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781 INTELLIGENT TRANSPORTATION SYSTEMS–MOTORIST INFORMATION SYSTEMS.

(REV 12-7-10) (FA 1-24-11) (7-11)

SUBARTICLE 781-1 (of the Supplemental Specifications) is deleted and the following substituted:

781-1 Description.

Furnish and install Motorist Information Systems meeting the general requirements of 781-2, the specific requirements for each system as defined in 781-3 through 781-6 of this specification, and in accordance with the details specified in the Contract Documents.

SUBARTICLE 781-3.1 (of the Supplemental Specifications) the first paragraph, is deleted and the following substituted:

781-3.1 Dynamic Message Sign with 18" Character Display (18" DMS): Furnish and install an 18" DMS in accordance with the details specified in the Contract Documents. Use only equipment and components that meet the requirements of these minimum specifications, and are listed on the Department's Approved Product List (APL).

SUBARTICLE 781-3.1.2 (of the Supplemental Specifications) the first subarticle, is deleted and the following substituted:

781-3.1.2 Sign Housing: Ensure that the external skin of the sign housing is constructed of aluminum alloy 5052 H32 that is a minimum of 0.125 inch thick. Ensure that the sign housing design and appearance is approved by the Engineer. If cable attachments are used in the sign housing, the cables shall be securely clamped using a method approved by the Engineer. No adhesive attachments shall be allowed.

Ensure that exterior seams and joints, except the finish coated face pieces, are continuously welded using an inert gas welding method. Limit the number of seams on the top of the housing to a maximum of three. Stitch weld the exterior housing panel material to the internal structural members to form a unitized structure.

Ensure that exterior mounting assemblies are fabricated from aluminum alloy 6061-T6 extrusions a minimum of 0.1875 inch thick. Include a minimum of three 6061-T6 structural aluminum Z members on the rear of the sign housing in accordance with the Design Standards, Index 18300. Ensure these structural members run parallel to the top and bottom of the sign housing and are each a single piece of material that spans the full length of the sign. Ensure the top member is placed within twelve inches from the top edge of the housing. Ensure the bottom member is placed within twelve inches from the bottom edge of the housing. Ensure these structural members are attached to the internal framework of the sign.

Ensure that the bottom panel of the sign housing includes a minimum of four drain holes with replaceable plugs that serve to open and close the drain. Ensure that the drain holes are centered from the front to the back of the housing, and equally spaced across the housing's full length. Ensure that all drain holes and other openings in the sign housing are screened to prevent the entrance of insects and small animals. Ensure that the bottom panels are sloped towards the drain holes to prevent water accumulation on the interior surfaces of the sign bottom.

Ensure that the top of the housing includes multiple steel lifting eyebolts or equivalent hoisting points. Ensure hoist points are attached directly to structural frame members by the sign manufacturer. Ensure hoist points are positioned such that the sign remains level when lifted. Ensure that the hoist points and sign frame allow the sign to be shipped, handled, and installed without damage.

Ensure all assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8 inch in diameter, are Type 304 or 316 passivated stainless steel and meet the requirements of ASTM F 593 and ASTM F 594. All assembly hardware greater than or equal to 5/8 inch in diameter must be galvanized and meet the requirements of ASTM A 325.

SUBARTICLE 781-3.1.2.8 (of the Supplemental Specifications) is deleted and the following substituted:

781-3.1.2.8 Photoelectric Sensor Devices: Ensure the sign electronics monitor ambient light using a minimum of three photocells. Ensure that the photocells are placed so they measure light levels on the front and rear of the sign, and ambient light conditions at the sign location. Ensure that the devices provide accurate ambient light condition information to the sign controller for automatic light intensity adjustment. Ensure that the automatic adjustment of the LED driving waveform duty cycle occurs in small enough increments that the sign's brightness changes smoothly, with no perceivable brightness change between adjacent levels. Ensure that stray headlights shining on the photoelectric sensor at night do not cause LED brightness changes.

