

EXPECTED IMPLEMENTATION JULY 2012

781 INTELLIGENT TRANSPORTATION SYSTEMS – MOTORIST INFORMATION SYSTEMS.

(REV 1-11-12) (FA 2-1-12) (7-12)

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

781-1 Description.

Provide 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.

ARTICLE 781-3 (of the Supplemental Specifications) is deleted and the following substituted:

781-3 Dynamic Message Signs.

781-3.1 Sign Types: Dynamic Message Signs must meet the requirements of NEMA TS4-2005. Dynamic Message Signs (DMS) are classified by the type of sign display and the type of mechanical construction. Provide monochrome, tri-color, or full-color signs as shown 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).

781-3.1.1 Front Access DMS: Ensure that front access signs meet the requirements of NEMA TS4 2005, section 3.2.5.

781-3.1.2 Walk-in DMS: Ensure that walk-in signs meet the requirements of NEMA TS4 2005, section 3.2.7.

781-3.1.3 Embedded DMS: Embedded DMSs are DMSs that are typically mounted to Ground Traffic Signs, Overhead Traffic Signs, or Overhead Cantilever Traffic Signs.

781-3.2 Sign Housing Requirements for all DMS: 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 for walk-in DMS and 0.090 inch thick for front and embedded DMS. Ensure the interior structure is constructed of aluminum. Ensure that the sign housing design and appearance is approved by the Engineer. Ensure that no internal frame connections or external skin attachments rely upon adhesive bonding or rivets.

Ensure the sign enclosure meets the requirements of NEMA TS4 2005, section 3.1.1. 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 sign housing complies with the fatigue resistance requirements of the fifth edition (2001) American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals with current addendums. Design and construct the DMS unit for continuous usage of at least 20 years and the sign structure for a 50-year design life. Ensure that equipment and structures are designed to withstand loads, including a wind load of 150 miles per hour, as defined in the FDOT Structures Manual without deformation or damage.

Ensure that the top of the housing includes multiple steel lifting eyebolts or equivalent hoisting points. Ensure hoist points are positioned such that the sign remains level

EXPECTED IMPLEMENTATION JULY 2012

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, screws, and locking washers less than 5/8 inch in diameter, are type 304 or 316 passivated stainless steel and meet the requirements of American Society for Testing and Materials (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 307.

Ensure all exterior, excluding the sign face, and all interior housing surfaces are a natural aluminum mill finish. Ensure signs are fabricated, welded, and inspected in accordance with the requirements of the current American National Standard Institute/American Welding Society (ANSI/AWS) Structural Welding Code-Aluminum.

Ensure the sign housing meets the requirements of NEMA TS4 2005, section 3.2.8 for convenience outlets.

781-3.2.1 Sign Housing for Walk-in DMS: 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 No. 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 these structural members are attached to the internal framework of the sign.

Ensure hoist points are attached directly to structural frame members by the sign manufacturer.

Ensure housing access is provided through an access door that meets the requirements of NEMA TS4 2005, section 3.2.7.1. Ensure the access door includes a keyed tumbler lock and a door handle with a hasp for a padlock. Ensure the door includes a closed-cell neoprene gasket and stainless steel hinges.

Ensure the sign housing meets the requirements of NEMA TS4 2005, section 3.2.7.3 for service lighting. If incandescent lamps are provided, ensure they are 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. If fluorescent lamps are provided, ensure they are fitted with protective guards.

Ensure that the sign housing includes emergency lighting that automatically illuminates the interior in the event of a power outage. Emergency lighting must be capable of operation without power for a minimum of 90 minutes.

781-3.2.1.1 Walk-in DMS Work Area: Ensure the walk-in DMS has a work area that meets the requirements of NEMA TS4 2005, section 3.2.7.2. Finish all edges of the walkway to eliminate sharp edges or protrusions.

781-3.2.2 Sign Housing for Front Access and Embedded DMS: Ensure front access and embedded signs meet the requirements of NEMA TS4 2005, section 3.2.4. Ensure access does not require specialized tools or excessive force.

EXPECTED IMPLEMENTATION JULY 2012

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781-3.2.3 Housing Face requirements for all DMS: Ensure the sign face meets the requirements of NEMA TS4 2005, section 3.1.3. Ensure that all sign face surfaces are finished with a matte black coating system that meets or exceeds American Architectural Manufacturers Association (AAMA) Specification No. 2605. Provide certification that the sign face parts are coated with the prescribed thickness. Except for Embedded DMS, ensure the sign face includes a contrast border that meets the requirements of NEMA TS4 2005, section 3.1.6.

