



**Kevin Keith, Director**

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**REQUEST FOR PROPOSALS  
SL12-071-RW  
DYNAMIC MESSAGE SIGN ASSEMBLY**

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**LIST OF ACRONYMS**

<b>MHTC</b>	Missouri Highways and Transportation Commission
<b>MoDOT</b>	Missouri Department of Transportation
<b>RFP</b>	Request for Proposals

**INTRODUCTION**

This Request For Proposal (**RFP**) seeks proposals from qualified organizations (**Offeror**) to furnish the described items to the Missouri Highways and Transportation Commission (**MHTC**). Six (6) copies of each proposal, and one CD, electronic copy, must be mailed in a sealed envelope to 2309 Barrett Station Road, Ballwin, MO 63021, Missouri Department of Transportation, or hand-delivered in a sealed envelope to the Procurement Office at 2309 Barrett Station Road, Ballwin, MO 63021 Proposals must be returned to the offices by **Wednesday, March 28, 2012** no later than **1:00 p.m. CST**.

MHTC reserves the right to reject any and all bids for any reason whatsoever. Time is of the essence for responding to the RFP within the submission deadlines.

**PROPOSAL**

- (1) The Offeror shall provide a fee proposal to MHTC on the **PRICE PAGE** in accordance with the terms of this RFP.
- (2) The Offeror agrees to provide the items at the fees quoted, under the terms of this RFP.

---

Authorized Signature of Offeror: \_\_\_\_\_

Date of Proposal: \_\_\_\_\_

Printed or Typed Name: \_\_\_\_\_

Mailing Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_

Telephone: \_\_\_\_\_ Fax: \_\_\_\_\_

Electronic Mail Address: \_\_\_\_\_

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**ACCEPTANCE**

This proposal is accepted by MHTC.

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(Name and Title)

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Date

**SECTION (1):  
GENERAL DESCRIPTION AND BACKGROUND**

- (A) **Request for Proposal:** This document constitutes a RFP from qualified organizations to provide Dynamic Message Sign Assemblies to MHTC and the Missouri Department of Transportation (MoDOT).  
This document includes specifications for four (4) types of Dynamic Message Sign Assemblies, Specifications A, B, C, and D of which C and D are optional at MoDOT's discretion. **To be considered, bidders should submit proposals for all four types of product.**
- (B) **Background:** The Missouri Department of Transportation (MoDOT) seeks proposals to provide DMS Assemblies. Each Offeror is solely responsible for a prudent and complete personal examination and assessment of the requirements and specifications, and/or any other existing condition, factor, or item that may affect or impact on the performance of the DMS boards as described and required by the Contractual Requirements. The Offeror shall not be relieved of responsibility for performance under the contract for any reason whatsoever, including, but not limited to (1) the Offeror's failure to comprehend specifications as supplied (2) the Offeror's failure to solicit pertinent data or information, etc.
- (C) **Fiscal Year:** The fiscal year runs from July 1-June 30, period of service will be from Date of Award through August 30, 2015, with the option(s) to extend the contract for up to two(2) one year periods, at the sole discretion of the Missouri Department of Transportation.

**SECTION (2):  
SCOPE OF WORK**

- (A) **Services:** The Offeror shall provide competitive, sealed proposals for the provision of dynamic message sign assemblies as set forth by this RFP.
- (B) **Specific Requirements:** The Offeror will provide to MoDOT six (6) copies and one electronic copy,(CD) of the program proposal which will include but may not be limited to the following:
- Shop drawings of devices
  - Schematic of typical communication layout
  - Timeline ( per pricing page)
  - Cost (per pricing page)
  - Specification compliance confirmation per line item (does or does not meet)
- (C) **Administration of Program:** The Offeror will consult MHTC's representative regarding any problems involved with the administration of the items provided pursuant to this RFP.

**SCOPE OF WORK SECTION 2D**  
**FUNCTIONAL SPECIFICATION FOR**  
**DYNAMIC MESSAGE SIGN ASSEMBLY**  
**SPECIFICATION A- OVERHEAD MOUNT- CONTROLLER OUTSIDE**

**1. GENERAL**

**1.1. Description**

This specification describes a walk-in, full matrix Dynamic Message Sign (DMS) assembly. The DMS assembly shall include the DMS, horizontal structural brackets, mounting hardware, electrical distribution, surge suppression and all miscellaneous hardware and incidental components (including internal cables) required to deliver a fully operational subsystem. The entire assembly shall be housed in a fully wired aluminum weatherproof enclosure.

The assembly also includes a sign controller to be mounted in a cabinet (provided by others) near the sign. In most cases, the cabinet will be mounted on the sign support structure concrete pad within close proximity to the sign structure.

All portions of the DMS display shall be clearly visible and legible from in-vehicle viewing distances between 200 ft (61 m) and 1000 ft (305 m) under normal roadway operating conditions. The DMS assembly shall be designed to operate in roadway configurations at least three travel lanes wide in the same direction.

All DMS equipment components, modular assemblies, and other materials located in the DMS housing shall be removable, transportable, and capable of being installed by a single technician utilizing a catwalk to an access door. Structural members and components thereof are not included in this requirement.

All components furnished under this functional specification shall be current production equipment and of recent manufacture. To ensure overall system compatibility, all DMS's shall be from the same manufacturer and production run.

**1.2. Manufacturer Qualifications**

The DMS manufacturer proposed to furnish displays and controllers for this project shall have been in business continuously for a minimum of five years prior to the date of bid opening. Further, the proposed manufacturer shall have furnished LED DMS systems for a minimum of three projects, each with at least five signs and controllers. Each of these signs and controllers shall have satisfactorily operated for a minimum of one year prior to the date of bid opening. The names, current addresses and phone numbers of individuals who can certify satisfactory operation of signs meeting the above stated requirements shall be provided with the initial material submittal.

**1.3. Item Identification**

Manufacturer model numbers shall be permanently affixed on all replaceable components. The manufacturer shall supply an Excel spreadsheet in the current MoDOT format containing the manufacturer's name, device type (i.e., DMS), Location Identifier, model number, part number and serial number as separate fields.

○1.4. **Environmental**

Except where otherwise specified, all components of the DMS assembly shall meet the temperature, humidity, vibration, and electrical requirements of NEMA TS-2. The DMS components shall be capable of continuous operation in a salt-laden atmosphere without degradation of material surfaces or performance.

○1.5. **Mechanical**

The total weight of the DMS assembly shall not exceed 4500 lb (2050 kg).

○1.6. **Electrical**

The presence of ambient radio signals, magnetic or electromagnetic interference, including those from power lines, transformers, or motors within 1 ft (0.3 m) of any components of the system, shall not impair the performance of the system. The system shall not radiate any electrical or electromagnetic signals that could adversely affect any other electrical or electronic device.

All system electronics shall be 100 percent solid state technology with the exception of the ventilation fans.

All high voltage (exceeding 24 Volts DC) components used in the sign shall be UL listed.

▪2. **DYNAMIC MESSAGE SIGN COMPONENTS**

○2.1. **DISPLAY ELEMENTS**

▪2.1.1. **Display**

Each DMS shall be of the full matrix type. The matrix shall be a minimum of 36 pixels high (rows) by a minimum 105 pixels wide (columns). The pixels shall be spaced uniformly with the same spacing vertically and horizontally to the rows (i.e., no pitch or slant is allowed). The outside border around the DMS display shall be approximately 12 inches (305 mm).

▪2.1.2. **Light Emitting Diodes**

Display pixels shall incorporate amber LED technology. The discrete LED's shall have the following optical characteristics:

- Peak wavelength of 590 or 592 nanometers,
- For each sign, the range of brightness shall be such that the brightest LED used is no more than twice as bright as the dimmest LED used.
- Viewing cone of 30 degrees.
- The dominant wavelengths of all LEDs shall fall within a band 3.5 nm wide.

The shop drawing submittal for the sign shall include the manufacturer's procedure for ensuring that the requirements for uniform brightness and uniform color are met.

### ▪2.1.3. Display Modules

All module surfaces which are visible from outside the DMS, excluding the LED pixels, shall be painted flat black in order to provide maximum display contrast and readability. There shall be a minimum of two pixels per module.

All serviceable components shall be modular, interchangeable, and removable from within the DMS enclosure. The DMS display shall be composed of identical and readily interchangeable display modules. Display modules shall be removable from the DMS with either simple hand tools or without any tools. All wiring interconnecting the individual display modules shall be modular harness assemblies with latching push-on/pull-off or twist on/off connectors.

The removal of any combination of one or more display modules shall not alter the structural integrity of the DMS assembly. Nor shall the removal of any combination of display modules affect the operation of the remaining operational modules in any way.

Pixels shall consist of two strings of LEDs and shall produce 40 Cd of luminous intensity at a drive current of 20 mA per string and a forward voltage drop of 24 volts or less.

LED's shall be soldered to circuit boards with through-hole type of circuit board mounting. Surface mounting of LED's will not be allowed.

To minimize the chance of LEDs being pushed out of alignment with the sign's optical axis, LED's must be mounted no more than 1/100 inch from the front side of the printed circuit board. The LED's must be mechanically protected, so that there is no contact with them when the module is gripped or dropped.

Display modules shall be attached to the support frame with captive fasteners in such a way that their position does not change when the sign is subjected to severe vibration.

The LED leads and the circuit board traces shall dissipate heat produced by the LEDs. Circuit traces that connect to the LEDs shall be two ounce copper plating or thicker. The width of traces that connect to those LED leads that carry heat from the LED chip shall be maximized.

Both sides of the board shall be protected with acrylic conformal coating. The coating on the front of the board is to seal the gap between the LEDs and the board, and shall be applied so as not to coat the LED housing above the gap. The LEDs may not be potted.

The peak current provided at maximum brightness must be 20 mA or, if adjustable, must be set at 20 mA when installed. If the maximum current is adjustable, the adjustment mechanism shall not permit values above 30 mA.

The top of the display modules shall tilt forward seven degrees. The amount of the forward tilt may shall be adjustable, in which case the adjusting mechanism must be calibrated and each position labeled. The mechanism that adjusts the tilt must rely on pins or bolts, not friction, to hold the modules at the desired angle.

## ○2.2. DISPLAY ELECTRONICS

### ▪2.2.1. Driver Circuitry

The driver circuitry shall be able to detect abnormal current values, including short circuits and open circuits, while a single pixel is being illuminated. The state of the LED's (on or off) in each pixel of the sign shall be read by the sign controller so it can report the actual message, including static, flashing and alternating messages, that is visibly displayed on the sign in a WYSIWYG format. This pixel read shall take place while a message is displayed on the sign without disturbing the message in any way and will include any half-out, full-out, half stuck on or fully stuck on pixels. Any flashing, flickering, blinking, dimming, or other disturbance of the message during this pixel status read shall be cause for rejection of the sign.