Supply the sign with a brightness-versus-ambient light matrix table with algorithms and/or other means of calculation that enables the sign to automatically adjust LED output according to ambient light level. Ensure the sign controller monitors the photocell circuits in the sign and correlates the readings with the brightness table to convert the measured light intensity into the desired pixel brightness. Ensure that the brightness table has a minimum of 255 levels. Ensure that the brightness table in each individual sign controller is adjustable from the TMC or a laptop computer, and can be customized according to each installation site's requirements. Ensure that the sign controller automatically controls the pixel brightness to compensate for differences in ambient light levels, such as the differences in day and night. In addition to the automatic mode, ensure that the brightness may be set from 1% to 99% in 1% increments manually from the front panel of the sign controller and remotely from the TMC.

Ensure that the brightness and color of each pixel is uniform over the sign's entire face within a 30 degree viewing angle from 200 to 1,100 feet in all lighting conditions. Non-uniformity of brightness or color over the sign's face shall be cause for rejection of the sign.

SUBARTICLE 781-3.1.2.9 (of the Supplemental Specifications) is deleted and the following substituted:

781-3.1.2.9 Sign Housing Internal Lighting and Electrical Outlets: Furnish the sign housing with a minimum of four internal fluorescent or incandescent light fixtures. Near the door, locate a 12-hour timer without a hold feature for the lights.

If incandescent lamps are provided, ensure that they are spaced evenly above the walkway and fully enclosed in heavy-duty shatterproof, protective fixtures. Ensure that incandescent fixtures include aluminum housing and base, a porcelain socket, and clear glass inner cover. Ensure that all removable components are secured with set screws.

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If fluorescent lamps are provided, ensure that the fixtures are spaced evenly above the walkway and fitted with protective guards.

Ensure that the sign housing includes emergency lighting that automatically illuminates the interior in the event of a power outage.

Ensure that the light produced from internal lighting is not visible from outside the sign during nighttime or other dark conditions and does not interfere with normal visible operation of the sign.

Equip each sign housing with at least three 15-amp, 120-volt rated ground fault interrupter (GFI) outlets that include protected duplex electrical receptacles. Locate one duplex receptacle near each end of the sign housing. Space the duplex receptacles evenly on the rear wall of the housing. Receptacles must all be at the same height and be 12 to 48 inches above the walkway.

SUBARTICLE 781-3.1 (of the Supplemental Specifications) is deleted and the following substituted:

781-3.1.3.3 LED and Pixel Specifications: Ensure that the sign utilizes amber LED lamps with a minimum viewing angle of 30 degrees and a peak wavelength of 590 nanometers. Ensure that the LED peak wavelength output varies no more than ±2 nanometers. Ensure that the LED pixel cone of vision is a minimum of 30 degrees (centered around the optical axis, or zero point, of the pixel). The cone perimeter is defined by the point where light output intensity is 50% of the intensity measured at the zero point of the pixel.

Ensure that each pixel has a diameter of 1.5 inches, plus or minus 10%, and that the LEDs in each pixel are clustered to maximize long-range visibility. Ensure that all pixels in all signs in a project, including operational support supplies, have equal color and on-axis intensity. Ensure that the sign display produces an overall luminous intensity of at least 9200 candelas per square meter when operating at 100% intensity. Measure the brightness of each LED in accordance with the International Commission on Illumination's (CIE) requirements as detailed in Test Method A of the CIE 127 (1997) standard. Provide the LED brightness and color bins that are used in each pixel to the Engineer for approval. Provide a letter of certification from the LED manufacturer that demonstrates testing and binning according to the CIE 127 (1997) standard.

Ensure each pixel contains two interlaced strings of LEDs. Ensure that all LEDs operate within the LED manufacturer's recommendations for typical forward voltage, peak pulsed forward current, and other ratings. Component ratings shall not be exceeded under any operating condition. Ensure that LED failure in one string within a pixel does not affect the operation of any other string or pixel.