781-3.2.3.1 Housing Face for Walk-in DMS: No exposed fasteners shall be allowed on the housing face. Ensure that display modules can be easily and rapidly removed from within the sign without disturbing adjacent display modules.

781-3.2.3.2 Housing Face for Front Access and Embedded DMS: Any exposed fasteners on the housing face shall be the same color and finish as the housing face. Only captive fasteners shall be used on the housing face.

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781-3.2.3.3 External Fascia Panels: If the sign includes external fascia panels, ensure that they are constructed using aluminum. Finish each fascia panel with a matte black coating system that meets or exceeds AAMA Specification No. 2605.

781-3.2.3.4 Lens Panel Assembly: If sign includes lens panel assemblies, ensure they are modular in design, removable, and interchangeable without misalignment of the lens panel and the light-emitting diode (LED) pixels. The lens panel assembly must consist of an environmental shielding layer coating to protect and seal the LEDs and internal electronics. The coating shall be a minimum 90% ultraviolet (UV) opaque. Lens panels must have a matte black coating that meets or exceeds AAMA Specification No. 2605. Lens panels must include a mask constructed of 0.080 inch minimum thickness aluminum. Ensure that the mask is perforated to provide an aperture for each pixel on the display module. Ensure that the apertures do not block the LED output at the required viewing angle.

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781-3.2.4 Sign Housing Ventilation System: The ventilation systems for walk-in, front-access, and embedded DMS must meet the requirements of NEMA TS4 2005, section 3.1.2.

Ensure that air drawn into the sign is filtered upon entry. Ensure the ventilation system is automatically tested once each day and that it may be tested on command from remote and local control access locations. Ensure the sign includes a sensor or a sensor assembly to monitor airflow volume to predict the need for a filter change. Ensure the ventilation system fans possess a 100,000-hour, L10 life rating.

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781-3.2.4.1 Ventilation System for Walk-in DMS: Ensure the sign includes a fail-safe ventilation subsystem that includes a snap disk thermostat that is independent of the sign controller. Preset the thermostat at 130°F. If the sign housing's interior reaches 130°F, the thermostat must override the normal ventilation system, bypassing the sign controller and turning on all fans. The fans must remain on until the internal sign housing temperature falls to 115°F.

781-3.2.5 Sign Housing Temperature Sensor: Ensure that the sign controller continuously measures and monitors the temperature sensors. Ensure that the sign blanks when a critical temperature is exceeded and that the sign will report this event when polled. Ensure that remote and local computers can read all temperature measurements from the sign controller.

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781-3.2.6 Sign Housing Humidity Sensor: Humidity sensors must detect from 0 to 100% relative humidity in 1% or smaller increments. Sensors must operate and survive in 0 to 100% relative humidity, and have an accuracy that is better than plus or minus 5% relative humidity. A humidistat is not acceptable.

EXPECTED IMPLEMENTATION JULY 2012

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781-3.2.7 Sign Housing Photosensors: Ensure the sign meets the requirements of NEMA TS4 2005, section 8.8. Ensure that the sensors 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.

Ensure that the brightness and color of each pixel is uniform over the sign's entire face within a 30-degree viewing angle in all lighting conditions.

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781-3.3: Display Modules: Provide display modules manufactured by one source and fully interchangeable throughout the manufacturer's sign system(s). Ensure that removal or replacement of a complete display module or LED board can be accomplished without the use of special tools.

Ensure display modules contain solid-state electronics needed to control pixel data and read pixel status.

Ensure that the sign has a full matrix display area as defined in the glossary of NEMA TS4 2005.

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781-3.3.1 LED and Pixel Specifications: Ensure that LED lamps have a minimum viewing angle of 30 degrees.

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 meets the luminance requirements of NEMA TS4 2005, section 5.4, for light emitting signs connected at full power. Ensure that amber displays produce an overall luminous intensity of at least 9200 candelas per square meter when operating at 100% intensity. Provide the LED brightness and color bins that are used in each pixel to the Engineer for approval. Ensure that the LED manufacturer demonstrates testing and binning according to the International Commission on Illumination (CIE) 127 (1997) standard.