### ▪2.2.2. Brightness Control

Pulsed drive current shall be used at the maximum brightness level. Pulse Width Modulation (PWM) shall be used to dim the sign to achieve the proper brightness level for a given ambient light condition. As part of the shop drawing submittal, a complete schematic of the LED power and driver circuits shall be provided for review by the Engineer. Multiplexing of the LED's shall not be allowed.

The DMS shall have photocells that detect when the sun is directly in front of the DMS or directly behind it. Those photocells, or a separate photocell, shall also distinguish night from day. These photocells shall not be affected by man-made light sources, such as highway lighting and/or headlights. They shall be easily accessible for maintenance.

### ▪2.2.3. Temperature Control

The DMS shall be designed so that the air temperature on the back side of the display modules never exceeds 140 degrees F (60 degrees C). A thermostat located in the middle of the top line of display modules shall shut down the LED display if the temperature rises above 140 degrees F (60 degrees C) and restore power when the temperature has dropped to 120 degrees F (50 degrees C). This shall be independent of the controller.

The sign shall also have one or more temperature sensors that report the sign temperature to the sign controller, which shall in turn report the temperature to the central software.

The sign shall have a remote bulb thermometer located just inside the door of the sign. The thermometer's temperature sensor shall be at the same location as the thermostat, so that a technician can readily determine whether the thermostat is operating properly.

#### ▪2.2.4. DMS Power Supplies

The maximum operating temperature of all power supplies shall be at least 150 degrees F (65 degrees C). All regulated power supplies shall have a minimum power factor of 0.95.

The LED display modules shall be operated at low internal DC voltage not exceeding 24 Volts.

The power supplies shall be short circuit protected by DC power OFF, and shall reset automatically after 5 seconds of AC power OFF. The power supplies shall also be protected by a suitable inrush current allowance to be recommended by the manufacturer and approved by the Engineer.

The power supplies shall have an efficiency rating of at least 75 percent.

### ○2.3. ENCLOSURE

The DMS enclosure shall be a weatherproof walk-in type enclosure that houses all electrical, communication, and electronic control devices necessary for the operation of the DMS. Permanent lifting angles or lugs shall be attached to the DMS enclosure for moving and mounting. A shelf or workbench shall be provided inside the enclosure for a notebook computer and related equipment.

#### ▪2.3.1. Structural Performance

The structural design of the LED DMS enclosure shall conform to current AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*. Additional design criteria are as follows:

- Wind Velocity = 80 mph (130 kilometers per hour)
- Gust Factor = 1.3

The performance and stability of the sign shall not be impaired due to vibration, wind, vacuum pressure, and/or other normally encountered forces created by the effects of traffic. The shop drawing submittal shall include structural design calculations for the enclosure, signed and stamped by a registered professional engineer in the state of Missouri. Include calculations demonstrating that wind gusts cannot cause the glazing to detach from the sign nor to contact the display modules.

### ▪2.3.2. Dimensions

The nominal dimensions of the sign enclosure shall be approximately 26 ft (8 m) in width x 10 ft (3.1 m) in height x 3 ½ ft (1.06 m) deep.

### ▪2.3.3. Material

The DMS enclosure shall be assembled from a continuously welded aluminum alloy 3003-H14 or 5052-H34 skin of at least 1/8 inch (3.5 mm thick). The enclosure shall not have sharp edges or corners and the inside and outside edges shall be free of burrs. Internal supports shall be of extruded aluminum alloy 6061-T6 members welded to form a support structure to provide rigidity and structural integrity. All metallic parts shall be corrosion resistant.

The DMS case and facial area shall be treated with a flat-black, factory-applied, Kynar flouropolymer resin based coating providing a minimum life span of 10 years. As part of the shop drawing submittal, the manufacturer may propose an alternate means of protecting the metal surfaces. Such alternates shall be subject to the approval of MoDOT.

### ▪2.3.4. Welding

The DMS housing shall be fabricated, welded and inspected in accordance with the requirements of ANSI/WS D1.2-90 Structural Welding Code-Aluminum (1990). Compliance with this requirement shall include, but is not limited to:

All manufacturing personnel who perform welding on the DMS housing shall be certified to AWS D1.2-90 for all weld types required for housing fabrication. The DMS manufacturer's submittal shall contain a copy of each welder's certification and the manufacturer's certified welding procedures.

DMS housing welding shall be inspected on a daily basis by a Certified Welding Inspector (CWI), who shall complete daily written reports on DMS welding progress, housing weld integrity, and any corrective action taken. These reports shall be archived by the DMS manufacturer and shall be available for immediate review upon request by the Engineer.

### ▪2.3.5. Access Door

Access to the interior of the sign enclosure shall be via a gasketed door measuring 75 inches (1905 mm) x 30 inches (762 mm) minimum. The door shall open outward onto a walkway and be located on the left right or non-roadway side of the enclosure with the hinge toward the front or sign face of the sign, unless otherwise directed by the MoDOT Engineer.

Gaskets shall be provided on all door openings and shall be dust-tight. Gaskets shall be a

minimum of ¼ inch (6 mm) thick closed cell neoprene and shall be permanently bonded to the metal. A gasket top channel shall be provided to support the top gasket on the door in order to prevent gasket gravitational fatigue.

The latching mechanism shall be a three point draw roller type. The pushrods shall be turned edgewise at the outward supports and have a minimum cross section of ¼ inch (6 mm) thick x ¾ inch (19 mm) wide. The mechanism shall have handles inside and outside the sign. A door hasp shall be provided to secure the door and it shall accommodate a ¼ inch (19mm) shank lock.

The door shall be provided with a catch mechanism to hold the door open at 90 degrees in a 60 mph (100 kph) wind acting at an angle perpendicular to the plane of the door.

#### ▪2.3.6. Walkway and Ladder

The DMS enclosure shall have an interior, nonskid walkway that extends the entire length of the sign enclosure. The walkway shall be free of obstructions and shall be at least 28 inch (711 mm) wide and provide minimum headroom of 75 inch (1905 mm) throughout the length of the enclosure. The interior walkway shall have removable panels for access to the space below the walkway.

The interior walkway shall be capable of supporting a concentrated load of 500 pounds per square foot at any location, and a total load of 1000 pounds within any 10 foot section of the walkway.

The DMS enclosure shall be equipped with a non-conductive ladder which is suitable for safely servicing the upper lines of the sign and shall automatically lock in place when in use. A latching system shall be provided which will allow the ladder to be securely stored within the sign enclosure when it is not in use.

#### ▪2.3.7. Display Face

The front face of the DMS shall be made of clear polycarbonate panels of at least 3/16 1/8 inch thickness. The polycarbonate shall transmit at least 85 percent of the light emitted by the LED's. The manufacturer's technical data sheet for the material utilized for the front face shall be provided as part of the submittal package.

The polycarbonate manufacturer shall guarantee that:

The yellowness index (ASTM test D-1925) of the material shall remain below 5.0 for three years from the date of purchase, and below 10.0 for five years.

The light transmission (ASTM test D-1003) of the material shall not decrease more than three percent in three years from the date of purchase, nor more than seven percent in five years.

Each window shall be covered with a 0.04-inch, minimum thickness, black aluminum mask. The aluminum mask shall have the same finish as the rest of the front of the sign

and shall provide openings directly in front of each pixel. Pixel openings shall be of sufficient size as to not interfere with LED light output.

#### **2.3.8. Ventilation**

The DMS enclosure ventilation shall include intake, exhaust, filtration, fan assembly and environmental control. Adequate ventilation shall be provided to allow climate control for DMS service technicians.

Vents shall be screened to keep out rodents and insects. The number and size of the vents shall be determined by the manufacturer to be of sufficient size to provide adequate ventilation. Intake vents shall use motorized louvers to prevent the entry of dirt and insects when the ventilation system does not require outside air. The exhaust vents shall be equipped with dampers for the same purpose. The intake vents shall be located to prevent the direct intake of truck exhaust.

A removable two stage air filter system shall be installed behind each intake vent. The filter filtration area shall completely cover the vent opening area such that no incoming air bypasses the filter. Brackets shall support the filter at the vents and be located to facilitate easy replacement.

The DMS enclosure shall be equipped with electric fans with ball or roller bearings. The capacity of each fan and the number of fans shall be sufficient to insure adequate ventilation if one fan becomes inoperable. An analysis shall be presented in the submittal material which shall document that the proposed system meets these requirements. The fans shall be mounted within the housing and vented. The number, placement, and size of the electric fans shall be determined by the manufacturer.

The fans shall be controlled by the DMS controller or a thermostat. If the fans are controlled by the DMS controller, there shall be parameters in the controller's database which will specify the turn-on temperature and the shut-down temperature. Both parameters shall be in the range of 70 degrees (20 degrees C) to 120 degrees F (48 degrees C).

The DMS shall have a window defogging system that is turned on and off by the DMS controller or a thermostat. The system shall use heated air blown on the inside of the windows. Heating strips on the windows or frames shall not be acceptable. The defogging system shall be capable of removing all condensation from a completely fogged window within five minutes.

### **2.4. ELECTRICAL SERVICE**

#### **2.4.1. Electrical Distribution Panel**

The primary electrical service panel shall be rated for 120/240 VAC, single phase, 3 wire and 100 amperes maximum with a 2 pole main circuit breaker and a 1 pole circuit breaker for each branch circuit and a copper ground bus. The panel shall have an interrupt rating of not less than 10 KA. The panel shall be General Electric Model AQF1121AB or AQF1121AT or an equivalent approved by MoDOT. Separate circuits shall be provided for the utility outlets. 120 VAC load shall be balanced. Incoming terminals shall be capable of a conductor range from 8 AWG (10 mm<sup>2</sup>) to a 4/0 AWG (120 mm<sup>2</sup>).

#### ▪2.4.2. Radio Interference and Surge Protection

Surge protection shall be provided on all ungrounded conductors leaving the sign housing. All devices shall be readily accessible for ease of replacement.

A two-stage surge protector and radio interference filter shall be on all incoming power lines. The two stages shall be electrically separate, so that the first stage protects all equipment using the power, while both the first and second stages protect electronic equipment. There shall be no maximum load for the first stage. The second stage shall be capable of protecting equipment drawing a total of 10 amps. The protector shall clamp both the main line and the main neutral at 250 volts, both relative to each other and relative to the cabinet ground. The response time shall be such that the actual voltage never exceeds 250 volts. The surge protector shall suppress surges of up to 20,000 amps (8 x 20 microsecond waveform). The clamping voltage shall change by no more than five percent after 20 such surges.

For each conductor used for communication and control, provide surge protection in the sign. Furnish a cable termination panel with surge protectors that match those in the sign, which, which the installation contractor can install in the cabinet along with the sign controller.

