Florida Department of Transportation

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January 22, 2010

Monica Gourdine
Program Operations Engineer
Federal Highway Administration
545 John Knox Road, Suite 200
Tallahassee, Florida 32303

Re: Office of Design, Specifications
Section 781
Proposed Specification: **7810301 ITS Motorist Information Systems.**

Dear Ms. Gourdine:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

These changes were proposed by Trey Tillander of the State Traffic Engineering and Operations Office to clarify technical requirements and to update items that have been noted during the review, approval and deployment of equipment.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via Email to ST986RP or rudy.powell@dot.state.fl.us.

If you have any questions relating to this specification change, please call Rudy Powell, State Specifications Engineer at 414-4280.

Sincerely,

Signature on File

Rudy Powell, Jr., P.E.
State Specifications Engineer

RP/ft
Attachment
cc: Gregory Jones, Chief Civil Litigation
Florida Transportation Builders' Assoc.
State Construction Engineer

**INTELLIGENT TRANSPORTATION SYSTEMS–MOTORIST INFORMATION SYSTEMS.**

**(REV ~~11-22-09~~ *1-20-10*) ~~(FA 2-4-09) (7-09)~~**

SUBARTICLE 781-3.1 (of the Supplemental Specifications) 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.

**781-3.1.1 General:** Ensure that all exposed material is corrosion resistant. Ensure that the electronic equipment associated with the sign remains secure from damage and protected from moisture, dust, dirt, and corrosion.

Ensure that ambient magnetic or electromagnetic fields, including those created by any system components, have no negative effects on system performance. Ensure that the system does not conduct or radiate signals that interfere with other electrical or electronic equipment including, but not limited to, other control systems and data processing, audio, radio, and industrial equipment.

Ensure that the sign housing complies with the fatigue resistance requirements of the fifth edition (2001) 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 the wind loads defined in the FDOT Structures Manual without deformation or damage.

Ensure that the sign is fabricated, welded, and inspected in accordance with the requirements of the current ANSI/AWS Structural Welding Code-Aluminum. Ensure that all identification markings on the sign and its components, including but not limited to panels, terminal blocks, and printed circuit boards, are silk-screened and sealed or otherwise indelible. Ensure that the equipment design allows access and maintenance without special tools. Ensure that all component parts are readily accessible for inspection and maintenance. Provide labeled test points for checking essential voltages. Ensure that all external connections are terminated using connectors. Key the connectors to preclude improper hookups. Provide a clear removable cover measuring 0.125 inch thick to cover all exposed power terminals. Ensure that the covers do not interfere with sign functions or maintenance operations.

*Ensure that the sign provides a minimum legible viewing distance that includes the area from 100 to a minimum of 1100 feet in advance of the sign. Ensure that the sign is legible for a minimum of 10 seconds when viewed from an approaching vehicle moving at the posted speed limit.*

SUBARTICLE 781-3.1.2 (of the Supplemental Specifications) 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 two 6061-T6 structural aluminum Z members with minimum dimensions of 4”x3”x5/16” on the rear of the sign housing that permit connection to overhead sign structures. 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 sign provides a minimum legible viewing distance that includes the area from 100 to 1100+ feet in advance of the sign. Ensure that the sign is legible for a minimum of 10 seconds when viewed from an approaching vehicle moving at the posted speed.~~

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.

SUBARTICLE 781-3.1.3.3 (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~~, three-quarter diode~~ LED lamps with a minimum viewing angle of *30*~~15~~ 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*~~15~~ 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, ±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*~~each pixel's on-axis intensity is a minimum of 40 candelas~~ 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 ~~circular~~ 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.*~~ powered from a regulated power source providing a maximum of 25 volts of direct current ($V_{DC}$). Ensure that LED power current is maintained at 25 milliamperes, ±2 milliamperes.~~ Ensure that LED failure in one string within a pixel does not affect the operation of any other string or pixel.~~ Do not exceed 1.5 watts per pixel for power drawn from a direct current (DC) supply, including the driving circuitry.~~

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 PCB, and are individually removable and replaceable using conventional electronic repair methods.

SUBARTICLE 781-3.1.3.4 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.1.3. 4 Optical, Electrical, and Mechanical Specifications for Display Modules:** Ensure that each display module contains connectors for power, controls, and data; contains display module control electronics and memory elements; and provides the signals to switch the LED pixels.

Ensure the display modules are rectangular and have an identical vertical and horizontal center-to-center distance (i.e., pitch) between adjacent

pixels ranging from 2.6 inches to 2.75 inches. 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.

Ensure that the LED circuit board is a NEMA FR4-rated, single 0.062-inch, black PCB. Ensure that alternate LED board configurations are submitted to and pre-approved by the Engineer prior to installation. Ensure that PCBs enable components to be removed and replaced without damage to boards, traces, or tracks. Ensure that the intercomponent wiring is a copper-clad track having a minimum weight of 2 ounces per square foot with an adequate cross section for carrying circuit current. 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 all PCBs, except for the LED motherboard and power supply PCBs, with a complete and conformal coating of silicone resin with a minimum thickness of 0.01 inch. 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. Meet the material requirements of MIL-I-46058C Military Standard, United States Department of Defense (USDOD).

Mount all LEDs so that the mechanical axis of the LED is ±1 degree to the sign's face to ensure uniformity of brightness over the sign's face. Ensure that LEDs are secured perpendicular to the display module within 0.5 degree~~. and may be easily removed from the display module PCB without tools.~~ 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.

Ensure that the voltage to the LED modules and their associated electronics does not exceed 25 $V_{DC}$. Ensure that there are a minimum of two, and a maximum of four, power supplies that are wired in a parallel configuration for redundancy. Ensure that multiple power supplies are used to provide power to each display module. Ensure the voltage measured at the display modules does not vary more than 50 millivolts over all the display modules in the sign with 17 pixels on at 100% intensity in each display module. Ensure that if one supply 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 supplies have a current sharing capability that allows them to provide equal amounts of current to their portion of the LED display.

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 an error message will be sent to the TMC or a laptop computer when it polls the sign controller if voltages measured are outside nominal values.

Ensure that LEDs are protected from external environmental conditions, including moisture, snow, ice, wind, dust, dirt, and UV rays. Do not use hoods, louvers, cylinders or visors that could impede the free flow of air over any surface of each individual LED. Do not use epoxy to encapsulate the LEDs.

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.

Characters must be legible under all light conditions at a distance ranging from *1*~~2~~00 to 1,100 feet within the ~~15~~*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.

Ensure that the sign controller allows a moving arrow to be displayed on one line with a standard text message on the other lines. Ensure that the moving arrows may be shown moving from the left or right, and starting from one end or in the middle of the sign and continuing to the end of the sign.