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.

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Provide a pixel test as a form of status feedback to the transportation management center (TMC) from the local sign controller. Ensure that the operational status of each pixel in the sign can be automatically tested once a day. Ensure that the pixel status test determines the functional status of the pixel as defined by the pixel Failure Status object in National Transportation Communications for ITS Protocol (NTCIP) 1203v0239 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).

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781-3.3.2 Optical, Electrical, and Mechanical Specifications for Display

Modules: Ensure the display modules are rectangular and have an identical vertical and horizontal pitch between adjacent pixels. Ensure that the separation between the last column of one display module and the first column of the next module is equal to the horizontal distance between the columns of a single display module. Full-color signs must have a pitch equal to or less than 35mm.

EXPECTED IMPLEMENTATION JULY 2012

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Ensure that the LED circuit board is a NEMA FR4-rated, single 0.062 inch, black PCB. Ensure that no PCB has more than two PCB jumper wires present. Finish all PCBs with a solder mask and a component-identifying silk screen.

Provide the LED motherboards with a complete conformal coating of silicone resin with a minimum thickness of 0.01 inch, except for the pixels on the front of the PCB. All other PCBs must be provided with a complete conformal coating of silicone resin with a minimum thickness of 0.01 inch. Meet the material requirements of MIL-I-46058C Military Standard, United States Department of Defense (USDOD).

Ensure that any devices used to secure LEDs do not block air flow to the LED leads or block the LED light output at the required viewing angle. Ensure that all components on the LED side of PCBs are black.

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Ensure that there are a minimum of two power supplies that are wired in a parallel configuration for redundancy. Ensure that if one or 25% of the supplies in a group, whichever is greater, completely fails, the sign shall still be supplied with enough power to run 40% of all pixels at a 100% duty cycle with an ambient operating temperature of 165°F.

Ensure that the sign controller continuously measures and monitors all LED module power supply voltages and provides the voltage readings to the TMC or a laptop computer on command.

Ensure that LEDs are protected from external environmental conditions, including moisture, snow, ice, wind, dust, dirt, and UV rays. Do not use epoxy to encapsulate the LEDs.

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781-3.3.3 Display Area for Walk-in DMS: Ensure that the display area is capable of displaying three lines of 15 characters using an 18 inch font that meets the height to width ratio and character spacing in the Manual on Uniform Traffic Control Devices for Streets and Highways 2009 Edition (MUTCD), section 2L.04, paragraphs 05, 06, and 08.

781-3.4 Characters, Fonts, and Color: 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. Submit a list of the character fonts to the Engineer for approval.

All signs must be loaded (as a factory default) with a font in accordance with or that resembles the standard font set described in NEMA TS4 2005, section 5.6. For signs with a pixel pitch of 35mm or less, ensure the sign is loaded (as a factory default) with a font set that resembles the Federal Highway Administration (FHWA) Series E2000 standard font.

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Ensure DMS fonts have character dimensions that meet the MUTCD, section 2L.04, paragraph 08.

Ensure that full-color signs can display the colors prescribed in the MUTCD, section 1A.12.

781-3.5 Main Power Supply and Energy Distribution Specifications:

Provide a nominal single-phase power line voltage of 120/240 V_{AC}. Ensure the DMS meets the requirements of NEMA TS4 2005, section 10.2.

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Locate all 120 V_{AC} wiring in conduit, pull boxes, raceways, or control cabinets as required by the National Electrical Code (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.

Provide Type XHHW power cables sized as required by the NEC for acceptable voltage drops while supplying alternating current to the sign.

EXPECTED IMPLEMENTATION JULY 2012

Provide surge protective devices (SPD) installed or incorporated in the sign system by the manufacturer to guard against lightning, transient voltage surges, and induced current. Ensure that SPDs meet or exceed the requirements of Section 785-2. Ensure SPDs protect all electric power and data communication connections.

781-3.6 Uninterruptible Power Supply (UPS): If a UPS is required in the Contract Documents for walk-in DMS, ensure the UPS is installed within the sign housing or as shown in the Plans. If a UPS is required in the Contract Documents for front access and embedded signs, ensure the UPS is installed within the control cabinet or as shown in the Plans. The UPS system must be capable of displaying the current message on a sign when a power outage occurs. Signs with UPS must be able to operate on battery power and display text messages for a minimum of two hours. Ensure the system uses sealed absorbed glass mat (AGM) batteries.