#### ▪2.4.3. DMS Enclosure Interior Lighting

The DMS enclosure shall be equipped with a switch controlled set of at least five fluorescent or incandescent light fixtures equipped with cold weather ballast (0 degrees F (-18 degrees C) minimum). The light switch shall be located near the entry door on the side opposite from the door hinges. The fixtures shall be complete with a guard. Each fixture shall have a 40-watt four-foot fluorescent lamp. The fixtures shall be equally spaced.

#### ▪2.4.4. Utility Outlets

The DMS enclosure shall be equipped with three, 20 amp, 120 VAC duplex (NEMA 5-20R) receptacles. These outlets shall be protected by ground-fault, circuit-interrupters. Two receptacles shall be located approximately three feet (1 m) from each end, and one receptacle shall be located in the center of the DMS enclosure. These are in addition to any outlets used by the equipment provided by the sign manufacturer.

#### ▪2.4.5. Conduit and Wiring

All lighting and receptacle circuits shall use at least 12 AWG (4 mm<sup>2</sup>) wiring enclosed in thin wall metallic conduit.

### ○2.5. CONTROLLER

Furnish a sign controller for the installation contractor to install in an equipment cabinet near the sign. The sign controller installed in said cabinet shall provide full local control of the sign. The controller must have sufficient memory and processing power to perform all the functions described in the specifications, including full functionality of the service software. Sign controller shall be a 19 inch rack mountable and have a 15 inch maximum depth.

#### ▪2.5.1. Watchdog Timer

The controller shall have a watchdog circuitry that automatically resets the controller when it locks up. There shall be a means for the controller to recognize and report the fact that it was reset by the watchdog timer.

#### ▪2.5.2. Memory

The controller shall have nonvolatile memory [DD1]. This memory shall contain the software and test messages.

The controller shall also have changeable memory that retains the data in memory for a minimum of one year following a power failure. It shall contain the library of messages, the message display schedule and changeable operating parameters.

#### ▪2.5.3. Clock

The controller shall have a time-of-year clock with a lithium battery backup. The battery shall keep the clock operating properly for at least 10 years without external power. The clock shall automatically adjust for daylight savings time and leap year through hardware, software or a combination of both. It shall be set by the sign controller's microprocessor. The clock shall be accurate to within 1 minute per month.

#### ▪2.5.4. Communication Interfaces

Communication between the central computer and the sign shall be by TCP or UDP Internet Protocol over Ethernet, so the controller must be IP addressable with an Ethernet port for this purpose.

The controller shall also have at an EIA-232 communication port for communication with a technician's laptop computer connected directly to the controller. The port shall be

capable of operation at all standard data rates up to 19,200 bits per second and shall be set to 9600 bits per second.

In addition, the controller shall have communication interfaces with the equipment in the sign, for such things as sign control, temperature monitoring, and brightness adjustment.

### ▪3. CONTROLLER SOFTWARE

#### ○3.1. Display Presentation

The DMS controller shall control the driver modules in such a way as to create the desired display on the sign.

Messages shall be communicated and stored using the Markup Language for Transportation Information (MULTI), as defined in the most recently adopted edition of the NTCIP Standard 1203, National Transportation Communications for ITS Protocol (NTCIP) Object Definitions for Dynamic Message Signs (DMS). The sign's method of operation must be consistent with that standard.

Space allocated to each character shall be proportional to the character's true width. Software shall handle such details as centering text on a line, right justification, left justification, and appropriate spacing of letters and words. Software shall also control flash, and alternating between pages of a two and three-page display.

There shall be a default value for each parameter supported. The manufacturer shall pre-load these default parameters with values approved by the Engineer.

#### ○3.2. Modes of operation

Signs shall be able to display a static message, a flashing message, or a multipage message as described below.

- **Static message:** The message chosen shall be displayed constantly on the sign face until the sign controller is instructed to do otherwise.
- **Flashing message:** A selected portion of the chosen message shall be displayed and blanked alternately at durations controllable in one second increments.
- **Multipage messages:** The chosen message shall display up to three different pages (each page consisting of up to four lines of text) alternately at durations separately controllable in one second increments.

#### ○3.3. Fonts

A user shall be able to create and display messages using at least four fonts, each stored in the controller. Two of the fonts shall be stored in the controller by the manufacturer.

Provide a font comparable to that shown in Figure 7-1 of Federal Highway Administration publication # FHWA-TS-90-043. 043 or current Federal Highway Administration publications and NTCIP Standards. Also, provide a similar bold font. The user shall be able to create at least two additional fonts, download them to the controller, and store them there.

### ○3.4. Display Selection

In the absence of instructions to the contrary from the control ports, the controller shall implement a display selected from those stored in its memory based upon date and time as specified in the schedule. It shall use a schedule stored in random access memory plus its time-of-year clock to select the proper display. The schedule system shall permit different schedules for different days of the week plus special schedules for special days, such as holidays.

The display of the scheduled message may be over-ridden by instructions sent from the control ports. A computer shall be able to cause the controller to implement a particular display selected from the messages stored in its memory, or a new display sent from the computer using MULTI. The computer shall also be able to edit or completely replace a message stored in the controller's memory, or revise the message schedule. In addition, it shall be able to cause the controller to report its schedule or the text of any message stored in its memory.

Software shall incorporate fail-safe procedures to check messages received and shall not change a message stored in memory, the display currently on the sign, the schedule stored in memory, or the current time unless the message is received correctly and constitutes a valid command.

### ○3.5. Schedule Operation

The schedule is activated by activating a message (i.e., setting an object with the syntax of MessageActivationCode or MessageIDCode) with the dmsMessageMemoryType set to schedule(6), the dmsMessageNumber set to 1, and the dmsMessageCRC set to 0x00 00 (and a sufficiently high activation priority if it is a MessageActivationCode object).

During schedule operation, the run-time priority applies to the operation of the schedule and the run-time priority of the referenced message is ignored. Thus, the run-time priority is constant for all scheduled messages and the central system can set this priority by modifying the value of dmsRunTimePriority.6.1.

The values of dmsMessageMultiString.6.1, dmsMessageBeacon.6.1, and dmsMessage PixelService6.1 are copied from the message called by the most recently called action and thus reflect the most recently called message that would be called by the scheduler whether or not the scheduler is running.

The activation priority of any scheduled message shall be 200 in the absence of a potential future object to specifically set this value.

One may activate the schedule for a defined duration by setting the duration in the activation code.

To get the scheduler to blank the sign, a blank message must be scheduled.

### ○3.6. **Brightness Control**

Manual and automatic dimming modes shall be provided, enabling the user to select the desired mode of operation. The dimming system shall select one of several levels from the sensed ambient light. The set points for each of the ambient light levels shall be set by the user via software. A user shall be able to send a command via the control ports to select a specific brightness level or to direct the controller to select an appropriate brightness based on current lighting conditions.

For each brightness level, a technician shall be able to easily determine what fraction of the full brightness current is applied to the LED's. The technician must be able to set the current value for a given brightness level to any value between 25% and 100% of the maximum current in five percent increments, and must be able to easily change these settings via computer commands.

### ○3.7. **Communication**

Controller hardware and software shall permit the communication with the central computer using polled operation, in which the sign controller informs the central computer of its current status in response to a query from the central computer. The sign controller never communicates except when polled.

The controller shall be able to receive commands simultaneously over both ports (one for the central computer and one for a laptop), process the commands in the order received, and respond to each command only via the port on which it was received.

### ○3.8. **Diagnostic Test**

Upon command, the controller shall test all systems, including but not limited to the electrical operation of all drivers and check for over current and under current pixels, photocells, ventilation, and displays. It shall communicate the result to the computer that issued the command using an NTCIP compliant method.

### ○3.9. **Power Interruptions**

The contents of the controller's memory shall be preserved by battery power during power interruptions, and the controller shall resume operation automatically when power is restored. Upon recovering from a power interruption, the controller shall report to the central computer that it has just recovered from a power interruption. It shall also consult a configuration parameter set by the user to determine whether to blank its display or to display the message that it would have been displaying if no power failure had occurred. There shall be separate

configuration parameters for long and short power failures, as well as a parameter specifying the maximum duration of a power failure classified as short.

### ○3.10. Test Messages

Test messages shall be stored in the controller's permanent memory. The test messages shall be functionally equivalent to the following:

- **All pixels on simultaneously.** This is to determine whether there are pixels or display modules that are not the same brightness as the rest.
- **Each module shows a unique display indicating which row and column it is in.** This test display is to determine whether any module is displaying what a different module should be displaying.
- **A display that alternates the two previous displays** at approximately ten second intervals. This is to enable an observer to identify which display module has a brightness problem.
- **A display that illuminates every pixel, one at a time,** in rapid succession. This is to be used in conjunction with the current sensors to automatically test each pixel for abnormal current consumption.
- **One display for each font,** showing every character composing the font.

The test messages shall include any other displays required to carry out the manufacturer's recommended procedures for maintenance and troubleshooting.

### ○3.11. Watchdog Timer Interface

The software shall regularly reset the watchdog timer so that it does not inappropriately reset the controller. When it starts operating, the software shall check the status of the watchdog timer and, if the timer indicates that it reset the controller, the controller shall report that fact to the central computer.

### ○3.12. Temperature Monitoring

Via the communication ports, a user shall be able to set a temperature threshold. When the highest temperature reported by the temperature sensors in the sign exceeds this threshold, the controller shall issue a temperature warning to the central computer.

### ○3.13. NTCIP Requirements

The controller shall communicate using current NTCIP Standards. Supply full documentation of all manufacturer-specific objects supported by the sign controller. This shall be in the form of an electronic file CD-ROM containing ASCII versions of a MIB in ASN.1 format. The MIB shall contain accurate and meaningful description fields and

supported ranges indicated in the syntax field of the object-type macros. The Department shall have the right to use the documentation described above for system integration purposes, regardless of what parties are involved in the system integration effort. The controller must adhere to the version of the following standards that is current at the time of bidding. A later version may be used if approved by the Engineer.

**Information level:**

The following objects defined in NTCIP 1201:

- All objects in the Global Configuration Node.
- The following objects in the Global Time Management Node: globalTime; globalDaylightSaving; maxTimeBaseScheduleEntries; timeBaseScheduleTable; maxDayPlans; maxDayPlanEvents; timeBaseDayPlanTable.
- All objects in the Report Parameters Node.
- All objects in the PMPP Object Node.