Provide a pixel test as a form of status feedback to the TMC from the local sign controller. Ensure that the operational status of each pixel in the sign can be automatically tested once a day. The operational status may also be tested when the TMC or a laptop computer prompts a pixel test. Ensure that a log file can be created containing a list of defective pixels as transmitted to the TMC or a laptop computer. Ensure that the log file includes the pixel status, module number, column number, and pixel number. Ensure that the pixel status test determines the functional status of the pixel as stuck-on or stuck-off and does not affect the displayed message for more than half a second.

Ensure that LEDs are individually mounted directly on a Printed Circuit Board (PCB), and are individually removable and replaceable using conventional electronic repair methods.

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SUBARTICLE 781-3.1.4 (of the Supplemental Specifications) is deleted and the following substituted:

781-3.1.4 Character Displays: Ensure that the signs are capable of displaying American Standard Code for Information Interchange (ASCII) characters 32 through 126, including all uppercase and lowercase letters and digits 0 through 9, at any location in the message line.

Ensure that the uppercase alphanumeric characters are displayed over the complete height of the matrix. Submit a list of the character fonts to the Engineer for approval.

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Characters must be legible under all light conditions at a distance ranging from 100 to 1,100 feet within the 30 degree cone of vision centered on the pixel's optical axis. Ensure that the operator is able to display compressed (i.e., 4 pixel by 7 pixel), expanded (i.e., 6 pixel by 7 pixel), or double-stroke (i.e., 7 pixel by 7 pixel) character fonts, and to change the default spacing between characters. Ensure that the spacing options include 1-, 2-, or 3-pixel columns between the characters. Ensure the system is loaded with a default font in accordance with the Standard Font set described in NEMA TS4-2005 (section 5.6). Ensure the system allows the assignment of font access privileges. Ensure that the sign controller is capable of a self-updating time and/or date display on the sign.

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SUBARTICLE 781-3.1 .7 (of the Supplemental Specifications) is deleted and the following substituted:

781-3.1.7 Operational Support Supplies: Furnish the operational support supplies listed in the table below. Promptly replace any of the supplies used to perform a warranty repair.

For every group of 10 or fewer 18" DMS provided or required, provide 1 set of supplies as follows:

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1 each	Sign Controller
10 each	LED Display Modules
1 each	Uninterruptible Power Supplies
1 each	System Interface Circuit
1 each	Cable for connecting interface circuits to daughter boards
1 each	Display Module Cables
2 each	Surge Suppression Sets
1 each	Fan Assembly
1 each	Time Relay for Fan Control
10 each	Every Small Fuse (≤ 10 amp)
2 each	Every Large Fuse (> 10 amp)
1 each	Sensor for each type of sensor

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The Engineer will review and approve the operational support supplies.

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SUBARTICLE 781-3.1.9 (of the Supplemental Specifications) is deleted and the following substituted:

781-3.1.9 Display System Hardware: Ensure the sign utilizes a system data interface circuit for communication between the sign controller and display modules. Ensure the following components reside inside the walk-in housing: sign controller, display system interface circuits, display modules, power supplies, local and remote control switches, LED indicators, an Electronic Industries Alliance (EIA)-232 plug-in connection for laptop computers, EIA-232 null modem cables (minimum of 4 feet long for connecting laptop controller to sign controller), workspace for a laptop computer, communication equipment and surge protective devices.

SUBARTICLE 781-3.1.11 (of the Supplemental Specifications) the first paragraph, is deleted and the following substituted:

781-3.1.11 Sign Controller Communication Interface: Ensure that the sign controller includes two separate EIA-232 serial interfaces inside the sign housing for communication with the TMC or a laptop computer, and one Ethernet 10/100 Base TX 8P8C port. Ensure that EIA-232 serial interfaces support the following:

Data Bits: 7 or 8 bits
Parity: Even, Odd, or None
Number Stop Bits: 1 or 2 bit

Ensure that all Category 5 unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-A standard.

