoperability between multiple vendors' field controllers.

(3) Ensure all sensors are compatible with an RPU that is *National Transportation Communications for ITS Protocol* (NTCIP) compliant for communication to MDOT's current statewide Road Weather Information System (RWIS) hosting system and/or Advanced Traffic Management System (ATMS) software.

(4) Ensure all sensors support at least one of following communication protocols in order to transmit data to the RPU:

- (a) Serial (RS-232/RS-422/RS-485);
- (b) Analog/Digital; or
- (c) Ethernet.

(5) Ensure the pavement sensor(s) meet the minimum performance requirements identified in Table 1 and Table 2 of this special provision.

B. Invasive Pavement Condition Sensor.

(1) The invasive pavement condition sensor is a single solid-state electronic “puck type” passive device with no moving parts, capable of measuring and recording road surface conditions and temperatures. Install the sensor in the roadway pavement at the locations shown on the plans.

(2) Ensure the invasive pavement condition sensor(s) is thermally passive, providing stable operation over the temperature range indicated in Table 1 herein. Ensure weather conditions, traffic, or ice control chemicals do not degrade the sensor’s performance.

(3) Install the sensor flush with pavement to obtain the temperature at roughly 0.2 inches (3mm) below the surface.

(4) Ensure the sensor provides the temperature reading at no more than 3 minute intervals.

(5) Ensure the sensor obtains the condition of the pavement surface including whether it is dry, wet, damp, or shows trace moisture.

(6) The sensor must obtain:

- (a) Freezing point temperature of NaCl, MgCl, or CaCl;
- (b) Chemical percentage or factor;
- (c) Ice percentage;
- (d) Depth of water layer up to 3mm; and
- (e) Conductivity (used for calculating chemical percentage).

(7) Ensure the sensor outputs the surface condition data to the RPU which will be used to calculate or determine a snow/ice warning, snow/ice watch, wet below freezing, and frost condition.

Table 1: Invasive Pavement Condition Sensor Performance Specifications

Sensor	Sensor Measurement	Specifications	
		Typical Accuracy Range	Operating Range
Surface Temperature	Surface Temperature	$\pm 0.2^{\circ}$ Celsius (C) ($\pm 0.36^{\circ}$ Fahrenheit (F))	-40 to $+60^{\circ}$ C (-40 to $+140^{\circ}$ F)
Surface Status	Dry	N/A	-30 to $+50^{\circ}$ C (-22 to $+122^{\circ}$ F)
	Wet		
	Chemical Wet		
	Damp		
	Trace Moisture		
Surface Condition	Freezing Point	$\pm 1.0^{\circ}$ C ($\pm 1.8^{\circ}$ F)	-15 to 0° C (+5 to $+32^{\circ}$ F)
	Chemical Percentage or Factor	$\pm 1.0^{\circ}$ C ($\pm 1.8^{\circ}$ F)	0 to 100% NaCl 0 to 20% All Others
	Ice Percentage	N/A	0 to 100%
	Depth of Water Layer	$\pm 30\%$ of measurement over the operating range	0.25 to 3mm (0 to 0.2 inches)
	Conductivity	NA	

C. Non-Invasive Pavement Condition Sensor. Ensure the non-invasive pavement condition sensor is a mounted sensor capable of recording surface temperatures and conditions at the locations shown on the plans.

(1) Ensure the sensor provides stable operation over the temperature range indicated in Table 2 herein. Ensure weather conditions does not degrade the sensor's performance.

(2) Ensure the sensor measures the temperature using infrared technology.

(3) Ensure the sensor provides the temperature reading at no more than 3 minute intervals.

(4) Ensure the sensor obtains the condition of the pavement surface including whether it is dry, wet, damp, or shows trace moisture.

(5) Ensure the sensor measures friction and/or provides a grip factor.

(6) Ensure the surface condition sensor obtains ice percentage, and depth of water layer up to 0.2 inches.

(7) Ensure the sensor outputs the surface condition data to the RPU which will be used to calculate or determine a snow/ice warning, snow/ice watch, wet below freezing, and frost condition.

(8) Ensure the sensor is mounted such that the distance between the surface measurement location and the sensor is between 20 feet (6 meters) and 49 feet (15 meters).

(9) Ensure the mounting height and downward pitch angle are in accordance with the manufacturer recommendations for the roadway.

Table 2: Non-Invasive Pavement Condition Sensor Performance Specifications

Sensor	Sensor Measurement	Specifications	
		Typical Accuracy Range	Operating Range
Surface Temperature	Surface Temperature	±0.8° C (1.44° F)	-30 to +50° C (-22 to +122° F)
Surface Status	Dry	N/A	
	Wet		
	Damp		
	Trace Moisture		
Surface Condition	Ice Percentage	N/A	
	Depth of Water Layer	±20% of measurement over the operating range	0.25 to 3mm (0 to 0.2 inches)
	Grip Level	N/A	0.01 to 1

D. Pavement Temperature Sensor.

(1) The pavement temperature sensor is a single solid-state electronic passive device with no moving parts, capable of measuring and recording road surface temperature. Install the sensor in the roadway pavement at the locations shown on the plans.

(2) Ensure the temperature sensor meets the requirements for surface temperature readings set forth in Table 1 herein. Ensure the sensor obtains the temperature roughly 0.2 inches (3mm) below the surface.