SUBARTICLE 781-3.1.8 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.1.8 Sign Controller:** Ensure that the sign is provided with a sign controller that includes operational firmware stored in nonvolatile memory. Program the controller to receive sign control commands from the TMC, to transmit responses (as requested) to the TMC, and to control sign operation and message displays. Ensure that sign controller functions include error logging and reporting, and providing the operational status of the sensors including temperature, photocell, airflow, humidity, and LED power supply sensors.

Ensure that the sign controller will read the internal temperature sensors, the external ambient temperature sensors, and the humidity sensors and use the readings in an algorithm that turns on heat tape and/or fans when conditions warrant to prevent frost on the face of the sign and condensation on the display modules and other electronic circuitry.

Ensure that the sign controller receives and sends messages by way of an Ethernet network and that the failure of any sign does not affect the operation of any other sign in the system.

Ensure that, at a minimum, the sign controller consists of local control panel status indicators including power on/off, TMC communication status,

laptop computer communication status, communication status with the electronics in the walk-in housing, and sign diagnostics and error status.

Ensure that the controller provides power-up and automatic restart capabilities with automatic sign blanking when recovering from a power-off condition. Ensure that the sign can be configured to either display a stored message or blank upon recovery from power loss and upon recovery from system resets. Utilize a hardware watchdog circuit to provide automatic recovery from critical errors and automatic shutdown in the event of critical hardware failure.

~~Mount the sign controller within the sign housing using industry standard keyed-type connectors with a retaining mechanism.~~ Ensure that there is a ground level access point at the *location shown in the plans and an access point within the sign* ~~sign location~~ that allows the sign to be programmed and controlled locally using a laptop computer.

SUBARTICLE 781-3.1.10 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.1.10 Control Cabinet ~~Specifications~~:** Provide a control cabinet that meets the requirements of Section 785-4. *Ensure that the minimum height of the cabinet is 46 inches* ~~*The cabinet minimum height must be 46 inches*~~.

Equip the ground control cabinet with the following assemblies and components, unless otherwise specified in the plans: power indicator, surge suppression on both sides of all electronics, communication interface devices, connection for a laptop computer for local control and programming, cables a minimum of 4 feet long to connect laptop computers, 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.

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

**781-3.2 Dynamic Message Sign with 12-inch *High* Character Display (12" DMS):** Furnish and install a 12" DMS in accordance with the details specified in the Contract Documents.

SUBARTICLE 781-3.2.2.2 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.2.2 Housing Face:** Ensure that housing face consists of internal structural members, external fascia panels, and lens panel assemblies. ~~Do not allow~~ *Ensure that the* ~~e~~*E*~~e~~xposed fasteners on the housing face ~~*must be*~~*are the same color and finish as the housing face*. *Use only captive fasteners on the housing face.*

SUBARTICLE 781-3.2.3.1 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.3.1 Module Arrangement and Character Size:** Assemble display modules to form a full matrix display as shown in the plans. Ensure that the display is capable of providing a minimum character ~~size~~ *height* of 12-inches when using 5-pixel by 7-pixel characters.

SUBARTICLE 781-3.2.3.2 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.3.2 LED and Pixel Specifications:** Ensure that the 12" DMS utilizes amber~~, three-quarter diode~~ 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 on 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 *minimum* diameter of ~~1~~*0*.~~0~~*5* inches, ~~±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*~~each pixel's on-axis intensity is a minimum of 40 candelas~~ 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 ~~circular~~ 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.* ~~powered from a regulated power source providing a maximum of 25 volts of direct current ($V_{DC}$). Ensure that LED power current is maintained at 25 milliamperes, ±2 milliamperes.~~ Ensure that LED failure

in one string within a pixel does not affect the operation of any other string or pixel. ~~Do not exceed 1.5 watts per pixel for power drawn from a direct current (DC) supply, including the driving circuitry.~~

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. Ensure the operational status may also be tested when the TMC or a laptop computer prompts a pixel test either remotely or on-site. 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 PCB, and are individually removable and replaceable using conventional electronic repair methods.

SUBARTICLE 781-3.2.3.3 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.3.3 Optical, Electrical, and Mechanical Specifications for Display Modules:** Ensure that each display module contains connectors for power, controls, and data; contains display module control electronics and memory elements; and provides the signals to switch the LED pixels.

Ensure the display modules are rectangular and have an identical vertical and horizontal center-to-center distance (i.e., pitch) between adjacent pixels ranging from 1.71 inches to 1.82 inches. 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.

Ensure that the LED circuit board is a NEMA FR4-rated, single 0.062-inch, black PCB. Ensure that alternate LED board configurations are submitted to and pre-approved by the Engineer prior to installation. Ensure that PCBs enable components to be removed and replaced without damage to boards, traces, or tracks. Ensure that the intercomponent wiring is a copper-clad track having a minimum weight of 2 ounces per square foot with an adequate cross section for carrying circuit current. 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 all PCBs, except for the LED motherboard and power supply PCBs, with a complete and conformal coating of silicone or acrylic resin with a minimum thickness of 0.01 inch. Provide the LED motherboards with a complete conformal coating of silicone or acrylic resin with a minimum thickness of 0.01 inch, except for the pixels on the front of the PCB. Meet the material requirements of *MIL-I-46058C Military Standard, United States Department of Defense (USDOD).*

Mount all LEDs so that the mechanical axis of the LED is ±1 degree to the sign's face to ensure uniformity of brightness over the sign's face. Ensure that LEDs are secured perpendicular to the display module within 0.5 degree. ~~and may be easily removed from the display module PCB without tools.~~ 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.

Ensure that the voltage to the LED modules and their associated electronics does not exceed 25 $V_{DC}$. Ensure that there are a minimum of two, and a maximum of four, power supplies that are wired in a parallel configuration for redundancy. Ensure that multiple power supplies are used to provide power to each display module. Ensure the voltage measured at the display modules does not vary more than 50 millivolts over all the display modules in the sign with 17 pixels on at 100% intensity in each display module. Ensure that if one supply 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 supplies have a current sharing capability that allows them to provide equal amounts of current to their portion of the LED display.

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 an error message will be sent to the TMC or a laptop computer when it polls the sign controller if voltages measured are outside nominal values.

Ensure that LEDs are protected from external environmental conditions, including moisture, snow, ice, wind, dust, dirt, and UV rays. Do not use hoods, louvers, cylinders or visors that could impede the free flow of air over any surface of each individual LED. Do not use epoxy to encapsulate the LEDs.

SUBARTICLE 781-3.2.8 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.8 Sign Controller:** Ensure that the sign is provided with a sign controller that includes operational firmware stored in nonvolatile memory. Program the controller to receive sign control commands, transmit responses (as requested), and to control sign operation and message displays both remotely and on site to and from designated users. Ensure that sign controller functions include error logging and reporting, and providing the operational status of the sensors including temperature, photocell, airflow, and humidity and LED power supply sensors.

Ensure that the sign controller will read the internal temperature sensors, the external ambient temperature sensors, and the humidity sensors and use the readings in an algorithm that turns on heat tape and/or fans when conditions warrant preventing frost on the face of the sign and condensation on the display modules and other electronic circuitry.