Configure one EIA-232 serial interface to drive asynchronous modems for full duplex communication with the TMC over point-to-point dial-up lines or a multidrop fiber or copper network. Ensure that switching between dial-up, Ethernet, and multidrop operation does not require sign controller software or hardware modifications.

For dial-up operations, acquire and bear the charges of installing and connecting the dial-up telephone line. Provide modems to be retained by the Department at each location. Provide a user-selectable data transmission rate of up to 19.2 kbps for dial-up operations.

Configure the second EIA-232 serial port for local communication with a laptop computer.

Ensure that the sign controller can be managed remotely from a TMC or locally using a laptop computer. Ensure that the TMC or a laptop computer can be used to remotely reset the sign controller.

Ensure that the sign controller and its software will display single-page and multi-page messages, with mixed fonts and spacing. Ensure that message page times and text flashing rates are programmable between 0.5 and 5 seconds in 0.1 second increments.

Ensure that the sign system will log and report errors and failures, including data transmission errors, receipt of invalid data, communication failure recoveries, alternating current power failures, power recoveries, pixel status reads, fan and filter airflow status, temperature status, power supply status, and information on the operational status of the temperature, photocell, airflow, humidity, and LED power supply sensors. Ensure that airflow and humidity sensor information is reported using the objects from the dmsClimateCtrlStatusTable of the NTCIP 1203 V2 standard.

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SUBARTICLE 781-3.2 (of the Supplemental Specifications) the first paragraph is deleted and the following substituted:

781-3.2 Dynamic Message Sign with 12-inch High Character Display (12Inch DMS): Furnish and install a 12 inch DMS in accordance with the details specified in the Contract Documents. Use only equipment and components that meet the requirements of these minimum specifications, and are listed on the Department's Approved Product List (APL).

SUBARTICLE 781-3.2.2 (of the Supplemental Specifications), the first Subarticle, is deleted and the following substituted:

781-3.2.2 Sign Housing: Ensure that the non-display external skin of the sign housing is constructed of aluminum alloy 5052 H32 that is a minimum of 0.090 inch thick. Ensure that the sign housing design and appearance is approved by the Engineer. If cable attachments are used in the sign housing, the cables shall be securely clamped using a method approved by the Engineer.

Ensure housing exterior is attached to the structural framework using a method approved by the Engineer. Ensure the housing bevel of the housing face is not greater than 1 foot on any side. Ensure housing provides an environmental seal for internal components with a minimum rating of IP54. Ensure all openings in housing (such as vents and drain holes) are safeguarded against the entrance of insects and animals.

Ensure LED display module(s) are mounted such that the legible viewing area is optimized.

Ensure all assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8 inch in diameter, are Type 304 or 316 passivated stainless steel and meet the requirements of ASTM F 593 and ASTM F 594. All assembly hardware greater than or equal to 5/8 inch in diameter must be galvanized and meet the requirements of ASTM A 325.

Ensure housing includes a method of hoisting to allow for proper mounting of device via use of standard construction equipment. Ensure the sign remains level when hoisted. Ensure hoisting design prevents damage when device is shipped, handled, and installed.

SUBARTICLE 781-3.2.4 (of the Supplemental Specifications) is deleted and the following substituted:

781-3.2.4 Character Displays: Ensure that the signs are capable of displaying American Standard Code for Information Interchange (ASCII) characters 32 through 126, including all uppercase and lowercase letters and digits 0 through 9, at any location in the message line.

Ensure that the uppercase alphanumeric characters are displayed over the complete height of the matrix. Submit a list of the character fonts to the Engineer for approval.

Characters must be legible under all light conditions at a distance ranging from 100 to 600 feet within the 30 degree cone of vision centered on the pixel's optical axis. Ensure that the operator is able to display compressed, expanded, or double-stroke character fonts, and to change the default spacing between characters. Ensure that the spacing options include 1-, 2-, or 3-pixel columns between the characters. Ensure the system is loaded with a default font in accordance with the Standard Font set described in NEMA TS4-2005 (section

5.6). Ensure the system allows the assignment of font access privileges. Ensure that the sign controller is capable of a self-updating time and/or date display on the sign.