781-3.7 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 DMS provided or required, provide one set of supplies as follows:

1 each	Sign controller and I/O board(s)
10 each	LED display modules
1 each	Display power supply
1 each	Uninterruptible power supply
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	Each type of small fuse (≤ 10 amp)
2 each	Each type of large fuse (> 10 amp)
1 each	Each type of sensor

781-3.8 Components: All components must meet the requirements of NEMA TS4 2005, section 8.

781-3.8.1 Mechanical Components: Ensure that all fasteners, including bolts, nuts, and washers less than 5/8 inch in diameter, are passivated stainless steel, Type 316 or Type 304 and meet the requirements of ASTM F 593 and ASTM F 594 for corrosion resistance. Ensure that all bolts and nuts 5/8 inch and over in diameter are galvanized and meet the requirements of ASTM A 307. Do not use self-tapping screws. Ensure that all parts are fabricated from corrosion resistant materials, such as plastic, stainless steel, aluminum, or brass. Ensure that construction materials are resistant to fungus growth and moisture deterioration. Ensure that all dissimilar metals are separated with an inert, dielectric material.

781-3.8.2 Sign Controller: Ensure that the sign controller monitors the sign in accordance with NEMA TS4 2005, section 9. Ensure the sign monitors the status of any photocells, LED power supplies, humidity, and airflow sensors. Ensure sign controllers use fiber optic cables for data connections between the sign housing and ground-level cabinet.

Ensure that the sign controller meets the requirements of NEMA TS4 2005, sections 8.9, 8.10. Ensure that the sign controller is capable of displaying a self-updating time and date message on the sign. Ensure that sign controllers within ground

EXPECTED IMPLEMENTATION JULY 2012

cabinets are rack-mountable, designed for a standard EIA-310 19 inch rack, and include a keypad and display.

781-3.8.3 Display System Hardware: Ensure the sign utilizes a system data interface circuit for communications between the sign controller and display modules. Except for embedded DMS, ensure that the following components reside inside the sign housing: sign controller (master or slave), 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.

781-3.8.4 Control Cabinet: Provide a control cabinet that meets the requirements of Section 785-4. Ensure that the minimum height of the cabinet is 46 inches.

Provide a ground control cabinet that includes the following assemblies and components: power indicator, surge suppression on both sides of all electronics, communication interface devices, connection for a laptop computer for local control and programming, a 4 foot long cable to connect laptop computers, a workspace for a laptop computer, and duplex outlets.

Provide for all telephone, data, control, power, and confirmation connections between the sign and ground control box, and for any required wiring harnesses and connectors.

781-3.8.5 Sign Controller Communication Interfaces: Ensure the sign controller has communication interfaces in accordance with NEMA TS4 2005, section 8.7.1. 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 the sign controller has a 10/100 Base TX 8P8C port or a 100 Base FX port Ethernet interface.

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. Ensure that switching between dial-up, Ethernet, and multidrop operation does not require sign controller software or hardware modifications.

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

781-3.9 Message and Status Monitoring: Ensure the DMS provides two modes of operation: (1) remote operation, where the TMC commands and controls the sign and determines the appropriate message or test pattern; and (2) local operation, where the sign controller or a laptop computer commands and controls the sign and determines the appropriate message or test pattern.

Ensure that the sign can perform the following functions:

1. Control Selection – Ensure that local or remote sign control can be selected. Ensure that there is a visual indicator on the controller that identifies whether the sign is under local or remote control.

EXPECTED IMPLEMENTATION JULY 2012

D 2. Message Selection – Ensure that the sign controller can select a blank message or any one of the messages stored in the sign controller’s nonvolatile memory when the control mode is set to local.

3. Message Implementation – Ensure that the sign controller can activate the selected message.

Ensure that the sign can be programmed to display a user-defined message, including a blank page, in the event of power loss.

Ensure that message additions, deletions, and sign controller changes may be made from either the remote TMC or a local laptop computer. Ensure that each font may be customized, and modifications to a font may be downloaded to the sign controller from the TMC or a laptop computer at any time without any software or hardware modifications.

Ensure that there is no perceivable flicker or ghosting of the pixels during sign erasure and writing periods.