Ensure that the sign controller receives and sends messages by way of an Ethernet network and that the failure of any sign does not affect the operation of any other sign in the system.

Ensure that, at a minimum, the sign controller provides for local control and programming of the sign, including power on/off, communications, and sign diagnostics and error status.

Ensure that the controller provides power-up and automatic restart capabilities with automatic sign blanking when recovering from a power-off condition. Ensure that the sign can be configured to either display a stored message or blank upon recovery from power loss and upon recovery from system resets. Utilize a hardware watchdog circuit to provide automatic recovery from critical errors and automatic shutdown in the event of critical hardware failure.

~~Mount the sign controller within the sign housing.~~ Ensure that there is a ground level access point at the *location shown in the plans*~~sign location~~ *and an access point within the sign* that allows the sign to be programmed and controlled locally using a laptop computer.

SUBARTICLE 781-3.2.10 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.10 Control Cabinet ~~Specifications~~:** Provide a control cabinet that meets the requirements of Section 785-4. *Ensure that the minimum height of the cabinet is 46 inches.*

Equip the ground control cabinet with the assemblies and components, as shown in the plans: power indicator, surge suppression on both sides of all electronics, communication interface devices, connection for a laptop computer for local control and programming, cables a minimum of 4 feet long to connect laptop computers, a UPS system, 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.

SUBARTICLE 781-3.2.11 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.11 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~~, Mark, or Spare~~
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 user selectable data transmission rates of up to 56 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.

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

**781-3.3 TMC Communication Specifications for all DMS:** Ensure that the sign controller is addressable by the TMC through the Ethernet communication 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, and the NTCIP Simple Transportation Management Framework, and conforms to Compliance Level 1. Ensure that the software implements all mandatory objects as defined in the FDOT standard Global MIB in Appendix A, all mandatory objects as defined in the FDOT-standard DMS MIB in Appendix B, and all mandatory objects as defined in the FDOT-specific DMS MIB in Appendix C as published online at www.dot.state.fl.us/trafficoperations/APL/fdot_dms_info.shtm at the time of contract letting. Ensure that the sign complies with the NTCIP 1201 v01, 1203 v01, 2101 v01.19, 2103 v01.13, 2201 v01.14, 2202 v01.05, and 2301 v01.08 standards. Ensure that compliance with FDOT MIB requirements takes precedence within NTCIP implementations. Ensure that any additional objects implemented by the software do not interfere with the standard operation of any mandatory objects.

Ensure that each sign provides full, standardized range support for all objects required by these specifications unless otherwise detailed in the plans. The standardized range is defined by a size, range or enumerated listing indicated in the object's syntax field and/or through descriptive text in the relevant standard object description field. Ensure that the sign maximum response time *does not exceed 100 milliseconds plus one millisecond for each byte in the response variable-bindings field.* ~~for any object or group of objects is 200 milliseconds unless otherwise indicated in the plans, or unless approved by the FDOT Traffic Engineering Research Laboratory (TERL).~~ Deviances from the full ranges for objects are detailed in Table 1.

| Table 1 – Range Deviances for Objects |
|---|

| Object | Minimum ~~Project~~ Requirements |
|---|---|
| FDOT Global MIB v01c | |
| Maximum Event Log Configurations | 50 |
| Event Configuration Mode | 2, 3, and 4 |
| Maximum Event Log Size | 200 |
| Maximum Event Classes | 7 |
| Maximum Group Address | 1 |
| FDOT DMS MIB v01c | |
| Number of Fonts | 4 |
| Maximum Font Characters | 255 |
| Default Background Color | 0 |
| Default Foreground Color | 9 |
| Default Justification Line | 2, 3, 4 |
| Default Justification Page | 2, 3, 4 |
| DMS – Number of Permanent Messages | 0 |
| DMS – Maximum Changeable Messages | 50 |
| DMS – Maximum Volatile Messages | 0 |
| Nonvolatile Memory | 5 KB |
| DMS – Control Mode | 2, 3, 4, and 5 |
| Number of Action Table Entries | 15 |
| Number of Brightness Levels | ~~255~~*16* |

Ensure that the software implements the tags (opening and closing where defined) of MULTI as detailed in Table 2 and as defined in the NTCIP 1203 standard.

**Table 2 – NTCIP 1203 Standard Software Tags ***

| Opening Tag | Closing Tag | Explanation |
|---|---|---|
| Cbx | | Color – Background – The background color for a message. |
| Cfx | | Color – Foreground – The foreground color for a message. |
| fx,y | | Field – The information to embed within a message that is based on data from some device, such as a clock, calendar, temperature sensor, detector, etc.<br>The following field tag values (IDs) are REQUIRED to be supported:<br>1 – the time in a 12-hour format;<br>2 – the time in a 24-hour format;<br>4 – the ambient temperature in degrees Fahrenheit;<br>7 – the day of the week;<br>8 – the date of the month;<br>9 – the month of the year;<br>10 – the year in two digits; and<br>11 – the year in four digits. |
| Fltxoy | /fl | Flash – Activate flashing of the text; define the flash-on and flash-off times; and the flash order (i.e., on/off or off/on). |

| Table 2 – NTCIP 1203 Standard Software Tags * | | |
|---|---|---|
| Opening Tag | Closing Tag | Explanation |
| Fox | | Font – Select a font number (as specified in the font table) for the message display. |
| Jlx | | Justification – Line – Specify line justification: left, center, right, or full. However, full justification is not required. |
| Jpx | | Justification – Page –Specify page justification: top, middle, or bottom. |
| mvtdw,s,r,text | | Moving – Text – Specify the parameters of a horizontal moving (scrolling) text. |
| Nlx | | New – Line – Specify the start of a new line. |
| Np | | New – Page – Specify the start of a new page. |
| Ptxoy | | Page – Time – Specify the page times (t = on, o = off). |
| Scx | /sc | Spacing – Character – Specify the spacing between characters. |
| * The letters "x" and "y" are character placeholders, usually for numbers, that specify the tag parameter(s). See the NTCIP 1203 standard and its amendments for further definitions. | | |

*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 1-minute increments. The controller must allow the user to define the NTP server by Domain Name System (DNS) and IP address.* Provide each sign controller with error detection and reporting features that will be used to guard against incomplete or inaccurate transmissions including cyclic redundancy checking of all data received from the TMC, with positive acknowledgment for all valid transmissions; status monitoring for communication line malfunctions or breakages; and content validation for all transmissions received for logic or data errors.

Provide communication 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. Where applicable, encode all data transmitted between the TMC and the sign controller using 1 start bit, 8 data bits, and 1 stop bit.

SUBARTICLE 781-4.2 (of the Supplemental Specifications) is deleted and the following substituted:

**781-4.2 Materials:**

**781-4.2.1 General:** Provide a~~n~~ HAR system ~~with~~ *that includes static signage with* ~~remotely operated~~ flashing *beacons* ~~lights and highway signs~~ 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.