NTCIP 1203, including all mandatory objects of the following optional conformance groups:

- dms Sign Configuration
- Font Configuration
- MULTI Configuration
- Default Message
- MULTI Error
- Illumination/Brightness
- Scheduling
- Auxiliary I/O
- Sign Status
- Status Error
- Pixel Error Status

Software shall also implement the following optional objects as defined in NTCIP 1201:

- eventConfigLogOID
- eventConfigAction
- eventClassDescription

Software shall also implement the following optional objects as defined in NTCIP 1203:

- dmsIllumLightOutputStatus
- watchdog-Failure-Count
- tempMaxSignHousing

The standardized range is defined by the size, range, or enumerated listing indicated in the object's syntax and/or through description text in the object's description field of the relevant standard, Every object required by these specifications shall support all values within its standardized range except:

OBJECT	MINIMUM PROJECT REQUIREMENTS
Max Time Base Schedule Entries	28
Max Day Plans	14
Max Day Plan Events	12
Max Event Log Configurations	50
Event Configuration Mode	2, 3, and 4
Max Event Log Size	200
Max Event Classes	16
Max Group Address	1
Number Fonts	4
Max. Font Characters	100
Number Action Table Entries	Equal to message capacity of sign

The module table required by Clause 2.2.3 of NTCIP 1201 shall contain at least one row with moduleType equal to 3 (software).

Displaying a blank sign shall be achieved in the same way that any message is displayed (i.e., by using an object that has a syntax of either MessageActivationCode or

MessageIDCode). However, a new memory type, dmsMessageMemoryType equal to 'blank (7)', shall be created to support this operation. It shall function as follows:

- The dmsMessageNumber for this memory type shall be reflective of the RunTime Priority and shall be between 1 and 255, inclusive.
- The CRC for this memory type shall be 0x00 00 and the normal CRC algorithm shall not be applied to blank messages.
- The dmsMessageMultiString shall be an octet string of length 0.
- The activate priority for any MessageActivationCode using this type of memory shall be used as the actual activation priority.

The software shall implement the following tags (opening and closing where defined) of MULTI as defined in NTCIP 1203

- Fields for 12 hour time, day of month, month, and four digit year
- Flash
- Font
- Justification Line
- Justification Page
- Moving Text
- New Line
- New Page
- Page Time
- Hexadecimal Character

**Application level:** NTCIP Standard 1101, Conformance Level 1.

**Transport level:** NTCIP 2202.

**Subnetwork level:** NTCIP 2104

#### ▪4. SIGN TESTING

All DMS components and assemblies furnished by the manufacturer shall be subject to testing and monitoring to determine conformance with all applicable requirements and to ensure proper operation of the equipment and subsystem. Test procedures shall be submitted to the MoDOT Engineer for review and approval prior to conducting any testing.

##### ○4.1. Factory Testing

The DMS subsystem factory test shall be held at the manufacturer's facility. The manufacturer shall provide all the necessary measurement devices which can be utilized to verify that the assembly is compliant with the requirements.

#### ○4.2. Field Testing

Upon delivery of the sign to the jobsite, the manufacturer and a MoDOT representative shall conduct a visual inspection of the DMS to check for manufacturing and installation defects. The installation contractor may witness this testing if he or she chooses. The DMS shall be powered during this preliminary inspection. Provide a generator and all necessary power and communication cables. The test procedure shall be designed to uncover manufacturing and installation defects of all types. Among the aspects that must be tested are the following:

- All diagnostic routines provided by the manufacturer.
- Proper operation of every pixel, including uniform brightness at all brightness levels and proper current consumption.
- Proper wiring of the display modules, checked by displaying a text message that identifies the modules proper row and column positions.
- Appropriate brightness for day and night conditions, and brightness from the sun at its worst condition for the location.
- Absence of leaks. This can be demonstrated by operating the blowers with the doors and exhaust vents closed to pressurize the sign enclosure, and checking for air bypassing the door or windows.
- Proper aiming of the display modules.
- Proper entry of memorized messages.
- Proper operation of sign monitoring.
- Proper operation of temperature sensors, blowers, defogging system, and lights.
- Proper grounding.
- Correct warning of sensors and alarms to the controller's inputs.
- Proper remote access and control using the central and laptop software provided in this project.

### ▪5. CENTRAL SIGN CONTROL SOFTWARE

#### ○5.1. General

This software shall enable a user to easily monitor and control not only the signs purchased under this procurement.

MoDOT will provide the computers, complete with operating systems, for this software. Provide MoDOT with a specification for the computers and operating system that MoDOT should supply.

The central software should enable multiple users to monitor and control the signs from workstations both local to the sign, and also from a remote office location.

#### ○5.2. Off Line Status

A user at the sign server or a workstation shall be able to take a sign off line, causing it to be ignored by the sign computer. This will be used when a malfunctioning sign is generating an excessive number of alarms. When a user attempts to control an off line sign, a message shall appear on his screen informing him that the sign is out of service. When a user takes a sign off line, the software shall ask the user to type in a comment of up to 100 characters explaining the action. The comment field may be left blank. The computer shall also record the user's name, based on his password, and include the name and comment in the failure report described below.

### ○5.3. Message Library

The sign server shall store a library of at least 999 messages on its hard disk. In addition to the message text, the file shall contain all the MULTI control codes needed for a sign to properly display the message

When adding a message to the library, a user shall specify the message name. If a message with the same name already exists in the library, the software shall notify the user and give him the options of replacing the existing file or selecting a new name for the message he has just created. A user shall also be able to delete library messages from within the program. The program shall ask the user to confirm each message deletion before actually deleting the file.

If the user is seeking a message to display, the software shall present a list so that the user can choose one. When the user makes his selection, the software shall display the entire message, exactly as it would appear on a sign, and shall ask the user to confirm that this is the message desired. The user shall then be able to post the message on one or more signs, edit the message, or do nothing with it.

### ○5.4. Sign Control

Future signs may have different line lengths and heights (measured in pixels) than the signs provided in this project, and may have more or fewer lines. The software shall display messages as a matrix of dots that replicate the way the message will actually appear on a selected sign. The presentation should be based on the number of lines on the sign and the height and width (in pixels) of the lines, as stored in a data base maintained by the sign computer. This type of display will be used during message creation and editing, as well as when displaying to a user the message currently on a sign. If the user is displaying a message from the library or creating a message without specifying what sign it will go on, the display shall be based on the characteristics of the signs provided in this project.

Upon creating or revising a message, the user shall be able to save it in the message library on the sign computer's hard disk or send it directly to one or more DMS controllers for storage or display.

When a user sends a message to one or more signs, the sign computer shall automatically check to be sure that the message will fit on the sign. This checking shall take into account

the selected fonts and the size of the sign's display. If the message won't fit, the computer shall alert the user and not post the message.

If a user chooses to send the same message to multiple signs, the software shall present the user with a list of all signs, so that the user can check off which signs the new message goes to. The screen shall also give the user a choice of "All Signs". The list shall identify signs by roadway and mile post. Using a single command, the user shall be able to cause the message to be stored in all the signs he specified, replacing those previously stored in the controllers. Similarly, the user shall be able to use a single command to have all the selected signs display the same message, or the same message number.

In addition to entering commands for immediate execution, a user may store commands in the sign computer for future execution. For example, the user may want to conduct a pixel test of every sign each night at 3:00 AM. A user shall be able to quickly and easily create, modify, suspend, or cancel a schedule of commands for the sign computer to issue to specified DMS controllers. The user shall be able to specify the same action at the same time for multiple signs, in the same way as was described in the preceding paragraph. A user shall also be able to schedule the printing of sign-related reports. A user shall not be able to schedule any command that he does not have the privilege to execute directly. The schedule shall show the name of the user who scheduled each command, based on his password. Actions that would be recorded in the event log if a user commanded them directly shall also be logged when they result from a scheduled command. The record shall include the user's name and an indication that the command was scheduled.

The software shall provide a single command that not only transmits a message to a sign (after confirming that it fits) but also causes the sign to immediately display that message on the sign (after confirming that the transmission was error free).

### o5.5. Status Monitoring

The sign server shall maintain an event log file on its hard disk with a record for each appearance or disappearance of an alarm from a DMS controller or sign. The file shall be in ASCII format with fixed-length fields separated by spaces, suitable for transfer to spreadsheet and data base management software. The record shall include the date, time, sign id, and nature of the change. If the alarm indicates a change in the sign display, the log shall include the exact text of the message, the device from which it was commanded, and, if commanded via the sign computer, the name of the person posting the message, based on his password. The log file shall include this same information each time a message is downloaded to a sign's memory from the sign computer.

The log shall also record each time a user at a workstation or the sign computer does the following:

- Changes the priority of a message.

- Changes the schedule.
- Changes a message in the library on the computer's hard disk.

The record shall include the user's name based on his password.

The log shall also record the beginning and end of communication failures. The sign computer shall deem a communication failure to have occurred if it does not get an error-free response to two consecutive commands to a controller. The computer shall deem a controller recovered if it responds properly to a command.

## ○5.6. Reports

The system shall provide the following reports to the user's screen, a disk file named by the user, or to the printer, as specified by the user:

- **Equipment Failures.** Lists each sign that is currently malfunctioning, along with the time and date of failure and a phrase indicating the nature of the problem. Also lists each DMS controller that is off line, along with the date and time it was taken off line, the comment written by the user who took it off line, and the user's name based on his password.
- **Sign System Configuration.** Lists the current values of all configuration parameters stored in the sign computer, clearly labeled. It includes such things as communication line and drop assignments. It does not include operating parameters stored in the DMS controllers.
- **Individual Sign Configuration.** Lists the current values of all changeable parameters stored in a DMS controller, clearly labeled. It includes such things as temperature thresholds. This report shall cover all signs, or a particular sign, as specified by the user. The information displayed shall be uploaded from the DMS controllers at the time the report is requested. If the sign computer is unable to upload the data from a particular sign, it shall use the corresponding data on its hard disk, but shall indicate in the report that the data is from the hard disk and may not be current.
- **Current Sign Status.** Lists sign location, text of message currently displayed, whether it is an emergency message (new signs only), whether the message has priority status (new signs only), storage location of the message in the sign's memory, entity that caused the message to be displayed (new signs only), and controller status (failed, working, or off line) for each sign in the system. This report shall cover all signs, or a particular sign, as specified by the user. If the report covers multiple signs, the signs shall be grouped by roadway and listed in the order in which a motorist would see them.

- **Event Log.** Lists all information in the event log file, with each field clearly labeled. The user shall be able to specify that only events between certain times, or pertaining to a certain sign, or pertaining to a certain type of event, or any combination of the foregoing, shall be included in the report. Events shall be listed chronologically.
- **Message Library.** Lists the text of each frame of each message in the message library, along with the duration for which the frame is displayed. Also lists the message's file name and latest revision date. Each frame shall be displayed in the report in the same way it would appear on a sign, with regard to text centering, bolding, and justification. Flashing text shall be underlined. Messages shall be grouped by subdirectory, and a user shall be able to specify that only certain subdirectories be included.
- **Sign Server Schedule.** Lists all information in the sign server's schedule, clearly labeled. The user shall be able to specify that only events between certain times, or pertaining to a certain sign, or pertaining to a certain type of event, or any combination of the foregoing, shall be included in the report. Events shall be listed chronologically.
- **Sign Memory.** Lists sign ID and location and the text of each message stored in the sign. The message portion of the report shall indicate the message's memory location number and shall display the text of each frame of the message, along with the duration for which the frame is displayed. Each frame shall be displayed in the report in the same way it would appear on a sign, with regard to text centering, bolding, and justification. Flashing text shall be underlined. All information shall be clearly labeled. The user shall be able to specify that the report cover only a particular sign, or all signs. The information displayed shall be uploaded from the DMS controllers at the time the report is requested. If the sign computer is unable to upload the data from a particular sign, it shall use the corresponding data on its hard disk, but shall indicate in the report that the data is from the hard disk and may not be current.
- **Bad Pixel Maps.** Consist of a matrix display indicating which display elements of a sign have failed, according to the DMS controller. The user shall be able to specify that the report cover only a particular sign or all signs with display problems. If the user specifies all signs with display problems, the report will cover all signs whose controllers are currently reporting malfunctioning drivers or display elements.