R **781-3.10 TMC Communication Specification for all DMS:** Ensure that the sign controller is addressable by the TMC through the Ethernet communications network using software that complies with the NTCIP 1101 base standard (formerly the NEMA TS 3.2 -1996 standard), including all amendments as published at the time of contract letting, the NTCIP Simple Transportation Management Framework, and conforms to Compliance Level 1. Ensure that the software implements all mandatory objects in the supplemental requirement SR-781-3-1, FDOT Dynamic Message Sign NTCIP Requirements, as published on the FDOT State Traffic Engineering and Operations Office web site at the time of contract letting. Ensure that the sign complies with the NTCIP 1102v01.15, 2101 v01.19, 2103v02.07, 2201v01.15, 2202 v01.05, and 2301v02.19 standards. Ensure that the sign complies with NTCIP 1103v02.17, section 3.

A Ensure that the controller’s internal time clock can be configured to synchronize to a time server using the network time protocol (NTP). NTP synchronization frequency must be user-configurable and permit polling intervals from once per minute to once per week in one-minute increments. The controller must allow the user to define the NTP server by internet protocol (IP) address.

Provide communications line circuits that are point-to-point or multipoint, and that provide full duplex asynchronous data transmissions at the rate shown in the contract documents or directed by the Engineer.

Assign each sign controller a unique address.

F **781-3.11 Sign Control Software:** Ensure that the sign is provided with computer software from its manufacturer that allows an operator to program, operate, exercise, diagnose, and read current status of all sign features and functions using a laptop computer. Ensure that sign control software provides a graphical representation that visibly depicts the sign face and the current ON/OFF state of all pixels as well as allows messages to be created and displayed on the sign. Ensure that the laptop computer and sign can communicate when connected directly by an EIA-232 cable and via Ethernet. Ensure that the software will allow communication between multiple users and multiple signs across the same communication network.

781-3.12 Sign Support Structure: Meet the requirements of 700-2.4.

T **781-3.13 Installation Requirements:** Provide walk-in DMS for locations over interstate travel lanes. Do not install the sign prior to the availability of electric power. Verify that any ventilation system incorporated within the sign is operational within 72 hours after sign installation.

EXPECTED IMPLEMENTATION JULY 2012

Ensure that the location of the lifting eyebolts, left in place or removed, is sealed to prevent water entry after installation.

Load the initial message libraries on both the sign control software and the sign controller. The Engineer will furnish the messages to be placed in these libraries.

781-3.14 Documentation: Provide documentation for electronic equipment in accordance with 603-8.

781-3.15 Licensing: Ensure that the manufacturer grants the Department a license that allows the Department to use and internally distribute any and all sign communications protocols, operating systems, drivers, and documentation.

781-3.16 Technical Assistance: Ensure that a manufacturer's representative is available to assist the Contractor's technical personnel during pre-installation testing and installation.

Do not provide initial power to the sign(s) without the permission of the manufacturer's representative.

781-3.17 Environmental Requirements: The DMS must meet the requirements of NEMA TS4 2005, section 2.

781-3.18 Pre-installation Field Testing: Conduct pre-installation tests on all units at a Contractor-provided facility within the appropriate District. Perform the tests on each unit supplied to verify that no damage was done to any sign during the shipment and delivery process. Notify the Engineer a minimum of 10 calendar days before the start of any tests. Conduct all tests according to the approved test procedures detailed in this section. Each DMS must pass the individual tests detailed below prior to installation.

781-3.18.1 Material Inspection: Examine each DMS carefully to verify that the materials, design, construction, markings, and workmanship comply with all applicable standards, specifications, and requirements.

781-3.18.2 Operational Test: Operate each DMS long enough to permit equipment temperature stabilization, and to check and record an adequate number of performance characteristics to ensure compliance with applicable standards, specifications, and requirements.

781-3.18.3 Pre-installation Test Failure Consequence: If any unit fails, the unit shall be corrected or another unit substituted in its place and the test repeated.

If a unit has been modified as a result of a failure, a report shall be prepared and delivered to the Engineer. The report shall describe the nature of the failure and the corrective action taken.

If a failure pattern develops, the Engineer may direct that design and construction modifications be made to all units without additional cost to the Department or an extension of the contract period.