**781-4.2.2 Transmitter:** Ensure that the transmitter complies with the requirements of Code of Federal Regulations (CFR) Title 47, Section 90.242, "Travelers' Information Stations", and 47 CFR Section 2.901 et seqq. (Part 2, Subpart J), of the Federal Communications Commission (FCC) Rules and Regulations.

Use a transmitter with a power efficiency of 80% or greater. Ensure that the transmitter is adjustable from 0 to 10 watts. Ensure that the transmitter frequency is set at the factory. Ensure that the transmitter parameters can be monitored locally and remotely.

Ensure that the radio frequency (RF) output impedance is 50 ohms and unbalanced.

Ensure that the audio input impedance is 600 ohms and balanced. Ensure that the transmitter module has audio distortion of less than 1.5% for a audio frequency response of 200 Hz to 3.5 kHz.

Provide a transmitter module with indicators or displays for power status, RF power output, and audio modulation level.

**781-4.2.3 Digital Recorder and Playback Unit:** Ensure that the digital recorder and playback unit can locally and remotely record, store, transmit, and receive digital messages or audio files. Ensure that the digital recorder and playback unit allows operator control by dual tone multi-frequency (DTMF) tones over standard public switched telephone networks (PSTNs) and digital cellular telephone, and digital commands via serial modem. Ensure that the digital recorder and playback unit is FCC certified under Part 68 for dial-up operations.

Ensure that the digital recorder and playback unit can schedule broadcasts, which shall be programmable by the day of the week, month, date, and time. Ensure that the digital recorder and playback unit uses solid state electronics. Do not use floppy disks or magnetic tapes. Use a digital recorder and playback unit with the ability to record and store a minimum of 250 distinct, variable-length messages, and provide a minimum of 14 minutes of recorded message time.

Ensure that the digital recorder and playback unit has access to, and command and control of, the remote flashing beacon controller.

Ensure that the digital recorder and playback unit is password protected and has an input source indicator. Ensure that the digital recorder and playback unit can simultaneously record and playback messages. Ensure that the digital recorder and playback unit can retain messages indefinitely, in the event of a power loss, and not require a battery. Ensure that the digital recorder and playback unit has built-in voice prompts.

~~**781-4.2.4 National Weather Service Receiver:** Provide a National Weather Service (NWS) receiver that is capable of automatically broadcasting alerts from the NWS. Allow the alert feature to be switched on or off and the duration to be set.~~

**781-4.2.5~~4~~ Transmitter Synchronizer:** Ensure that multiple HAR transmitters broadcasting the same message are synchronized. Ensure that the synchronization eliminates interference and audio distortion within possible overlapping areas. ~~Provide a transmitter synchronizer module of modular design.~~

Provide a global positioning system (GPS) receiver for audio synchronization and frequency synchronization. Provide a minimum of eight channels in

the transmitter synchronizer module. Ensure that the accuracy of the module is within 45 nanoseconds at 10 MHz reference.

**781-4.2.6~~5~~ Antenna Assembly:** Provide an antenna assembly with hardware and cables to mount the antenna as shown in the plans. Use either a vertical monopole, which propagates omnidirectional radio waves in a circular pattern, or a directional array that propagates radio waves in a noncircular shape, according to the plans.

Use an antenna that can be tuned to the transmission frequency either mechanically or electronically. Tune the antenna to the same frequency as the transmitter.

**781-4.2.7~~6~~ Ground Plane:** Install system grounding components in accordance with 785-1 or as shown in the plans. Use a minimum of American Wire Gauge (AWG) #20 wire for any radial ground planes. Install these wires extending outward from the base of the antenna, at a minimum of 6 inches below ground, forming a circular pattern with a radius of 30 to 100 feet.

**781-4.2.8~~7~~ Surge Suppressor:** Install transient voltage surge suppressors between the transmitter and the antenna. *Ensure surge protection devices meet the requirements of* ~~as required in~~ *Section* 785-2.

**781-4.2.9~~8~~ HAR Sign and Flashing Beacons:** Provide roadside signs with flashing beacons that are activated when the associated HAR system is transmitting. Ensure that the HAR sign conforms to the FDOT Standard Index for Special Sign Details pertaining to highway advisory radio.

Provide 12-inch beacons that comply with Section 650, along with controller, communications, power and material needed to provide a fully functioning flashing beacon system. Ensure that the flashing beacons use a NEMA-rated flasher circuit. Ensure that the flashing beacons can be operated locally and remotely.

**781-4.2.~~10~~9 Power *System*~~Distribution~~:** *Provide a solar or AC power system as shown in the plans.* ~~*Both solar and AC powered sites must be provided with*~~Provide a power distribution system*, for both solar and AC powered sites, that includes*~~with~~ automatic *battery* charging circuitry. *Ensure that b*~~B~~*attery chargers* ~~*must*~~ to prevent overcharging and *provide*~~with the capability~~ *a means* of ~~low-voltage~~ battery disconnection and isolation.

Provide external AC power supply module with backup batteries as shown in the plans. Ensure that *AC powered systems* ~~the power supply module~~ *utilize* ~~is a nominal~~ 120 volts of alternating current ($V_{AC}$) *nominal input voltage*. Ensure that the *HAR* ~~power supply module~~ operates *from 89-135VAC with a frequency* ~~at 50~~*of* ~~to~~ 60 *+/-3* Hz ~~and a maximum of 150 watts~~. Provide batteries that can continuously operate the HAR system at full power for a minimum period of three days without an external power source. Ensure that *loss of AC power to the system does not* ~~the system has an automatic charging unit and automatic power changeover with no~~ interrupt~~ion to~~ HAR transmissions.

Provide a solar power supply module, as shown in the plans, with photovoltaic array and battery storage system to operate the HAR system continuously at full power for a minimum period of three days without sunlight. Verify that the system's solar panels are compliant with the International Electrotechnical Commission (IEC) requirements detailed in the IEC 61215 standard. Verify that the DC output power

specifications are a nominal 13.6 volts of direct current ($V_{DC}$) at 5 amps, with a maximum of 15 $V_{DC}$ and a maximum of 10 amps.

Provide *12-volt* batteries *that are rated at a minimum of* ~~capable of~~ 180*Ah* ~~amps per hour~~, are deep cycle, and maintenance-free.

Provide an accessible attachment point that allows connection of a portable generator for emergency power.

**781-4.2.11~~0~~*0* Control Cabinet:** Provide a control cabinet for housing the transmitter, digital recorder and playback unit, ~~NWS receiver,~~ transmitter synchronizer, power, surge suppressors, and flashing beacon controller, as shown in the plans. Ensure that cabinets meet NEMA 3R requirements for aluminum enclosures and conform to Section 676. Use a cabinet that is constructed of aluminum alloy 5052-H32 measuring 0.125 inch thick.