SUBARTICLE 781-3.2.5 (of the Supplemental Specifications) is deleted and the following substituted:

781-3.2.5 Main Power Supply and Energy Distribution Specifications:

Provide a nominal single-phase power line voltage of 120/240 V_{AC} protected by a two-pole (i.e., common trip) main circuit breaker sized as required for the sign and its controller. Ensure that the system operates within a voltage range of 97 to 135 V_{AC} as specified in NEMA TS 4, Subsection 2.1.3.1.

Ensure that all power inside the sign housing is supplied by 120 V_{AC} independently protected by a thermomagnetic circuit breaker at the sign's service entry point. Locate all 120 V_{AC} wiring in conduit, pull boxes, raceways, or control cabinets as required by the NEC. Ensure that no 120 V_{AC} wiring is exposed inside or outside of the sign housing. Do not use the sign housing as a wiring raceway or control cabinet.

Ensure that the sign and its controller have an operating frequency of 60 hertz (Hz), plus or minus 3.0Hz, as stated in NEMA TS 4, Subsection 2.1.3.2. Ensure that the drop in the unit's voltage between no-load and full-load during normal operations does not exceed 10% of the nominal voltage. Provide power protection through the use of a thermomagnetic circuit breaker connected to a 5-milliampere GFI device that protects all service outlets. Provide a 100-amp 120/240 V_{AC} two-pole load center with a 20-circuit capability. Provide separate circuit breakers for each sign circuit.

Provide Type XHHW power cables sized as required by the NEC for acceptable voltage drops while supplying alternating current to the sign. Ensure that the sign power consumption does not exceed 3,000 VA under any circumstance, including operation of fans and heaters (if provided within the sign), sign controllers and communication equipment, and all pixels illuminated at 100% brightness.

Provide protection devices such as surge protective devices and lightning arrestors installed or incorporated in the sign system by the manufacturer to guard against lightning, transient voltage surges, and induced current. Ensure that the protection devices meet or exceed the device protection requirements as contained in Section 785-2. Use protection devices on all electric power and data communication connections.

Ensure that the DC and AC voltage ratings and dissipation factors of capacitors used in the sign system exceed the worst-case design parameters of the circuitry by 50%. Ensure that capacitors that are not surface mount components are mechanically supported by a clamp or fastener that is resistant to cracking, peeling, and discoloration.

Ensure that resistors used in the sign are within 5% of the tolerance of the specified temperature range and, when operated in excess of 50% of its power rating, have an adequate heat sink.

Ensure all transistors, integrated circuits, and diodes are a standard type, listed by the EIA, and clearly identifiable.

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SUBARTICLE 781-3.2.7 (of the Supplemental Specifications) is deleted and the following substituted:

781-3.2.7 Operational Support Supplies: Furnish the operational support supplies listed in the table below. Promptly replace any of the supplies used to perform a warranty repair.

For every group of 10 or fewer 12inch DMS signs provided or required, provide 1 set of supplies as follows:

1 each	Sign Controller
5 each	LED Display Modules
1 each	Uninterruptible Power Supplies
1 each	System Interface Circuit
1 each	Cable for connecting interface circuits to daughter boards (if applicable)
1 each	Display Module Cables
2 each	Surge Suppression Sets
1 each	Fan Assembly
1 each	Time Relay for Fan Control
10 each	Every Small Fuse (≤ 10 amp)
2 each	Every Large Fuse (> 10 amp)
1 each	Sensor for each type of sensor

The Engineer will review and approve the operational support supplies.