The time and date for which the information is current shall appear on every page of each printed report. All pages shall be numbered.

### ○5.7. Alarms

The sign computer shall issue alarms by beeping and displaying a message clearly identifying the problem in a prominent box that pops up on the user's screen. The box shall disappear when the user clicks on it and the beeping shall stop. If the alarm is of the type called "recurring", the beeping and screen message recur every 15 minutes as long as the condition persists. The sign computer shall issue a single alarm for the following situations:

- A new sign failure.
- The sign computer is unable to change a sign's display as scheduled because the currently displayed message has priority status.

A sign computer shall issue a repetitive alarm if its hard disk is over 90 percent full.

#### ○5.8. Timekeeping

The software shall track and display the current date and time, and shall automatically adjust for standard and daylight savings time without operator intervention.

#### ○5.9. Password Protection

Only users who have proper authorization, as indicated by their passwords, shall be able to undertake the following actions:

- Place equipment on standby.
- Change sign messages, blank signs, and change message priority.
- Replace or delete messages stored in a DMS controller's memory.
- Display test patterns on a sign.
- Change or delete the sign computer's schedule.
- Modify the message library on the sign computer's hard disk.
- Change sign configuration parameters.
- Delete the event log.
- View passwords.
- Change passwords and privileges.

Users may be granted or denied permission to use each protected command independently. Via an encrypted lookup table, the server shall determine which of the protected commands a user may use.

The software shall ask the user for his password at the time the protected command is entered. The computer shall not carry out these commands unless the user has the proper privileges.

#### ○5.10. User Interface

The sign control software shall provide a graphical user interface with a GPS coordinate map of the signs. The user shall enter commands by selecting the sign icons and various menu options. The user shall make selections from menus and from lists of signs, messages, and options using a mouse. The interface shall be easy to use, minimizing memorization and opportunities for errors. The interface shall automatically check commands for out-of-range values and other errors. When it checks an error, it shall beep, reject the command or data, and provide the user with a clear explanation.

The software shall have the complete text of the software operator's manual stored on disk, readily available to the user.

#### ○5.11. Testing

The purpose of the sign computer software test is to demonstrate that the software operates reliably and is in full compliance with the specifications. The Contractor shall conduct the tests following the approved test plan but, if practical, shall also perform any supplemental tests requested by the MoDOT's representatives at the time of testing. To be accepted, the software must pass all the tests.

The test plan shall test every interface, feature, and function of the software, including features present but not required by these specifications. The testing shall demonstrate that the software does the following:

- Operates properly when six multiply workstations are simultaneously sending the server DMS controller commands and data at maximum speed, while the sign computer is also continuously communicating with the signs..
- Deals appropriately with communication errors and operator errors.

Test equipment and supplies needed for the testing are part of testing and will not be paid separately.

The testing shall not present a danger to motorists nor give them misleading information.

## ▪6. TECHNICIAN LAPTOP SOFTWARE

Provide laptop software that enables a technician to test all features and functions of the sign, and to set and change all of the sign's operating parameters. Provide MoDOT with the specifications for the computers to run this software. This software shall be delivered on a CD or diskette other electronic form so that it can be installed on MoDOT's computers. Provide the appropriate license that may be required to use the software on up to 10 computers.

## ▪7. TRAINING

### ○7.1. General

Training shall be provided for MoDOT's engineering, maintenance and operations staff at a facility provided by MoDOT. The training shall include all material and manuals required for each participant.

At least 30 days prior to commencement of the training courses, the manufacturer shall submit detailed course curriculums, time requirements, draft handouts, and resumes of instructors. MoDOT will review and request modifications of that material as appropriate. The courses shall be conducted at a MoDOT provided location, and at a time and date mutually agreed upon by MoDOT and the manufacturer. The training material generated for each course shall contain manuals and other handouts for each attendee which shall serve not only as subject guidance, but as quick reference material for future use by the students. All course material, in reproducible form, shall be delivered to the Engineer immediately following course completion.

### ○7.2. Maintenance Training

The maintenance training shall be provided for a minimum of 8 hours for at least ten maintenance personnel with an electronics background. The training shall include operation instructions, theory of operation, circuit description, field adjustments, preventive maintenance procedures, troubleshooting, operation of diagnostic and configuration software (if applicable), and repair of components.

### ○7.3. Engineering Training

The engineering training shall be provided for a minimum of 4 hours for at least ten engineering and operations personnel. The training shall include a complete demonstration of the operation and capabilities of the equipment

## ▪8. INSTALLATION SUPPORT

### ○8.1. On-Site Training

Train the installation contractor for the unpacking, assembly, mounting to the sign truss, positioning, and connection to the fiber optic communication cable, or spread spectrum radio integration and testing of the DMS assembly. Tell the contractor what types of cables to run between the controller cabinet and the sign, and how they should be terminated. The

contractor shall not perform any work until the manufacturer has certified the contractor as qualified. A MoDOT representative shall be present to observe the training

**○8.2. Support during Installation**

Provide both on-site and remote factory support. Provide a technical assistance hot line from the hours of 8:00 AM to 5:00 PM CST Monday through Friday. Provide assistance to installation contractor on Acceptance Testing, including but not limited to viewing angle, tilt angle, and other sign performance specifications.

**▪9. DELIVERY**

The bid price shall include delivery and off loading to the ground at a location in Missouri to be specified by the installation contractor. Coordinate the delivery time and location with both the contractor and the MoDOT Engineer.

**▪10. DOCUMENTATION AND WARRANTY**

**○10.1. Documentation and Drawings**

Provide twelve sets of complete shop drawings, catalog cuts, schematics and operations/maintenance manuals for each component for evaluation. A software manual in both paper and electronic format shall be provided with each set, which also describes the required protocol for Advanced Transportation Management System (ATMS) software vendor. A section of each set of the maintenance manuals shall include complete subcomponent parts listing.

**○10.2. Warranty**

The complete DMS assembly shall carry a two-year warranty from the date of acceptance against any imperfections in workmanship or materials. The central software shall also carry a two year warranty against defects. Provide free telephone technical assistance for software users during this period.

Any repairs made by the manufacturer or representative shall be documented and returned with units when warranty repaired. This documentation shall disclose exact repairs and identify the parts replaced by part number and serial number. All warranty repairs shall be completed within 30 days of delivery of the equipment to the designated repair depot.

**▪11. METHOD OF MEASUREMENT**

- Measurement of dynamic message signs, including all specified equipment, documentation, delivery, and testing, will be made per each.

- Measurement of the test sign, including all specified equipment, documentation, delivery, and testing, will be made per each.
- Measurement of the central sign control software, including all specified documentation and testing, will be made per lump sum.
- Measurement of the technician laptop software, including all specified equipment, documentation, and testing, will be made per lump sum.
- Measurement of maintenance training, including all specified documentation, will be made per class-hour.
- Measurement of engineering training, including all specified documentation, will be made per class-hour
- Measurement of installation support will be made per sign installed.

**▪12. BASIS OF PAYMENT**

Accepted dynamic message signs will be paid for at the unit or lump sum price for each of the pay items included in the contract. No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

## **SCOPE OF WORK SECTION 2E**

### **FUNCTIONAL SPECIFICATION FOR DYNAMIC MESSAGE SIGN ASSEMBLY (SHOULDER MOUNT)**

### **SPECIFICATION B CONTROLLER OUTSIDE OF HOUSING**

#### **1.0 General Information**

##### **1.1 Description**

This specification describes two types of permanently mounted, amber LED Dynamic Message Signs (DMS).

- a. Full matrix with 18 in characters, 3 lines and 15 characters per line
- b. Full matrix with 18 in characters, 3 lines and 12 characters per line

The DMS shall include the DMS Led matrix, sign controller/interface board, cabinet (provided by others) for sign controller/interface board, electrical distribution connections, main circuit breaker, surge suppression devices and electrical transfer switch with electrical connector for portable generator power connection. The DMS shall be housed in a fully wired aluminum (or other corrosion resistant material) weatherproof enclosure. In most cases, the cabinet will be mounted on concrete pad within close proximity to the sign structure.

All portions of the DMS display shall be clearly visible and legible from in-vehicle viewing distances between 200 ft and 1000 ft under normal roadway operating conditions. The DMS shall be designed to operate in roadway configurations at least three travel lanes wide in the same direction. The DMS are to be designed for mounting on two steel support posts by the use of Z-bars.

All DMS equipment components, modular assemblies, and other materials located in the DMS housing shall be removable, transportable, and capable of being installed by a single technician.

All components furnished under this functional specification shall be current production equipment and of recent manufacture. To ensure overall system compatibility, all DMS's shall be from the same manufacturer and production run.

##### **1.2 Manufacturer Qualifications**

The DMS manufacturer that propose to furnish DMS and signs controllers for this RFP shall meet the following requirements:

- a. Manufacturer has been in business continuously for a minimum of five years prior to the date of proposal opening.

b. Manufacturer has furnished amber LED, full matrix, permanently mounted DMS with 18 inch height characters with at least 3 lines and 15 characters per line, for a minimum of five projects, with each project having at least five DMS assemblies.

c. The DMS listed in the reference projects shall have implemented 1203 - NTCIP Object Definitions for Dynamic Message Signs (DMS) standard. Manufacturer shall also provide a compliance matrix that shows the level of conformance to mandatory and options objects of NTCIP 1203 standard.

d. Each of these DMS shall have satisfactorily operated for a minimum of one year prior to the date of proposal opening.

### **1.3 Proposal Submittal Data**

Manufacturer must submit the model numbers and product brochures of the DMS they propose to furnish as part of their proposal. The manufacturer shall submit a matrix that indicated “compliance”, “non-compliance” or “provide alternate design” for each specification requirement with their proposal. As noted in Section 1.6 of the specifications, if a manufacturer has a DMS that provides a different technological design to meet certain requirements of the specification, that manufacturer must provide sufficient information to allow evaluation of their technological design, by MoDOT, to determine if the functionality requirements of the specifications are met.