**781-4.2.12~~1~~*1* Performance Requirements:** Furnish a~~n~~ HAR system that is compatible with the current version of the Department's SunGuide~~SM~~ Software System.

Ensure that the system has a text-to-speech capability for converting typed words to audio files. Ensure that the system logs the status of all devices. Ensure that the operator is able to record, edit, and delete messages, and to select desired messages for broadcast. Ensure that the system maintains event schedules, diagnostic information, and logs of messages that have been downloaded and played, along with the date and time that a message was activated for each HAR. Ensure that the HAR system provides system failure remote alarms and indicates system status in the user interface.

**781-4.2.13~~2~~*2* Environmental Specifications:** Ensure that the HAR system installed at the field site is able to withstand temperatures between -29° and 165°F as per the NEMA TS 2 standard at 95% noncondensing humidity. Ensure that the HAR system meets the requirements specified in the Plans Preparation Manual for wind loading.

SUBARTICLE 781-5.2.1 (of the Supplemental Specifications) is deleted and the following substituted:

**781-5.2.1 Sensors:** Provide an RWIS that can collect and store data from various sensors~~, which are divided into the following three categories~~ *including, but not limited to*:

1. Roadway sensors located in or under the pavement.
2. Atmospheric sensors mounted on towers that are installed along the roadway or on bridges.
~~3. Subsoil sensors located in soil adjacent to the ESS.~~

Ensure that all RWIS sensors and other field equipment are made of materials able to withstand wet, corrosive, dusty and humid weather conditions characteristic of the Florida climate.

Provide hardware and fasteners that meet the requirements of 603-2.

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

SUBARTICLE 781-5.2.3 (of the Supplemental Specifications) is deleted and the following substituted:

**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) Subsurface temperature~~
    ~~C~~*B*) *Surface*~~Precipitation~~ data that includes ~~precipitation type, *presence*percent of~~ 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
    G) Solar radiation (optional)
3. Subsoil data *(optional)*, including:
    A) Temperature
    B) Moisture ~~(optional)~~
4. High water data

SUBARTICLE781-5.2.4 (of the Supplemental Specifications) is deleted and the following substituted:

**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) over any of the following media, as detailed in the plans:

1. Microwave communications, specifically, Florida's statewide Motorist Aid System (MAS) microwave communication infrastructure.
2. Ethernet communications over single-mode fiber optic cable that transfers data at a minimum rate of 10 megabits per second (Mbps).
3. Twisted-pair copper wire capable of transferring data at a rate of up to 128 kilobits per second (kbps).
4. Cellular mobile telephone service with data transmission rates of up to 56 kbps.

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

In certain cases, provide peer-to-peer wireless communication between RPUs at a maximum distance of 5 miles. Ensure that the RPU is capable of, or adaptable to, providing this type of communication.

**INTELLIGENT TRANSPORTATION SYSTEMS–MOTORIST INFORMATION SYSTEMS.**

**(REV 1-20-10)**

SUBARTICLE 781-3.1 (of the Supplemental Specifications) 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.

**781-3.1.1 General:** Ensure that all exposed material is corrosion resistant. Ensure that the electronic equipment associated with the sign remains secure from damage and protected from moisture, dust, dirt, and corrosion.

Ensure that ambient magnetic or electromagnetic fields, including those created by any system components, have no negative effects on system performance. Ensure that the system does not conduct or radiate signals that interfere with other electrical or electronic equipment including, but not limited to, other control systems and data processing, audio, radio, and industrial equipment.

Ensure that the sign housing complies with the fatigue resistance requirements of the fifth edition (2001) 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 the wind loads defined in the FDOT Structures Manual without deformation or damage.

Ensure that the sign is fabricated, welded, and inspected in accordance with the requirements of the current ANSI/AWS Structural Welding Code-Aluminum. Ensure that all identification markings on the sign and its components, including but not limited to panels, terminal blocks, and printed circuit boards, are silk-screened and sealed or otherwise indelible. Ensure that the equipment design allows access and maintenance without special tools. Ensure that all component parts are readily accessible for inspection and maintenance. Provide labeled test points for checking essential voltages. Ensure that all external connections are terminated using connectors. Key the connectors to preclude improper hookups. Provide a clear removable cover measuring 0.125 inch thick to cover all exposed power terminals. Ensure that the covers do not interfere with sign functions or maintenance operations.

Ensure that the sign provides a minimum legible viewing distance that includes the area from 100 to a minimum of 1100 feet in advance of the sign. Ensure that the sign is legible for a minimum of 10 seconds when viewed from an approaching vehicle moving at the posted speed limit.

SUBARTICLE 781-3.1.2 (of the Supplemental Specifications) 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 two 6061-T6 structural aluminum Z members with minimum dimensions of 4”x3”x5/16” on the rear of the sign housing that permit connection to overhead sign structures. 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.

SUBARTICLE 781-3.1.3.3 (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, ±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 PCB, and are individually removable and replaceable using conventional electronic repair methods.

SUBARTICLE 781-3.1.3.4 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.1.3. 4 Optical, Electrical, and Mechanical Specifications for Display Modules:** Ensure that each display module contains connectors for power, controls, and data; contains display module control electronics and memory elements; and provides the signals to switch the LED pixels.

Ensure the display modules are rectangular and have an identical vertical and horizontal center-to-center distance (i.e., pitch) between adjacent pixels ranging from 2.6 inches to 2.75 inches. 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.

Ensure that the LED circuit board is a NEMA FR4-rated, single 0.062-inch, black PCB. Ensure that alternate LED board configurations are submitted to and pre-approved by the Engineer prior to installation. Ensure that PCBs enable components to be removed and replaced without damage to boards, traces, or tracks. Ensure that the intercomponent wiring is a copper-clad track having a minimum weight of 2 ounces per square foot with an adequate cross section for carrying circuit

current. 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 all PCBs, except for the LED motherboard and power supply PCBs, with a complete and conformal coating of silicone resin with a minimum thickness of 0.01 inch. 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. Meet the material requirements of MIL-I-46058C Military Standard, United States Department of Defense (USDOD).

Mount all LEDs so that the mechanical axis of the LED is ±1 degree to the sign's face to ensure uniformity of brightness over the sign's face. Ensure that LEDs are secured perpendicular to the display module within 0.5 degree. 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.

Ensure that the voltage to the LED modules and their associated electronics does not exceed 25 $V_{DC}$. Ensure that there are a minimum of two, and a maximum of four, power supplies that are wired in a parallel configuration for redundancy. Ensure that multiple power supplies are used to provide power to each display module. Ensure the voltage measured at the display modules does not vary more than 50 millivolts over all the display modules in the sign with 17 pixels on at 100% intensity in each display module. Ensure that if one supply 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 supplies have a current sharing capability that allows them to provide equal amounts of current to their portion of the LED display.

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 an error message will be sent to the TMC or a laptop computer when it polls the sign controller if voltages measured are outside nominal values.