SUBARTICLE 781-3.2.9 (of the Supplemental Specifications) is deleted and the following substituted:

781-3.2.9 Display System Hardware: Ensure the sign utilizes a system data interface circuit for communication between the sign controller and display modules. Ensure that the following components reside inside the sign housing: sign controller, display system interface circuits, display modules, power supplies, local and remote control switches, LED indicators, Electronic Industries Alliance (EIA)-232 null modem cables (minimum of 4 feet long for connecting laptop computer to sign controller), and surge protective devices.

SUBARTICLE 781-3.12 (of the Supplemental Specifications), the first Subarticle, is deleted and the following substituted:

781-3.12 Testing: Conduct performance testing of materials and equipment not previously tested and approved. If the technical data is not considered adequate for approval, samples may be requested for testing by the Engineer. The contract period will not be extended for time lost or delays caused by testing prior to the Engineer's final approval of any items.

Subject the equipment covered by these specifications to design approval tests (DATs) and factory demonstration tests (FDTs). APL certification is acceptable in lieu of DATs and FDTs. Arrange and conduct the tests in accordance with the testing specifications stated in this section. Unless otherwise specified, the Contractor is responsible for satisfying all inspection requirements prior to submission for the Engineer's inspection and acceptance.

The Engineer reserves the right to witness all DATs and FDTs. The tests on all or one type of equipment must be completed within five calendar days. The Contractor shall be financially responsible for testing each DMS.

Provide five copies of all design approvals, FDTs, stand-alone and subsystem test procedures, and data forms for the Engineer's approval at least 60 calendar days prior to the beginning of testing. Include in the test procedures the sequence in which the tests will be conducted. Obtain the Engineer's approval of the test procedures prior to testing the equipment.

Furnish data forms, certified and signed by the manufacturer, containing all of the data taken, and the quantitative results for all tests. Send one copy of the data forms to the Engineer.

Provide the test fixtures and test instruments for all the tests.

SUBARTICLE 781-4.2.1 (of the Supplemental Specifications) is deleted and the following substituted:

781-4.2.1 General: Provide a HAR system that includes static signage with flashing beacons to notify motorists of active HAR broadcasts. Ensure that all HAR transmitter components are modular and fit in a rack-mounted chassis. Use HAR subsystems and components that are programmable remotely or onsite.

Ensure that the HAR system includes software, hardware and any other component required to fully configure, operate and monitor the HAR field equipment locally and remotely using a personal computer. Use only equipment and components that meet the requirements of these minimum specifications, and are listed on the Department's Approved Product List (APL).

SUBARTICLE 781-4.2.7 (of the Supplemental Specifications) is deleted and the following substituted:

781-4.2.7 Surge Protective Devices: Install surge protective devices between the transmitter and the antenna. Ensure surge protective devices meet the requirements of Section 785-2.

ARTICLE 781-5 (of the Supplemental Specifications) is deleted and the following substituted:

781-5 Road Weather Information System.

781-5.1 Description: Furnish and install a road weather information system (RWIS) as shown in the plans.

781-5.2 Materials: Provide an RWIS consisting of environmental sensor stations (ESS) installed at specified locations. Provide an ESS as shown in the plans that includes environmental sensors mounted on an approved structure (typically a concrete pole), other sensors mounted in the roadway, and a remote processing unit (RPU) at the base of the structure. Ensure that the RPU can collect, store, and process sensor data to describe current weather conditions.

Provide any ancillary equipment or incidental items required, including mounting hardware, power supplies, grounding, surge protection devices, and communication equipment, at each ESS location to make a complete and fully operational RWIS. Ensure that the system

provides real-time, accurate, reliable data on all system parameters to the degree of precision defined in this specification.

Ensure all assembly hardware, including nuts, bolts, external screws and locking washers less than 5/8 inch in diameter, are Type 304 or 316 passivated stainless steel and meet the requirements of ASTM F 593 and ASTM F 594. All assembly hardware greater than or equal to 5/8 inch in diameter must be galvanized and meet the requirements of ASTM A 325.

