MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
REMOTE PROCESSING UNIT

a. Description. This work consists of furnishing, installing, integrating, testing, and warrantying a remote processing unit (RPU) as a part of an environmental sensor station (ESS) installation as shown on the plans. Ensure this work is done in accordance with the standard specifications, except as modified herein. The plans indicate device quantity, location, communications medium, and power for each ESS.

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. Use identical and completely interchangeable equipment at each field location.

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

D. Different configurations of sensors and/or equipment may be specified at various ESS sites. Ensure equipment with the same function and range are identical when used at each site. This is intended to minimize the number of variations of spare parts and software patches necessary to maintain the ESS sites.

2. Requirements of Regulatory Agencies. Comply with the following codes or standards:

A. *NTCIP 1204 - Environmental Sensor Station* (ESS) *Interface Protocol*.

3. Functional and Performance Requirements.

A. General. Ensure the RPU can accept a minimum of 20 sensors concurrently and can be expanded to accept additional sensors. Ensure the RPU can connect to a dry contact solid state relay to open or close based on any weather condition parameter sensed by the ESS site.

B. All data communication from the proposed RPU to the MDOT's statewide Road Weather Information System (RWIS) hosting system using the specified communication medium is to be performed via an Ethernet port on the RPU that supports a minimum of 10 megabits per second (Mbps).

(1) Ensure the RPU is open protocol allowing for interoperability and connectivity to multiple vendors' products.

(2) RPU design must maximize the use of solid-state components and ensure each sensor outputs/controls are protected against lightning.

(3) The RPU must have sufficient memory and capability to record and archive automated ESS instrument observations for a period of 3 days, at minimum. Ensure the interval between archived observations is selectable between 1 minute and 20 minutes.

C. Communications and Interfaces. RPU communication with the hosted server must utilize *Federal Standard NTCIP-ESS* protocol. Ensure the RPU allows the server to poll the RPU via Ethernet communication. Ensure the RPU is also capable of supporting file transfer protocol (FTP) of all weather data and camera imagery in NTCIP format to a remote server or central hosting system.

D. The RPU must incorporate “watch-dog” circuitry, monitor its own operation, and reset itself if the RPU software enters an indeterminate state. Ensure the RPU also has the capability to be reset remotely by a user administrator.

E. For maximum reliability, ensure the design utilizes extensive lightning protection for all channels and serial ports, including auto-reset circuit breakers for power, transient voltage suppression (VTS) diode, and gas discharge tubes.

F. Ensure the RPU is capable of being modified to utilize solar power or other power sources in place of conventional commercial electric power.

G. Ensure the RPU is enclosed inside an ITS Cabinet (paid for under a separate pay item) that is resistant to damage by weather and vandals. All remaining equipment is expected to be installed in the ITS cabinet including modems, switches, surge protection devices and power equipment. Ensure the Engineer approves the final placement of the RPU.

H. Ensure RPU software configuration is performed by personal computer (PC) with browser connected to the RPU Ethernet port.

I. Ensure the RPU software has a user interface on the RPU (either through web or an external display) for sensor configuration and routine maintenance. Ensure troubleshooting and complete configuration of the RPU can be accomplished by local on-site access or remote access. Ensure software fixes and upgrades for the RPU are accomplished remotely by connecting directly into the RPU.

J. Ensure the RPU supports communications of the field data in compliance with *NTCIP 1204, "Object Definitions for ESS*," and is field upgradeable for future *NTCIP* version releases at no additional cost to the contract. Furnish and install all hardware or software upgrades to any ESS components affected by changes to *NTCIP* standards which occur prior to the completion of the warranty period.

K. Ensure the RPU, at a minimum, can collect data from the following sensors:

(1) Relative humidity/air temperature sensor;

(2) Barometric pressure sensor;

(3) Wind speed and direction, mechanical or ultrasonic sensors;

(4) Precipitation occurrence sensor;

(5) Present weather and visibility sensor (combined sensor);

(6) Precipitation sensor;

(7) Visibility sensor;

(8) Snow depth sensor;

(9) Solar radiation sensor;

(10) Water level sensor;

(11) Rain gauge sensor;

(12) Digital visibility sensors;

(13) Passive pavement sensor;

(14) Active pavement sensor;

(15) Non-invasive pavement temperature sensor;

(16) Non-invasive laser-based pavement sensor;

(17) Sub-surface temperature probe;

(18) Temperature depth probe sensor;

(19) Wireless in pavement traffic sensor;

(20) Side fire traffic radar;

(21) Fixed color web camera;

(22) Pan/Tilt/Zoom (PTZ) color web camera; and

(23) External device control - such as spread spectrum radio activation of signs.