Ensure that LEDs are protected from external environmental conditions, including moisture, snow, ice, wind, dust, dirt, and UV rays. Do not use hoods, louvers, cylinders or visors that could impede the free flow of air over any surface of each individual LED. Do not use epoxy to encapsulate the LEDs.

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.

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.

Ensure that the sign controller allows a moving arrow to be displayed on one line with a standard text message on the other lines. Ensure that the moving arrows may be shown moving from the left or right, and starting from one end or in the middle of the sign and continuing to the end of the sign.

SUBARTICLE 781-3.1.8 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.1.8 Sign Controller:** Ensure that the sign is provided with a sign controller that includes operational firmware stored in nonvolatile memory. Program the controller to receive sign control commands from the TMC, to transmit responses (as requested) to the TMC, and to control sign operation and message displays. Ensure that sign controller functions include error logging and reporting, and providing the operational status of the sensors including temperature, photocell, airflow, humidity, and LED power supply sensors.

Ensure that the sign controller will read the internal temperature sensors, the external ambient temperature sensors, and the humidity sensors and use the readings in an algorithm that turns on heat tape and/or fans when conditions warrant to prevent frost on the face of the sign and condensation on the display modules and other electronic circuitry.

Ensure that the sign controller receives and sends messages by way of an Ethernet network and that the failure of any sign does not affect the operation of any other sign in the system.

Ensure that, at a minimum, the sign controller consists of local control panel status indicators including power on/off, TMC communication status, laptop computer communication status, communication status with the electronics in the walk-in housing, and sign diagnostics and error status.

Ensure that the controller provides power-up and automatic restart capabilities with automatic sign blanking when recovering from a power-off condition. Ensure that the sign can be configured to either display a stored message or blank upon recovery from power loss and upon recovery from system resets. Utilize a hardware watchdog circuit to provide automatic recovery from critical errors and automatic shutdown in the event of critical hardware failure.

Ensure that there is a ground level access point at the location shown in the plans and an access point within the sign that allows the sign to be programmed and controlled locally using a laptop computer.

SUBARTICLE 781-3.1.10 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.1.10 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.

Equip the ground control cabinet with the following assemblies and components, unless otherwise specified in the plans: power indicator, surge suppression on both sides of all electronics, communication interface devices, connection for a laptop computer for local control and programming, cables a minimum of 4 feet long to connect laptop computers, 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.

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

**781-3.2 Dynamic Message Sign with 12-inch High Character Display (12" DMS):** Furnish and install a 12" DMS in accordance with the details specified in the Contract Documents.

SUBARTICLE 781-3.2.2.2 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.2.2 Housing Face:** Ensure that housing face consists of internal structural members, external fascia panels, and lens panel assemblies. Ensure that the exposed fasteners on the housing face are the same color and finish as the housing face. Use only captive fasteners on the housing face.

SUBARTICLE 781-3.2.3.1 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.3.1 Module Arrangement and Character Size:** Assemble display modules to form a full matrix display as shown in the plans. Ensure that the display is capable of providing a minimum character height of 12-inches when using 5-pixel by 7-pixel characters.

SUBARTICLE 781-3.2.3.2 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.3.2 LED and Pixel Specifications:** Ensure that the 12" DMS 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 on 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 minimum diameter of 0.5 inches, , 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. Ensure the operational status may also be tested when the TMC or a laptop computer prompts a pixel test either remotely or on-site. 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 PCB, and are individually removable and replaceable using conventional electronic repair methods.

SUBARTICLE 781-3.2.3.3 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.3.3 Optical, Electrical, and Mechanical Specifications for Display Modules:** Ensure that each display module contains connectors for power, controls, and data; contains display module control electronics and memory elements; and provides the signals to switch the LED pixels.

Ensure the display modules are rectangular and have an identical vertical and horizontal center-to-center distance (i.e., pitch) between adjacent pixels ranging from 1.71 inches to 1.82 inches. 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.

Ensure that the LED circuit board is a NEMA FR4-rated, single 0.062-inch, black PCB. Ensure that alternate LED board configurations are submitted to and pre-approved by the Engineer prior to installation. Ensure that PCBs enable components to be removed and replaced without damage to boards, traces, or tracks. Ensure that the intercomponent wiring is a copper-clad track having a minimum weight of 2 ounces per square foot with an adequate cross section for carrying circuit current. 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 all PCBs, except for the LED motherboard and power supply PCBs, with a complete and conformal coating of silicone or acrylic resin with a minimum thickness of 0.01 inch. Provide the LED motherboards with a complete conformal coating of silicone or acrylic resin with a minimum thickness of 0.01 inch, except for the pixels on the front of the PCB. Meet the material requirements of *MIL-I-46058C Military Standard, United States Department of Defense (USDOD).*

Mount all LEDs so that the mechanical axis of the LED is ±1 degree to the sign's face to ensure uniformity of brightness over the sign's face. Ensure that LEDs are secured perpendicular to the display module within 0.5 degree. 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.

Ensure that the voltage to the LED modules and their associated electronics does not exceed 25 $V_{DC}$. Ensure that there are a minimum of two, and a maximum of four, power supplies that are wired in a parallel configuration for redundancy. Ensure that multiple power supplies are used to provide power to each display module. Ensure the voltage measured at the display modules does not vary more than 50 millivolts over all the display modules in the sign with 17 pixels on at 100% intensity in each display module. Ensure that if one supply 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 supplies have a current sharing capability that allows them to provide equal amounts of current to their portion of the LED display.

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 an error message will be sent to the TMC or a laptop computer when it polls the sign controller if voltages measured are outside nominal values.

Ensure that LEDs are protected from external environmental conditions, including moisture, snow, ice, wind, dust, dirt, and UV rays. Do not use hoods, louvers, cylinders or visors that could impede the free flow of air over any surface of each individual LED. Do not use epoxy to encapsulate the LEDs.

SUBARTICLE 781-3.2.8 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.8 Sign Controller:** Ensure that the sign is provided with a sign controller that includes operational firmware stored in nonvolatile memory. Program the controller to receive sign control commands, transmit responses (as requested), and to control sign operation and message displays both remotely and on site to and from designated users. Ensure that sign controller functions include error logging and reporting, and providing the operational status of the sensors including temperature, photocell, airflow, and humidity and LED power supply sensors.

Ensure that the sign controller will read the internal temperature sensors, the external ambient temperature sensors, and the humidity sensors and use the readings in an algorithm that turns on heat tape and/or fans when conditions warrant preventing frost on the face of the sign and condensation on the display modules and other electronic circuitry.

Ensure that the sign controller receives and sends messages by way of an Ethernet network and that the failure of any sign does not affect the operation of any other sign in the system.

Ensure that, at a minimum, the sign controller provides for local control and programming of the sign, including power on/off, communications, and sign diagnostics and error status.