(3) Ensure the sensor provides the temperature reading at no more than 3 minute intervals.

b. Materials.

1. Use only new, corrosion resistant materials in accordance with the details shown on the plans and in this special provision.

2. Ensure all electrical components operate on 120 volt alternating current (AC) (±10 percent) 50/60 hertz (Hz) electricity. Provide appropriate direct current (DC) conversion for any equipment requiring DC power. If the site is solar powered, the Contractor will be allowed to power the devices using DC equipment. Provide appropriate DC to DC and DC to AC conversion, as necessary.

3. Install equipment in such a way as to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.

4. Ensure all field equipment:

A. Meets the following minimum temperature and environmental requirements:

(1) Operating/Storage temperature range of -22 degrees F to +140 degrees F; and

(2) Non-condensing operating humidity range of 5 to 95 percent;

B. Provide an aspirated radiation shield or sensor design to meet the performance requirements noted in Table 1 herein.

c. Construction. Ensure all elements included in this special provision, including power and communications, complies with the standard specifications, this special provision, and any applicable state and local regulations.

1. Installation.

A. Ensure all cabling is labeled on both ends, bundled, and stressed.

B. Ensure installation of pavement sensors is in conformance with the manufacturer's requirements for the device as specified, as it may be upgraded over its operational life.

C. Ensure the installation meets local and state electrical requirements including grounding. Grounding must be paid for and covered under 20SP-826A - Grounding, Bonding, Lightning Protection and Surge Protection for Intelligent Transportation System Equipment.

D. Ensure that a representative from the pavement sensor manufacturer or other certified company is in attendance during installation of the first ESS site.

E. Do not damage any part or equipment during installation. Ensure damaged parts or equipment are replaced at no additional cost to the contract. Repair is not an acceptable means of replacement. Ensure all equipment is replaced with new parts.

F. Wiring joints and splices are only permitted at the ESS cabinet (shown on plans) or at access points shown on the plans.

G. All exterior cable installations must incorporate suitable drip loops and ice bridges.

H. Protect the power, control, and return conductors along with all site equipment as specified by the ESS RPU and sensor manufacturers with the appropriate surge protector.

I. Ensure invasive pavement sensor installations use a pavement cut of normal saw blade size to hold sensor cable. Ensure pavement cuts are filled with appropriate flexible sealant as recommended by manufacturer (3M DBR-6, Q-SEAL 290S, or approved equal). Ensure pavement cuts and sealant are as specified in this special provision. Install an epoxy sealer over the sensor so the top is flush with the roadway surface.

J. Conditions of the materials under the roadway surface are unknown and any costs incurred while installing equipment in roadway are considered covered under this special provision.

K. Supply a 150 foot, 300 foot, or 500 foot waterproof molded cable capable of operating at extended cable lengths up to 5,000 feet from the RPU as shown on the plans.

2. Testing.

A. Include the pavement sensor in the Test Plan required in 20SP-826H - System Integration and Testing to verify the sensor meets the minimum operational parameters specified by the sensor manufacturer.

B. Furnish test equipment that is capable of testing procedures and those procedure's parameters that are equal or better than the minimum test parameters specified by the sensor manufacturers.

C. Ensure Post-construction testing is conducted. This is a site test to demonstrate after the completion of each pavement condition sensor installation, the operation of the device and ESS as a fully integrated system as required by this special provision and the anticipated use by MDOT. Testing of the device must consist of demonstrating all capabilities and parameters required by device type as indicated in Tables 1 and 2 of this special provision.

3. Manufacturer Warranty.

A. Ensure any defect in design, materials, or workmanship which may occur during proper and normal use through final system acceptance is corrected by and/or replacement by the Contractor without cost to the contract.

B. All pavement sensors and equipment must carry a manufacturer's standard warranty (equipment and parts) of 2 years from the date of shipment with at least 1 year remaining at the start of burn-in. Furnish warranty and other applicable documents from the manufacturer, and a copy of the invoice showing the date of shipment, to the Engineer prior to final written acceptance. Ensure all warranties are transferred to MDOT upon written final acceptance.

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay item:

Pay Item	Pay Unit
Pavt Sensor, (type).....	Each

No additional payment will be provided for sensors that are incorporated into the device that are not called for on the plans. The device must provide the full functionality required of each sensor type. In the event of a failure of one sensor type, the Contractor must provide a complete device to replace the faulty unit.

Pavt Sensor, (type) includes furnishing, installing, integrating, testing, warranting, and making fully operational as noted on the plans and in accordance with this special provision. The following provides a summary for the pay item listed above.

1. Pavt Sensor, Invasive Condition. This pay item includes a passive pavement condition sensor capable of reporting surface temperature, condition and status, cabling, and communications connections for a fully functional sensor.

2. **Pavt Sensor, Non-Invasive Condition.** This pay item includes a non-invasive pavement condition sensor capable of reporting surface temperature, condition and status. The sensor includes all cabling, mounting hardware, accessories and power and communications connections for a fully functional sensor.

3. **Pavt Sensor, Temperature.** This pay item includes an invasive pavement temperature sensor capable of reporting surface temperature only. The sensor includes all cabling, accessories and power and communications connections for a fully functional sensor.