781-5.2.1 Sensors: Provide an RWIS that can collect and store data from various sensors including, but not limited to:

1. Roadway sensors located in or under the pavement.
2. Atmospheric sensors.

Ensure that all RWIS sensors and other field equipment are made of UV, heat, and corrosion resistant materials

Provide ultrasonic anemometers and other sensors that are electronic devices which do not rely on moving parts to create electrical signals for processing.

781-5.2.2 Sensor Performance: Each environmental sensor and its associated transducers shall record the following attributes to the listed degree of accuracy:

Roadway Data		
Surface Temperature	±0.36° F between -40° and 176° F	
Precipitation	Type:	Dry, wet at >32° F; wet at <32° F; frozen, frost and dew
	Percent of Ice:	From 0 to 100%
	Depth/Amount:	From 0 to 0.5 inch
Atmospheric Data		
Temperature	±1° F between -40° and 176° F; resolution of 0.1 degree	
Relative Humidity at 70° F	±5% between 10 and 100%	
Barometric Pressure	Accurate to ±0.02 inch of mercury (in. Hg) between 27.2 and 31.9 in. Hg; resolution of 0.005 inches Hg	
Precipitation	Type:	Light rain, rain and ice
	Intensity:	±20% between 0.02 to 200 inches per hour
	Visibility:	±10% from 0.005 to 1 mile
Wind	Direction:	±3 degrees between 0 and 360 degrees
	Speed:	±3% between 0 and 120 mph

Ensure that pavement sensors function as specified above when installed at a maximum of 2,000 feet from the RPU.

781-5.2.3 ESS: Install an ESS having the sensors necessary to collect, store, and transmit the following data:

1. Roadway data, including:
   - A) Temperature
   - B) Surface data that includes ice and precipitation depth/amount.
2. Atmospheric data, including:
   - A) Temperature
   - B) Relative humidity
   - C) Barometric pressure
   - D) Precipitation data that includes type and intensity

E) Visibility as affected by fog, smoke, or a combination thereof

F) Wind data, including direction and average speed

781-5.2.4 Communications: Use an RPU capable of transmitting all collected data to the transportation management center (TMC) using the National Transportation Communications for ITS Protocol (NTCIP). Ensure that the RWIS field station supports EIA 232/485 serial communication, TCP/IP, and UDP/IP.

Ensure that all communications, including those between sensors and the RPU, are nonproprietary and compatible with the Department's SunGuide® Software System.

781-5.2.5 Remote Processing Unit:

The RPU shall store a minimum of 24 data records. Each data record will include sensor readings of a user-defined time interval of up to 5 minutes.

Ensure that the RPU operates using a nominal input voltage at the cabinet of 110 to 120 V_{AC}, and also be capable of operating on 12 V_{DC} of solar battery power. The RPU shall issue an alarm to the TMC if the AC power supply is low or if there has been a complete power loss. Ensure that the system sends a message when the unit returns to normal conditions.

781-5.2.6 RPU Enclosure: Use a cabinet listed on the APL to house and protect the RPU and all field electronics associated with the RWIS.

781-5.2.7 RWIS Software: Ensure that the RWIS software enables the system operator to derive environmental measurements, such as the dew point, wind chill, and heat index, from sensor data received. Ensure that the RWIS software can be used to report minimums, maximums, averages, cumulative values, and standard deviations for all data over a prescribed time period.

Ensure that the RWIS software provides English-to-metric unit conversions, when applicable, and lets the operator choose which unit of measure to report if more than one unit is common for a particular measurement.

When the software supplied with the RWIS is installed on a laptop computer or a remote workstation, ensure that the operator is able to access, either remotely through the workstation or at the site with the laptop computer, all user-defined parameters and stored data within the RPU, including the ability to view, download, and delete stored data.

781-5.2.8 Electrical Specifications: Provide RWIS equipment and components installed at the ESS that operate at 110 to 120 V_{AC} from a commercial utility company or, alternatively, 12 V_{DC} from a solar-powered or battery-powered system. In cases where the ESS are mounted on the Department's MAS towers, ensure that the devices can utilize the 48 V_{DC} power supply available at the site.