781-3.19 Installed Site Tests: Conduct an approved, stand-alone equipment installation test at the field site. Test all stand-alone (i.e., non-network) functions of the field equipment using equipment installed as detailed in the Plans and as approved by the Engineer.

Complete approved data forms and turn them over to the Engineer for review and as a basis for rejection or acceptance. Provide a minimum notice of 30 calendar days prior to all tests to permit the Engineer or his representative to observe each test.

If any unit fails to pass its stand-alone test, correct the unit or substitute another unit in its place, then repeat the test.

If a unit has been modified as a result of a stand-alone test failure, prepare a report describing the nature of the failure and the corrective action taken and deliver it to the Engineer

EXPECTED IMPLEMENTATION JULY 2012

prior to re-testing the unit. If a failure pattern develops, the Engineer may direct that design and construction modifications be made to all units without additional cost to the Department or an extension of the contract period.

781-3.20 System Testing: Conduct approved DMS system tests on the field equipment with the master equipment including, at a minimum, all remote control functions. Display the return status codes from the sign controller for a minimum of 72 hours. Complete approved data forms and turn them over to the Engineer for review, and as a basis for rejection or acceptance.

Demonstrate the sign's ability to display the proper predefined message or remain blank when power is restored following an AC power interruption.

If the system test fails because of any subsystem component, repair that component or substitute another in its place, then repeat the test. If a component has been modified as a result of a system test failure, prepare a report and deliver it to the Engineer prior to retesting.

781-3.21 Operational Testing: After the system testing is successfully completed, conduct one continuous 72-hour, full-operating test prior to conducting the 60-day acceptance test. The Engineer will approve the type of tests to be conducted. Include in the tests all control, monitoring, and communications functions of the field equipment by the master equipment.

781-3.22 Acceptance Testing: Conduct a 60-day acceptance test after the successful completion of the approved 72-hour operational test. During the 60-day test period, limit downtime due to mechanical, electrical, or other malfunctions to a maximum total of five calendar days. If the equipment fails to operate for a total of five or more calendar days, testing will be restarted. The Engineer may select to pause and extend the 60-day test period by the number of days lost by failure and repair time in lieu of restarting the full 60-day test. The Engineer will furnish the Contractor with a letter of approval and completion stating the first and last day of the 60-day test period.

ARTICLE 781-7 (of the Supplemental Specifications) is deleted and the following substituted:

781-7 Method of Measurement.

Measurement for payment will be in accordance with the following work tasks.

781-7.1 Furnish and Install: For DMS, the quantity to be paid for will be each sign furnished, installed, complete in accordance with the details shown in the plans, warranted, made fully operational, and tested in accordance with the specifications in this section.

For DMS Support Structure, the quantity to be paid for will be each structure furnished, installed, complete in accordance with the details shown in the plans; including posts and supports, catwalks, handrails, footings, excavation, site grounding, painting, and incidentals necessary to complete the work.

The Contract unit price for each HAR system, furnished and installed, will include furnishing, placement, and testing of all materials and equipment, and for all tools, labor, equipment, hardware, operational software package(s) and firmware(s), supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work.

The Contract unit price for an RWIS at each field location, furnished and installed, will include furnishing, placement, and testing of all materials and equipment, and for all tools, labor, equipment, hardware, operational software package(s) and firmware(s), supplies,

EXPECTED IMPLEMENTATION JULY 2012

support, personnel training, shop drawings, warranty documentation, and incidentals necessary to complete the work.

781-7.2 Furnish: The Contract unit price per each DMS, HAR or RWIS system, furnished, will include all equipment specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

781-7.3 Install: The Contract unit price per each DMS, HAR or RWIS system, installed, will include placement, and testing of all materials and equipment, and for all tools, labor, equipment, hardware, operational software package(s) and firmware(s), supplies, support, personnel training, shop drawings, documentation, and incidentals necessary to complete the work. The Engineer will supply the equipment specified in the Contract Documents.

ARTICLE 781-8 (of the Supplemental Specifications) is deleted and the following substituted:

781-8 Basis of Payment.

Price and payment will be full compensation for furnishing all materials and completing all work as specified in this section or shown in the plans.

Payment will be made under:

Item No. 781-2	Highway Advisory Radio System – each.
Item No. 781-3	Road Weather Information System – each.
Item No. 781-4	Dynamic Message Sign – each.
Item No. 781-5	Dynamic Message Sign Support Structure – each.