### **1.4 Environmental**

Except where otherwise specified, all components of the DMS assembly shall meet the temperature, humidity, vibration, and electrical requirements of NEMA TS-2. The DMS components shall be capable of continuous operation in a salt-laden atmosphere without degradation of material surfaces or performance.

### **1.5 Electrical**

The presence of ambient radio signals, magnetic or electromagnetic interference, including those from power lines, transformers, or motors within 1 ft (0.3 m) of any components of the system, shall not impair the performance of the system. The system shall not radiate any electrical or electromagnetic signals that could adversely affect any other electrical or electronic device.

All system electronics shall be 100 percent solid-state technology with the exception of the ventilation fans if they are required

All high voltage (exceeding 24 Volts DC) components used in the sign shall be UL listed.

### **1.6 Technology Variations**

It is recognized that some DMS manufactures have developed and successfully provided Dynamic Message Signs that have different designs such as display modules do not require ventilation, use of integrated sign controller/LED matrix boards, different approach for weatherproof environmental design. If a specific requirement of the

specifications for DMS enclosure construction, ventilation, sign controllers/interface board is not required due to technological designs, the manufacturer shall provide detailed explanations of how their DMS design meets the functionality of specification requirement. The details shall be submitted with the proposal.

### **1.7 Definitions**

- a. Central computer – a computer that is located in a MoDOT Transportation Management Center, which has the manufacturer’s central DMS application software that provides remote operation of the DMS
- b. Display Matrix module – contains at least 35 pixels with at least 5 columns and 7 rows.
- c. DMS - dynamic message sign that can change the message presented to the viewer. Includes the dynamic message sign, sign controller/interface board, sign controller cabinet and interconnect fiber cable.
- d. Laptop – portable computer that allows authorized user to access the central computer and use the laptop as workstation by accessing the MoDOT VPN service. Allows authorized user to connect locally to DMS sign controller/interface board to perform diagnostics, create new messages, select pre-programmed messages or reprogram the sign controller/interface board
- e. LED – light emitting diode
- f. NTCIP – National Transportation Communications for Intelligent Transportation System Protocol
- g. Pixel – contains a cluster of LEDs
- h. Sign controller/Interface board – controls the DMS display matrix, displays stored messages, messages created from a remote workstation or local laptop, provides means to store performance information for remote diagnostics or local diagnostics
- i. Shop drawing submittal – Drawings and schematics that must be submitted by the manufacturer for approval of the proposed dynamic message signs.
- j. Workstation – operates as a remote client to the central computer. An authorized workstation user can access the central computer by use of the MoDOT VPN service.

## **2.0 DYNAMIC MESSAGE SIGN COMPONENTS**

### **2.1 DISPLAY ELEMENTS**

#### **2.1.1 Display**

2.1.2 Each DMS shall be of the full matrix type. The pixels shall be spaced uniformly with the same spacing vertically and horizontally to the rows (i.e., no pitch or slant is

allowed). The DMS shall be capable of displaying graphical images and alphanumeric characters on the display area.

### **2.1.2 Light Emitting Diodes**

Display pixels shall incorporate amber LED technology. The discrete LED's shall have the following optical characteristics:

- (a) Peak wavelength of 590 or 592 nanometers,
- (b) For each DMS, the range of brightness shall be such that the brightest LED used is no more than twice as bright as the dimmest LED used.
- (c) Viewing cone of 30 degrees.
- (d) The dominant wavelengths of all LED's shall fall within a band 3.5 nm wide.
- (e) The LEDs shall be AlInGaP, Precision Optical Performance T 1-3/4 diodes
- (f) The LEDs shall be rated for 100,000 hours continuous operation at 30mA drive current, with less than 30% lumen depreciation. The cone perimeter shall be defined by its 50% intensity points.
- (g) The LED brightness and color bins that are used in each pixel shall be provided to the engineer for approval. The manufacture shall provide information on test procedures used to measure and sort the LEDs for brightness and color.

**The shop drawing submittal for the sign shall include the manufacturer's procedure for ensuring that the requirements for uniform brightness and uniform color are met.**

### **2.1.3 Display Modules**

All module surfaces, which are visible from outside the DMS, excluding the LED pixels, shall be painted flat black in order to provide maximum display contrast and readability. There shall be a minimum of thirty-five (35) pixels per module. Each module shall have at least 5 columns and 7 rows of pixels and shall be capable of displaying 18 inch characters with 5 X 7 fonts and 4 X 7 fonts. There shall be at least one pixel space between consecutive characters on each line of the full matrix DMS and at least 2 pixel spacing between rows of the full matrix DMS when it is used to display messages in a 3 line format. The DMS display modules shall also be capable of displaying graphic messages and alphanumeric characters per line, the DMS display matrix shall have at least 90 pixel columns and 27 pixel rows to display graphic and alphanumeric messages.

For DMS with 18 inch characters and 15 characters per line, the DMS display matrix shall have at least 90 pixel columns and 27 pixel rows to display graphic and alphanumeric messages.

For DMS with 18 inch characters and 12 characters per line, the DMS display matrix shall have at least 75 pixel columns and 27 pixel rows to display graphic and alphanumeric messages.

All serviceable components shall be modular, interchangeable, and removable from within the DMS enclosure. The DMS display shall be composed of identical and readily interchangeable display modules. Display modules shall be removable from the DMS with either simple hand tools or without any tools. All wiring interconnecting the individual display modules shall be modular harness assemblies with latching push-on/pull-off or twist on/off connectors.

The removal of any combination of one or more display modules shall not alter the structural integrity of the DMS. Nor shall the removal of any combination of display modules affect the operation of the remaining operational modules in any way. Pixels shall consist of two strings of LED's and shall produce 40 Candela of luminous intensity at a drive current of 20 mA per string and a forward voltage drop of 24 volts or less.

LED's shall be soldered to circuit boards with through-hole type of circuit board mounting. Surface mounting of LED's will not be allowed.

To minimize the chance of LED's being pushed out of alignment with the sign's optical axis, LED's must be mounted no more than 1/100 inch from the front side of the printed circuit board. The LED's must be mechanically protected, so that there is no contact with them when the module is gripped or dropped.

Display modules shall be attached to the support frame with captive fasteners in such a way that their position does not change when the sign is subjected to severe vibration. The LED leads and the circuit board traces shall dissipate heat produced by the LED's. Circuit traces that connect to the LED's shall be two ounce copper plating or thicker. The width of traces that connect to those LED leads that carry heat from the LED chip shall be maximized.

Both sides of the board shall be protected with acrylic conformal coating. The coating on the front of the board is to seal the gap between the LED's and the board, and shall be applied so as not to coat the LED housing above the gap. The LED's may not be potted. The peak current provided at maximum brightness must be 20 mA or, if adjustable, must be set at 20 mA when installed. If the maximum current is adjustable, the adjustment mechanism shall not permit values above 30 mA.

## **2.2 DISPLAY ELECTRONICS**

### **2.2.1 Driver Circuitry**

The driver circuitry shall be able to detect abnormal current values, including short circuits and open circuits, while a single pixel is being illuminated. The state of the LED's (on or off) in each pixel of the sign shall be read by the sign controller so it can report the actual message, including static, flashing and alternating messages, that is visibly displayed on the sign in a WYSIWYG format. This pixel read shall take place while a message is displayed on the sign without disturbing the message in any way and will include any half-out, full-out, half stuck on or fully stuck on pixels. Any flashing,

flickering, blinking, dimming, or other disturbance of the message during this pixel status read shall be cause for rejection of the sign.

### **2.2.2 Brightness Control**

Pulsed drive current shall be used at the maximum brightness level. Pulse Width Modulation (PWM) shall be used to dim the sign to achieve the proper brightness level for a given ambient light condition. As part of the shop drawing submittal, a complete schematic of the LED power and driver circuits shall be provided for review by MoDOT's project representative. Multiplexing of the LED's shall not be allowed.

The DMS shall have photocells that detect when the sun is directly in front of the DMS or directly behind it. Those photocells, or a separate photocell, shall also distinguish night from day. These photocells shall not be affected by man-made light sources, such as highway lighting and/or headlights. They shall be easily accessible for maintenance.

### **2.2.3 Temperature Control**

The DMS shall be designed so that the air temperature on the backside of the display modules never exceeds 140 degrees F (60 degrees C). A thermostat located in the middle of the top line of display modules shall shut down the LED display if the temperature rises above 140 degrees F (60 degrees C) and restore power when the temperature has dropped to 120 degrees F (50 degrees C). This shall be independent of the controller. The sign shall also have one or more temperature sensors that report the sign temperature to the sign controller, which shall in turn report the temperature to the central software.

### **2.2.4 DMS Power Supplies**

The maximum operating temperature of all power supplies shall be at least 150 degrees F (65 degrees C). All regulated power supplies shall have a minimum power factor of 0.95. The LED display modules shall be operated at low internal DC voltage not exceeding 24 Volts.

The power supplies shall be short circuit protected by DC power OFF, and shall reset automatically after 5 seconds of AC power OFF. The power supplies shall also be protected by a suitable inrush current allowance to be recommended by the manufacturer and approved by MoDOT's project representative.

The power supplies shall have an efficiency rating of at least 75 percent.

## **2.3 ENCLOSURE**

### **2.3.1 Material**

The DMS enclosure shall be assembled from a continuously welded (or extruded) aluminum alloy 3003-H14 or 5052-H34 skin of at least 1/8 inch (3.5 mm thick). The enclosure shall not have sharp edges or corners and the inside and outside edges shall be free of burrs. Internal supports shall be of extruded aluminum alloy 6061-T6 members

welded to form a support structure to provide rigidity and structural integrity. All metallic parts shall be corrosion resistant.

The DMS case and facial area shall be treated with a flat-black, factory-applied, Kynar flouropolymer resin based coating providing a minimum life span of 10 years. The DMS case top may be left in natural aluminum finish to reduce internal temperatures of the DMS enclosure. As part of the shop drawing submittal, the manufacturer may propose an alternate means of protecting the metal surfaces. Such alternates shall be subject to the approval of MoDOT.

Each DMS shall be provided with the following:

- a. Lifting eyebolts for shipment and for installation of the signs without incurring age to the enclosure.
- b. Z-bars on the back of the DMS enclosure for mounting the DMS
- c. Installation details and hardware for mounting the DMS on two steel post (post and foundations provided by others)
- d. Ladder rails for attaching a ladder to the DMS for servicing the DMS matrix modules
- e. Heater to reduce moisture and prevent fogging of the display face panel
- f. Mounting brackets near the top of the DMS enclosure for mounting a 900 MHZ RF antenna on a 3 inch diameter mast, that is 4 inches in diameter. Also a weather resistance entrance for the RF antenna cable.

The DMS shall be designed to withstand 100 mile per hour wind and withstand a load of 3 pounds of ice per square foot of surface area.