Ensure that solar- and battery-powered units operate continuously for 14 days without requiring battery recharging. Provide an appropriate means of conversion for any device that requires a different power source.

Equip each ESS installation with provisions for emergency backup power in the event of primary power loss. Ensure that backup power is capable of continuing the ESS' operations for a minimum of 12 hours.

781-5.2.9 Foundation and Tower Specifications: Provide a supporting tower or pole as shown in the plans. Ensure the tower or pole provides a mounting platform for atmospheric sensors free of influences from topography, buildings, and vehicles. Ensure that the tower also supports any lightning protection devices (e.g., grounding rods) for the site. Provide a support structure that is self-supporting without guy wires, using a 50-year design life, and in accordance with the current Structures Manual.

If the field site is solar powered, ensure that the structure provides the mounting platform for the solar array and the control cabinet that houses the battery bank and charger.

Place a concrete work pad measuring 4 feet wide by 3 feet long by 4 inches deep in front of the RPU control cabinet if the cabinet is ground mounted. Construct the pad using concrete meeting the requirements of Section 347.

781-5.3 Applicable Standards: Ensure that the RWIS complies with all applicable standards from the National Weather Service.

Ensure that the RWIS complies with the latest revisions of all applicable NTCIP standards, including NTCIP-1201 and NTCIP-1204. Ensure that all RWIS field equipment complies with the environmental requirements of section A615 of the MSTCSD.

781-5.4 Installation Requirements: Ensure that all equipment and materials furnished, assembled, fabricated, or installed are commercial off-the-shelf products.

Unless detailed otherwise in the plans, mount all atmospheric sensors except anemometers at cabinet-top height, approximately 10 feet above grade. Mount anemometers at the top of the tower or as shown in the plans. Locate pavement sensors as shown in the plans.

Install all wiring so that it is either internal to a pole or in conduit.

Install all buried lead-in cable to pavement sensors in conduit.

Mount all roadway sensors flush with the roadway surface.

781-5.5 Testing: Utilize a testing procedure that includes a remote field sensor and RPU test, a remote-to-central communication test, and a systems operational test. Conduct the following tests and submit the results to the Engineer:

1. Perform and document laboratory tests verifying proper sensor calibration.
2. Calibrate instrument alignment with true north.
3. Furnish sensor calibration protocols and adjustment procedures.
4. Verify and ensure that sensors are reporting proper field data.
5. Detail regular site maintenance procedures and calibration training.
6. Provide block diagrams, schematics, catalogs, and line drawings.
7. Program source codes in both printed and digital form.
8. Verify proper orientation of wiring and cabling.
9. Ensure that above-ground conduit is straight, neat, and properly secured.
10. Verify that the grounding system is installed per the requirements of 785-2.

Subject the RWIS to a 30-day observation period, during which time the Contractor shall perform any and all maintenance, recalibration, and data verification required by the Engineer.

Certify anemometers by wind tunnel tests. Submit test results to the Engineer for review and approval. Upon request, furnish independent laboratory testing documentation certifying adherence to the stated wind force criteria using a minimum effective projected area (EPA), the actual EPA, or an EPA greater than that of the device to be attached.

Perform local field operational testing at each RWIS field site according to the test plans detailed in this section. After the environmental sensor and RPUs, and other RWIS hardware, power supplies, and connecting cables have been installed, perform the following:

1. Verify that physical construction has been completed as specified in the plans.
2. Inspect the quality and tightness of ground and surge protector connections.
3. Check power supply voltages and outputs.
4. Connect devices to the power sources.
5. Verify installation of specified cables and connections between the environmental sensor and RPUs, and the control cabinet.
6. Test local operation of all environmental sensor and RPU components.

Deliver a summary test report and a copy of all test results to the Engineer for approval. Include documentation of any discrepancies found during testing, along with

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environmental sensor and RPU serial numbers. Include assembly installation locations and successful test completion dates.