L. Ensure all of the above sensors and devices are connected to a RPU within the ESS. Ensure any combination of sensors as shown on the plans are accommodated by one or more RPU's.

M. Ensure the RPU collects data from the sensors shown on the plans and, at minimum, support the calculation and presentation of the following items using the

NTCIP compliant RPU.

(1) Atmospheric.

(a) Air Temperature. Minimum/maximum air temperature, relative humidity, dew point.

(b) Anemometer (Wind Sensor). Wind speed, direction, maximum wind gust.

(c) Precipitation. Precipitation rate, intensity, classification, accumulation, start/end time, time since last precipitation, forecasted snow accumulation, probability of precipitation.

(d) Barometric Pressure. Absolute atmospheric pressure.

(2) Pavement Condition Sensor. Pavement temperature, condition, chemical concentration, conductivity, snow/ice warning, snow/ice watch, wet below freezing, frost, chemical wet, depth of water layer.

(3) Sub-Surface Temperature Probe. Temperature reading up to 15 sub-surface depths.

(4) Camera. Ensure up to 8 camera images are capable of being stored digitally by the RPU until requested or retrieved at the head-end.

(5) Maintenance and Operation.

(a) RPU must display real-time data for all sensors connected.

(b) Ensure the RPU supports local maintenance of all devices physically connected to the RPU using an integrated web-based data display.

(c) Ensure the RPU has an automated reset system, which in case of power failure or other interruption of normal operation allows the system to return to normal operation.

b. Materials.

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

2. Ensure all electrical components operate on 120 VAC (± 10 percent) 50/60 hertz (Hz) electricity. Furnish appropriate DC conversion for any equipment requiring DC power. If the site is solar powered, the Contractor is allowed to power the devices using DC equipment. Provide appropriate DC-to-DC or AC-to-DC conversion equipment as needed.

3. Design the equipment to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.

4. All field equipment must:

A. Meet the following minimum temperature and environmental requirements:

(1) Operating/Storage temperature range of -30 ºF to 140 ºF (-34 ºC to +60 ºC).

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

B Survive exposure to either direct solar heating or to high temperatures within an enclosure, as stated in storage temperature range noted above.

5. Ensure the RPU incorporates surge suppression protection for each of the devices inside of the ITS Cabinet (to be paid for under 20SP-826A - Grounding, Bonding, Lightning Protection, and Surge Protection for Electrical System Equipment).

c. Construction. All elements included in this special provision, including power and communications, must comply with the construction requirements stated in the standard specifications, the special provisions, and any applicable state and local regulations.

1. Installation.

A. Ensure all installation is done in a neat and professional manner. Ensure all cabling is labeled on both ends, bundled, and stressed.

B. Ensure installation of the RPU is in accordance 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 will be paid for and covered under 20SP-826A - Grounding, Bonding, Lightning Protection, and Surge Protection for Electrical System Equipment.

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

E. Ensure the appropriate surge protector protects the power, control, and return conductors along with all site equipment as specified by the ESS RPU and sensor manufacturers. Surge protection is to be paid for under 20SP-826A - Grounding, Bonding, Lightning Protection, and Surge Protection for Electrical System Equipment.

2. Testing.

A. Include the RPU in Acceptance Test Plan (ATP) as detailed in 20SP-826H - System Integration and Testing.

B. Furnish test equipment at no additional cost to the contract. Test procedures and passing criteria must, at a minimum, be the requirements of the RPU manufacturer.

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 replaced

by the Contractor without cost to the contract.

B. All RPUs and associated equipment must carry a standard manufacturer's 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**
Remote Processing Unit	Each

Remote Processing Unit includes the processing unit, cabling, mounting accessories, and power and communications connections for a fully functional unit.