### **2.3.2 Welding**

If welding of the DMS housing is required, the DMS shall be fabricated, welded and inspected in accordance with the requirements of ANSI/WS D1.2-90 Structural Welding Code-Aluminum (1990). All manufacturing personnel who perform welding on the DMS housing shall be certified to AWS D1.2-90 for all weld types required for housing fabrication. The DMS manufacturer's submittal shall contain a copy of each welder's certification and the manufacturer's certified welding procedures.

DMS housing welding shall be inspected on a daily basis by a Certified Welding Inspector (CWI), who shall complete daily written reports on DMS welding progress, housing weld integrity, and any corrective action taken. These reports shall be archived by the DMS manufacturer and shall be available for immediate review upon request by MoDOT.

### **2.3.3 Display Face**

If access to the inside of the DMS housing is required, then multiple hinged rigid rear doors to access the LED full matrix display shall be provided. The door panels shall be fabricated using aluminum sheeting and have entrance locks. Each door shall be weatherproof and be designed to prevent entry of blowing rain when closed. The doors shall be rigid when in the open position.

The DMS housing shall provide safe and convenient access to all display modular assemblies, components and wiring located within the DMS housing. All of those internal components shall be removable and replaceable by a single technician.

The front face of the DMS shall use clear polycarbonate panels of at least 3/16-inch thickness. The polycarbonate shall transmit at least 85 percent of the light emitted by the LED's. The manufacturer's technical data sheet for the material utilized for the front face shall be provided as part of the submittal package. The front face of the DMS shall be waterproof. The polycarbonate manufacturer shall guarantee that:

- a. The yellowness index (ASTM test D-1925) of the material shall remain below 5.0 for three years from the date of purchase, and below 10.0 for five years.
- b. The light transmission (ASTM test D-1003) of the material shall not decrease more than three percent in three years from the date of purchase and no more than seven percent in five years.

Each window shall be covered with a 0.04-inch, minimum thickness, black aluminum (or other durable material) mask. The mask shall have the same finish as the rest of the front of the sign and shall provide openings directly in front of each pixel. Pixel openings shall be of sufficient size as to not interfere with LED light output. Horizontal louvers may substitute for the mask.

#### **2.3.4 Ventilation**

If ventilation of the DMS is required, the DMS enclosure ventilation shall include intake, exhaust, filtration, fan assembly and environmental control.

Vents shall be screened to keep out rodents and insects. The number and size of the vents shall be determined by the manufacturer to be of sufficient size to provide adequate ventilation. Intake vents shall use motorized louvers to prevent the entry of dirt and insects when the ventilation system does not require outside air. The exhaust vents shall be equipped with dampers for the same purpose. The intake vents shall be located to prevent the direct intake of truck exhaust.

A removable two-stage air filter system shall be installed behind each intake vent. The filter filtration area shall completely cover the vent opening area such that no incoming air bypasses the filter. Brackets shall support the filter at the vents and be located to facilitate easy replacement.

The DMS enclosure shall be equipped with electric fans with ball or roller bearings. The capacity of each fan and the number of fans shall be sufficient to insure adequate

ventilation if one fan becomes inoperable. An analysis shall be presented in the submittal material, which shall document that the proposed system meets these requirements. The fans shall be mounted within the housing and vented. The number, placement, and size of the electric fans shall be determined by the manufacturer. The fans shall be controlled by the DMS controller or a thermostat. If the fans are controlled by the DMS controller, there shall be parameters in the controller's database, which will specify the turn-on temperature and the shutdown temperature. Both parameters shall be in the range of 70 degrees (20 degrees C) to 120 degrees F (48 degrees C).

The DMS shall have a window defogging system that is turned on and off by the DMS controller or a thermostat. Heated air or heated strips are acceptable.

## **2.4 STRUCTURAL SUPPORTS**

Two structural supports will be used to attach to the Z-bars of the roadside mounted DMS. The sign support structures will be located at the two outer quarter point of the DMS enclosure (distance from the edge of the DMS enclosure to the center of the nearest sign support structure. Quarter point is the length of the DMS enclosure divided by 4. The manufacturer shall not locate an access door within plus or minus twelve (12) inches from the outer quarter points of the DMS enclosure. Example: the DMS length is 20 feet. The quarter point is 5 feet, so the sign supports will be installed somewhere from 4 feet from the end of the DMS enclosure to 6 feet from the edge of the DMS enclosure.

## **2.5 SIGN CONTROLLER/INTERFACE BOARD**

Each DMS shall have a microprocessor-based system sign controller/interface board that is mounted on an EIA 19 inch rack in a separate cabinet. The cabinet is mounted on a pedestal or on the DMS sign support. The separate controller cabinet will allow access to the sign controller/interface board without the bucket truck or ladder. The controller must have sufficient memory and processing power to perform all the functions described in the specifications.

The sign controller/interface shall not require continuous communication with the central software in order to perform most DMS message functions.

The sign controller/interface shall meet the following operational requirements:

- a. Communicate using the 1203 - NTCIP DMS protocol that is native to the controller/interface board firmware
- b. Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation
- c. Include a front panel user interface with LCD and keypad or software that can be loaded into a laptop for local direct operation and diagnostics
- d. A power on-off switch and power on LED indicator

- e. A local/remote mode toggle switch to select remote NTCIP network communications operations or local operations via the sign controller or local laptop connected to the serial or Ethernet communications port.
- f. LED indicator to indicate local or remote mode status
- g. Reset switch or function to restart the sign controller/interface board
- h. Status indicators or function that the sign controller/interface is operational
- i. Status indicators or function that the communications ports are active
- j. DMS-specific control firmware (embedded software) to monitor all external and internal sensors and communication inputs and control the display modules as directed by external control software and the front panel or local laptop interface
- k. Use a fiber optics cable for communications of data to and from the sign controller/interface board to the DMS LED display panels. Use of copper data circuits between the external sign controller/interface board and the DMS LED display panels is not allowed.

### **2.5.1 Watchdog Timer**

The controller shall have a watchdog circuitry that automatically resets the controller when it locks up. There shall be a means for the controller to recognize and report the fact that it was reset by the watchdog timer.

### **2.5.2 Memory**

The controller shall have nonvolatile memory that contains the operating DMS software and messages.

The controller shall also have changeable memory that retains the data in memory for a minimum of one year following a power failure. It shall contain the library of messages, the message display schedule and changeable operating parameters. The controller memory shall be capable of storing at least 100 messages in non-volatile memory.

### **2.5.3 Clock**

The controller shall have a time-of-year clock with a lithium battery backup. The battery shall keep the clock operating properly for at least 5 years without external power. The clock shall automatically adjust for daylight savings time and leap year through hardware, software or a combination of both. It shall be set by the sign controller's microprocessor. The clock shall be accurate to within 1 minute per month.

## **2.6 COMMUNICATION INTERFACES**

The sign controller/interface board or cabinet shall be provided with the following communications ports:

- a. Minimum of two (2) NTCIP-compliant RS232 communication ports

- b. Minimum of one (1) NTCIP-compliant Ethernet port with RJ45 connector
- c. One (1) dial-up Hayes-compatible modem with standard RJ11 connector

### **2.6.1 Serial Communication Ports**

These ports shall support multiple communication interfaces, including, but not limited to, direct null-modem (for local laptop control), dial-up and leased-line modems, radio systems, cellular modems, and fiber optic modems. The RS232 ports shall all have standard DB9M connectors.

The baud rate, connection type, and NTCIP communication protocol shall be configurable. Each port must support all typical serial baud rates ranging from 1200 to 115,200 baud. All three ports shall be capable of supporting either of the following sub network profiles: NTCIP 2101 (PMPP) or NTCIP 2103 (PPP). They shall also be capable of supporting either NTCIP 2201 (Null) or NTCIP 2202 (Internet) transport profiles. Only one each of the transport and sub network profiles shall be active at any time on each port.

### **2.6.2 Ethernet Port**

The 10/100Base-T Ethernet communication port shall be available for use for communicating from the central control system to the DMS sign controller/interface board through an Ethernet network. The Ethernet port shall have a standard RJ45 connector.

Communications on the Ethernet port shall be NTCIP-compatible using the NTCIP 2202 Internet transport profile and the NTCIP 2104 Ethernet sub network profile. This shall permit the controller to be operated on any typical Ethernet network using the TCP/IP and UDP/IP protocols.

### **2.6.3 Dial-Up Modem Communication Port**

The modem port shall have a standard RJ11 connector. This modem shall be configured to support either the NTCIP 2101 (PMPP) or the NTCIP 2103 (PPP) sub network profile. At least one of the following transport profiles shall also be available for configuration: NTCIP 2201 (Null) or NTCIP 2202 (Internet). Only one each of the transport and sub network profiles shall be active at any time on the port.

The modem shall be configurable to support both incoming and outgoing calls as supported by NTCIP. The modem shall support a minimum communication speed range from 1200 baud to 28,800 baud. The modem shall support the following protocols at a minimum: Hayes-compatible “AT” command set, MNP5, MNP10, and V.42bis.

### **2.6.4 IP Addressable**

The DMS sign controller/interface board shall be provided with user selectable IP addresses and the address shall be configurable through the front panel or laptop user interface.

NTCIP 2101 (PMPP) networks shall be configured with an address in the range 1 to 255 with a default address of 1. NTCIP 2104 (Ethernet) networks shall use a static IP address. Both the IP address and subnet shall be configurable. NTCIP 2103 (PPP) networks shall not require network addressing.

## **2.7 SIGN CONTROLLER/INTERFACE CABINET (provided by others)**

### **2.7.1 Cabinet Racks**

Each DMS shall be provided with a separate cabinet that contains the following:

- a. EIA 19 inch rack for mounting the sign controller/interface board
- b. Rack space for mounting a future Ethernet switch (Cisco 2955) and power supply
- c. Rack space for a future 4 port Control terminal server on a rack mounted shelf (provided by others)
- d. One EIA 19 inch, 6 inch height rack shelf for wireless modem

### **2.7.2 Power**

- a. Power circuit breaker, AC power terminal block and chassis ground for connection to 120 volt AC, power source
- b. A utility outlet circuit consisting of a minimum of one (1) 15-A NEMA 15-R, 120 VAC duplex outlet, with ground-fault circuit interrupters. This outlet shall be located near the power breaker.
- c. Outlet circuit consisting of a minimum of two (2) 15-A NEMA 15-R, 120 VAC duplex outlets.