Ensure that the controller provides power-up and automatic restart capabilities with automatic sign blanking when recovering from a power-off condition. Ensure that the sign can be configured to either display a stored message or blank upon recovery from power loss and upon recovery from system resets. Utilize a hardware watchdog circuit to provide automatic recovery from critical errors and automatic shutdown in the event of critical hardware failure.

Ensure that there is a ground level access point at the location shown in the plans and an access point within the sign that allows the sign to be programmed and controlled locally using a laptop computer.

SUBARTICLE 781-3.2.10 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.10 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.

Equip the ground control cabinet with the assemblies and components, as shown in the plans: power indicator, surge suppression on both sides of all electronics, communication interface devices, connection for a laptop computer for local control and programming, cables a minimum of 4 feet long to connect laptop computers, a UPS system, 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.

SUBARTICLE 781-3.2.11 (of the Supplemental Specifications) is deleted and the following substituted:

**781-3.2.11 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 user selectable data transmission rates of up to 56 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.

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

**781-3.3 TMC Communication Specifications for all DMS:** Ensure that the sign controller is addressable by the TMC through the Ethernet communication 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, and the NTCIP Simple Transportation Management Framework, and conforms to Compliance Level 1. Ensure that the software implements all mandatory

objects as defined in the FDOT standard Global MIB in Appendix A, all mandatory objects as defined in the FDOT-standard DMS MIB in Appendix B, and all mandatory objects as defined in the FDOT-specific DMS MIB in Appendix C as published online at www.dot.state.fl.us/trafficoperations/APL/fdot_dms_info.shtm at the time of contract letting. Ensure that the sign complies with the NTCIP 1201 v01, 1203 v01, 2101 v01.19, 2103 v01.13, 2201 v01.14, 2202 v01.05, and 2301 v01.08 standards. Ensure that compliance with FDOT MIB requirements takes precedence within NTCIP implementations. Ensure that any additional objects implemented by the software do not interfere with the standard operation of any mandatory objects.

Ensure that each sign provides full, standardized range support for all objects required by these specifications unless otherwise detailed in the plans. The standardized range is defined by a size, range or enumerated listing indicated in the object's syntax field and/or through descriptive text in the relevant standard object description field. Ensure that the sign maximum response time does not exceed 100 milliseconds plus one millisecond for each byte in the response variable-bindings field. Deviances from the full ranges for objects are detailed in Table 1.

| Table 1 – Range Deviances for Objects | |
|---|---|
| Object | Minimum Requirements |
| FDOT Global MIB v01c | |
| Maximum Event Log Configurations | 50 |
| Event Configuration Mode | 2, 3, and 4 |
| Maximum Event Log Size | 200 |
| Maximum Event Classes | 7 |
| Maximum Group Address | 1 |
| FDOT DMS MIB v01c | |
| Number of Fonts | 4 |
| Maximum Font Characters | 255 |
| Default Background Color | 0 |
| Default Foreground Color | 9 |
| Default Justification Line | 2, 3, 4 |
| Default Justification Page | 2, 3, 4 |
| DMS – Number of Permanent Messages | 0 |
| DMS – Maximum Changeable Messages | 50 |
| DMS – Maximum Volatile Messages | 0 |
| Nonvolatile Memory | 5 KB |
| DMS – Control Mode | 2, 3, 4, and 5 |
| Number of Action Table Entries | 15 |
| Number of Brightness Levels | 16 |

Ensure that the software implements the tags (opening and closing where defined) of MULTI as detailed in Table 2 and as defined in the NTCIP 1203 standard.

| **Table 2 – NTCIP 1203 Standard Software Tags** * |
|---|

| Opening Tag | Closing Tag | Explanation |
|---|---|---|
| Cbx | | Color – Background – The background color for a message. |
| Cfx | | Color – Foreground – The foreground color for a message. |
| fx,y | | Field – The information to embed within a message that is based on data from some device, such as a clock, calendar, temperature sensor, detector, etc.<br>The following field tag values (IDs) are REQUIRED to be supported:<br>1 – the time in a 12-hour format;<br>2 – the time in a 24-hour format;<br>4 – the ambient temperature in degrees Fahrenheit;<br>7 – the day of the week;<br>8 – the date of the month;<br>9 – the month of the year;<br>10 – the year in two digits; and<br>11 – the year in four digits. |
| Fltxoy | /fl | Flash – Activate flashing of the text; define the flash-on and flash-off times; and the flash order (i.e., on/off or off/on). |
| Fox | | Font – Select a font number (as specified in the font table) for the message display. |
| Jlx | | Justification – Line – Specify line justification: left, center, right, or full. However, full justification is not required. |
| Jpx | | Justification – Page –Specify page justification: top, middle, or bottom. |
| mvtdw,s,r,text | | Moving – Text – Specify the parameters of a horizontal moving (scrolling) text. |
| Nlx | | New – Line – Specify the start of a new line. |
| Np | | New – Page – Specify the start of a new page. |
| Ptxoy | | Page – Time – Specify the page times (t = on, o = off). |
| Scx | /sc | Spacing – Character – Specify the spacing between characters. |
| * The letters “x” and “y” are character placeholders, usually for numbers, that specify the tag parameter(s). See the NTCIP 1203 standard and its amendments for further definitions. | | |

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 1-minute increments. The controller must allow the user to define the NTP server by Domain Name System (DNS) and IP address. Provide each sign controller with error detection and reporting features that will be used to guard against incomplete or inaccurate transmissions including cyclic redundancy checking of all data received from the TMC, with positive acknowledgment for all valid transmissions; status monitoring for communication line malfunctions or breakages; and content validation for all transmissions received for logic or data errors.

Provide communication 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. Where applicable, encode all data transmitted between the TMC and the sign controller using 1 start bit, 8 data bits, and 1 stop bit.

SUBARTICLE 781-4.2 (of the Supplemental Specifications) is deleted and the following substituted:

**781-4.2 Materials:**

**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.

**781-4.2.2 Transmitter:** Ensure that the transmitter complies with the requirements of Code of Federal Regulations (CFR) Title 47, Section 90.242, “Travelers’ Information Stations”, and 47 CFR Section 2.901 et seqq. (Part 2, Subpart J), of the Federal Communications Commission (FCC) Rules and Regulations.

Use a transmitter with a power efficiency of 80% or greater. Ensure that the transmitter is adjustable from 0 to 10 watts. Ensure that the transmitter frequency is set at the factory. Ensure that the transmitter parameters can be monitored locally and remotely.

Ensure that the radio frequency (RF) output impedance is 50 ohms and unbalanced.

Ensure that the audio input impedance is 600 ohms and balanced. Ensure that the transmitter module has audio distortion of less than 1.5% for a audio frequency response of 200 Hz to 3.5 kHz.

Provide a transmitter module with indicators or displays for power status, RF power output, and audio modulation level.

**781-4.2.3 Digital Recorder and Playback Unit:** Ensure that the digital recorder and playback unit can locally and remotely record, store, transmit, and receive digital messages or audio files. Ensure that the digital recorder and playback unit allows operator control by dual tone multi-frequency (DTMF) tones over standard public switched telephone networks (PSTNs) and digital cellular telephone, and digital commands via serial modem. Ensure that the digital recorder and playback unit is FCC certified under Part 68 for dial-up operations.

Ensure that the digital recorder and playback unit can schedule broadcasts, which shall be programmable by the day of the week, month, date, and time. Ensure that the digital recorder and playback unit uses solid state electronics. Do not use floppy disks or magnetic tapes. Use a digital recorder and playback unit with the ability to record and store a minimum of 250 distinct, variable-length messages, and provide a minimum of 14 minutes of recorded message time.

Ensure that the digital recorder and playback unit has access to, and command and control of, the remote flashing beacon controller.

Ensure that the digital recorder and playback unit is password protected and has an input source indicator. Ensure that the digital recorder and playback

unit can simultaneously record and playback messages. Ensure that the digital recorder and playback unit can retain messages indefinitely, in the event of a power loss, and not require a battery. Ensure that the digital recorder and playback unit has built-in voice prompts.

**781-4.2.4 Transmitter Synchronizer:** Ensure that multiple HAR transmitters broadcasting the same message are synchronized. Ensure that the synchronization eliminates interference and audio distortion within possible overlapping areas. Provide a global positioning system (GPS) receiver for audio synchronization and frequency synchronization. Provide a minimum of eight channels in the transmitter synchronizer module. Ensure that the accuracy of the module is within 45 nanoseconds at 10 MHz reference.

**781-4.2.5 Antenna Assembly:** Provide an antenna assembly with hardware and cables to mount the antenna as shown in the plans. Use either a vertical monopole, which propagates omnidirectional radio waves in a circular pattern, or a directional array that propagates radio waves in a noncircular shape, according to the plans.

Use an antenna that can be tuned to the transmission frequency either mechanically or electronically. Tune the antenna to the same frequency as the transmitter.

**781-4.2.6 Ground Plane:** Install system grounding components in accordance with 785-1 or as shown in the plans. Use a minimum of American Wire Gauge (AWG) #20 wire for any radial ground planes. Install these wires extending outward from the base of the antenna, at a minimum of 6 inches below ground, forming a circular pattern with a radius of 30 to 100 feet.

**781-4.2.7 Surge Suppressor:** Install transient voltage surge suppressors between the transmitter and the antenna. Ensure surge protection devices meet the requirements of Section 785-2.

**781-4.2.8 HAR Sign and Flashing Beacons:** Provide roadside signs with flashing beacons that are activated when the associated HAR system is transmitting. Ensure that the HAR sign conforms to the FDOT Standard Index for Special Sign Details pertaining to highway advisory radio.

Provide 12-inch beacons that comply with Section 650, along with controller, communications, power and material needed to provide a fully functioning flashing beacon system. Ensure that the flashing beacons use a NEMA-rated flasher circuit. Ensure that the flashing beacons can be operated locally and remotely.

**781-4.2.9 Power System:** Provide a solar or AC power system as shown in the plans. Provide a power distribution system, for both solar and AC powered sites, that includes automatic battery charging circuitry. Ensure that battery chargers prevent overcharging and provide a means of battery disconnection and isolation.

Provide external AC power supply module with backup batteries as shown in the plans. Ensure that AC powered systems utilize 120 volts of alternating current ($V_{AC}$) nominal input voltage. Ensure that the HAR operates from 89-135VAC with a frequency of 60 +/-3 Hz. Provide batteries that can continuously operate the HAR system at full power for a minimum period of three days without an external power source. Ensure that loss of AC power to the system does not interrupt HAR transmissions.

Provide a solar power supply module, as shown in the plans, with photovoltaic array and battery storage system to operate the HAR system continuously at full power for a minimum period of three days without sunlight. Verify that the system's solar panels are compliant with the International Electrotechnical Commission (IEC) requirements detailed in the IEC 61215 standard. Verify that the DC output power specifications are a nominal 13.6 volts of direct current ($V_{DC}$) at 5 amps, with a maximum of 15 $V_{DC}$ and a maximum of 10 amps.

Provide 12-volt batteries that are rated at a minimum of 180Ah, are deep cycle, and maintenance-free.

Provide an accessible attachment point that allows connection of a portable generator for emergency power.

**781-4.2.10 Control Cabinet:** Provide a control cabinet for housing the transmitter, digital recorder and playback unit, transmitter synchronizer, power, surge suppressors, and flashing beacon controller, as shown in the plans. Ensure that cabinets meet NEMA 3R requirements for aluminum enclosures and conform to Section 676. Use a cabinet that is constructed of aluminum alloy 5052-H32 measuring 0.125 inch thick.

**781-4.2.11 Performance Requirements:** Furnish a HAR system that is compatible with the current version of the Department's SunGuide® Software System.

Ensure that the system has a text-to-speech capability for converting typed words to audio files. Ensure that the system logs the status of all devices. Ensure that the operator is able to record, edit, and delete messages, and to select desired messages for broadcast. Ensure that the system maintains event schedules, diagnostic information, and logs of messages that have been downloaded and played, along with the date and time that a message was activated for each HAR. Ensure that the HAR system provides system failure remote alarms and indicates system status in the user interface.

**781-4.2.12 Environmental Specifications:** Ensure that the HAR system installed at the field site is able to withstand temperatures between -29° and 165°F as per the NEMA TS 2 standard at 95% noncondensing humidity. Ensure that the HAR system meets the requirements specified in the Plans Preparation Manual for wind loading.

SUBARTICLE 781-5.2.1 (of the Supplemental Specifications) is deleted and the following substituted:

**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 mounted on towers that are installed along the roadway or on bridges.

Ensure that all RWIS sensors and other field equipment are made of materials able to withstand wet, corrosive, dusty and humid weather conditions characteristic of the Florida climate.

Provide hardware and fasteners that meet the requirements of 603-2.

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

SUBARTICLE 781-5.2.3 (of the Supplemental Specifications) is deleted and the following substituted:

**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
    G) Solar radiation (optional)
3. Subsoil data (optional), including:
    A) Temperature
    B) Moisture
4. High water data

SUBARTICLE781-5.2.4 (of the Supplemental Specifications) is deleted and the following substituted:

**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) over any of the following media, as detailed in the plans:

1. Microwave communications, specifically, Florida's statewide Motorist Aid System (MAS) microwave communication infrastructure.
2. Ethernet communications over single-mode fiber optic cable that transfers data at a minimum rate of 10 megabits per second (Mbps).
3. Twisted-pair copper wire capable of transferring data at a rate of up to 128 kilobits per second (kbps).
4. Cellular mobile telephone service with data transmission rates of up to 56 kbps.

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

In certain cases, provide peer-to-peer wireless communication between RPUs at a maximum distance of 5 miles. Ensure that the RPU is capable of, or adaptable to, providing this type of communication.