### **2.7.3 Surge Protection**

- a. Sign controller/interface signal and power inputs shall be protected from electrical spikes and transients as follows:
  - i. The AC power feed for all equipment shall be protected at the load center by a parallel-connection surge suppresser rated for a minimum surge of 10 kA.
  - ii. A series-connected surge suppressor capable of passing 15 amps of current shall protect the sign controller and other control and communication equipment. This device shall conform to the following requirements:
    - (1) Withstand a peak 50,000 ampere surge current for an 8x20 microsecond wave form

- (2) Maximum continuous operating current of 15 amps at 120 VAC, 60 Hz
  - (3) Series inductance of 200 micro henrys (nominal)
  - (4) Temperature range of -40°F to +158°F (-40°C to +70°C)
  - (5) The device shall be UL-1449 recognized
  - (6) UL 1449 surge rating of 400 V or less
- b. Transient voltage surge suppressors shall protect all copper communication lines used to pass data between the sign controller and sign.
- c. Transient voltage surge suppressors shall protect all communication signals connecting to the control equipment from off-site sources using copper cables.

#### **2.7.4 Interface Fiber Cable**

Manufacturer shall provide 50 feet of fiber optics cable with connectors for connection of the DMS display matrix to the sign controller/interface board.

The sign controller cabinet shall use a Type 336 or larger aluminum enclosure. The cabinet is to be base mounted.

The sign controller cabinet shall be provided with a transfer switch and connector to allow an emergency generator to power the DMS. The transfer switch and connector are to be housed in a NEMA 3R or NEMA 4 or NEMA 4X self contained aluminum lockable enclosure that is mounted on the side of the sign controller cabinet. The transfer switch and NEMA L5 male power locking connector rated at 125 V AC. A heavy duty weather resistant lock and 2 keys shall be provided for the transfer switch enclosure. The manufacturer shall provide a 30 foot extension cord for connection of an emergency power generator to the DMS NEMA L5 male power connector. Instructions should be provided on how to convert power from the power grid to an emergency power generator.

Each cabinet shall include two fluorescent lighting fixtures mounted inside the front and back portion of the cabinet. These fixtures shall include a cool white lamp with protective cover and shall operate by normal power UL listed ballast.

A door actuated switch shall be installed to turn on the cabinet light when the door is open. Each switch should work each individual light.

All main cabinet doors shall accept a NO. 2 Corbin Key. Two sets of keys shall be supplied with each cabinet.

The sign controller cabinets will be mounted on a concrete base by a separate installation contractor.

## 3.0 DMS DISPLAYS REQUIREMENTS

### 3.1 Display Presentation

Space allocated to each character shall be proportional to the character's true width. Software shall handle such details as centering text on a line, right justification, left justification, and appropriate spacing of letters and words. Software shall also control flash, and alternating between pages of a two and three-page display. There shall be a default value for each parameter supported. The manufacturer shall pre-load these default parameters with values approved by the Engineer.

### 3.2 Modes of operation

Signs shall be able to display a static message, a flashing message, or a multipage message as described below.

- a. **Static message:** The message chosen shall be displayed constantly on the sign face until the sign controller is instructed to do otherwise.
- b. **Flashing message:** A selected portion of the chosen message shall be displayed and blanked alternately at durations controllable in one-second increments for a minimum range of 1 to 6 seconds
- c. **Multi-page messages:** The chosen message shall display up to two different pages (each page consisting of up to three lines of text) alternately at durations separately controllable in one-second increments for a minimum range of 1 to 6 seconds.

### 3.3 Fonts

A user shall be able to create and display messages using at least four eighteen height fonts, each stored in the sign controller/interface board. Two of the fonts shall be stored in the controller by the manufacturer. One font is comparable to that shown in Figure 7-1 of Federal Highway Administration publication # FHWA-TS-90-043. The other font is a compressed 4 X 7 eighteen inch height font. The user shall be able to create at least two additional fonts, download and store the fonts in the sign controller/interface board. All fonts must include the following characters:

- a. The letters "A" through "Z", in both upper and lower case
- b. Decimal digits "0" through "9"
- c. A blank space
- d. Eight (8) directional arrows
- e. Punctuation marks, , ! ? - ' " " " ; ; and special characters, such as: # & \* + / ( ) [ ] < > @

### 3.4 Display Selection

Messages shall be activated on a DMS in three ways:

- a. **Manual** – An operator using the front panel LCD/keypad interface or NTCIP-compatible control software manually instructs a particular message to be activated.
- b. **Schedule** – The internal time-based scheduler in the DMS may be configured to activate messages at programmable times and dates. Prior to activation, these messages and their activation times and dates shall be configured using the control software.
- c. **Events** – Certain events, like a power loss, may trigger the activation of pre-configured messages when they occur. These events must be configured using the control software.

A displayed message shall remain on the sign until one of the following occurs:

- a. The message's duration timeout expires
- b. The sign controller/interface board receives a command to change the message
- c. The sign controller/interface board receives a command to blank the sign
- d. The schedule stored in the sign controller/interface board memory indicates that it is time to activate a different message
- e. A special event, such as a loss of communication, occurs that is linked to message activation

In the absence of instructions from the communications ports, the sign controller/interface board shall implement a display selected from those stored in its memory based upon date and time as specified in the schedule. It shall use a schedule stored in random access memory plus its time-of-year clock to select the proper display. The schedule system shall permit different schedules for different days of the week plus special schedules for special days, such as holidays.

The display of the scheduled message may be over-ridden by instructions sent from the communications ports. A computer shall be able to cause the sign controller/interface board to implement a particular display selected from the messages stored in its memory, or a new display sent from the computer. The computer shall also be able to edit or completely replace a message stored in the controller's memory, or revise the message schedule. In addition, it shall be able to cause the controller to report its schedule or the text of any message stored in its memory.

Software shall incorporate fail-safe procedures to check messages received and shall not change a message stored in memory, the display currently on the sign, the schedule stored

in memory, or the current time unless the message is received correctly and constitutes a valid command.

The DMS sign controller shall support the activation of messages based on a time/date-based schedule. The format and operation of the message scheduler shall conform to NTCIP 1201 and NTCIP 1203 standards.

### **3.5 Brightness Control**

Manual and automatic dimming modes shall be provided, enabling the user to select the desired mode of operation. The dimming system shall select one of several levels from the sensed ambient light. The set points for each of the ambient light levels shall be set by the user via software. A user shall be able to send a command via the control ports to select a specific brightness level or to direct the controller to select an appropriate brightness based on current lighting conditions.

For each brightness level, a technician shall be able to easily determine what fraction of the full brightness current is applied to the LED's. The technician must be able to set the current value for a given brightness level to any value between 25% and 100% of the maximum current in five percent increments, and must be able to easily change these settings via computer commands.

### **3.6 Diagnostic Test**

Upon command, the controller shall test the electrical operation of all drivers and check for over current and under current pixels. It shall communicate the result to the computer that issued the command using an NTCIP compliant method.

### **3.7 Power Interruptions**

The contents of the controller's memory shall be preserved by battery power during power interruptions, and the controller shall resume operation automatically when power is restored. Upon recovering from a power interruption, the controller shall report to the central computer that it has just recovered from a power interruption. It shall also consult a configuration parameter set by the user to determine whether to blank its display or to display the message that it would have been displaying if no power failure had occurred. There shall be separate configuration parameters for long and short power failures, as well as a parameter specifying the maximum duration of a power failure classified as short.

### **3.8 Test Messages**

Test messages shall be stored in the controller's permanent memory. The test messages shall be functionally equivalent to the following:

- a. All pixels on simultaneously in at least two adjacent display modules. This is to determine whether there are pixels or display modules that are not the same brightness as the rest.
- b. Each module shows a unique display indicating which row and column it is in. This test display is to determine whether any module is displaying what a different module should be displaying.
- c. One display for each font, showing every character composing the font.

The test messages shall include any other displays required to carry out the manufacturer's recommended procedures for maintenance and troubleshooting.

### **3.9 Watchdog Timer Interface**

The software shall regularly reset the watchdog timer so that it does not inappropriately reset the controller. When it starts operating, the software shall check the status of the watchdog timer and, if the timer indicates that it reset the controller, the controller shall report that fact to the central computer.

### **3.10 Temperature Monitoring**

A user shall be able to set a temperature threshold. When the highest temperature reported by the temperature sensors in the sign exceeds this threshold, the controller shall issue a temperature warning to the central computer.

### **3.11 Lost Communications Monitoring**

The DMS sign controller/interface board shall monitor the frequency of communication packets from the central system. If the controller detects that communication has not occurred between the controller and central system for longer than a configurable timeout, then the controller will automatically activate a communication loss message as defined by NTCIP. This communication loss message shall be able to be disabled by the user.

## **4.0 CENTRAL SIGN CONTROL SOFTWARE**

### **4.1 General Information**

The DMS manufacturer shall provide their central software with communications protocols that complies with NTCIP 1203 standard, with minimal customization. Deviations from these specifications will be accepted if, in the opinion of the Engineer, they provide comparable functionality.

### **4.2 MoDOT Servers**

MoDOT will furnish and install or use existing servers in the Transportation Management Centers (TMC) located at Gateway Guide in St. Louis, Missouri. The DMS application is to be web based and accessible by authorized MoDOT staff through the use of the MoDOT VPN.

#### **4.3 Workstations**

The manufacturer will provide a statewide client/server license for district and central office personnel workstations and their authorized maintenance contractors. Also the unit price for the client/server license is applicable to other Missouri public agencies that may purchase DMS from this RFP.

#### **4.4 Off Line Status**

A user at the sign server or a workstation shall be able to take a sign off line, causing it to be ignored by the sign computer. This will be used when a malfunctioning sign is generating an excessive number of alarms. When a user attempts to control an off line sign, a message shall appear on his screen informing him that the sign is out of service. When a user takes a sign off line, the software shall ask the user to type in a comment of up to 100 characters explaining the action. The comment field may be left blank. The computer shall also record the user's name, based on his password, and include the name and comment in the failure report described below.

#### **4.5 Message Library**

The sign server shall store a library of at least 500 messages on its hard disk. In addition to the message text, the file shall contain all the MULTI control codes needed for a sign to properly display the message

When adding a message to the library, a user shall specify the message name. If a message with the same name already exists in the library, the software shall notify the user and give him the options of replacing the existing file or selecting a new name for the message he has just created. A user shall also be able to delete library messages from within the program.

The program shall ask the user to confirm each message deletion before actually deleting the file. If the user is seeking a message to display, the software shall present a list so that the user can choose one. When the user makes his selection, the software shall display the entire message, exactly as it would appear on a sign, and shall ask the user to confirm that this is the message desired. The user shall then be able to post the message on one or more signs, edit the message, or do nothing with it.

#### **4.6 Sign Control**

Future signs may have different line lengths and heights (measured in pixels) than the signs provided in this project, and may have more or fewer lines. The software shall display messages as a matrix of dots that replicate the way the message will actually

appear on a selected sign. The presentation should be based on the number of lines on the sign and the height and width (in pixels) of the lines, as stored in a database maintained by the sign computer. This type of display will be used during message creation and editing, as well as when displaying to a user the message currently on a sign. If the user is displaying a message from the library or creating a message without specifying what sign it will go on, the display shall be based on the characteristics of the signs provided in this project.

Upon creating or revising a message, the user shall be able to save it in the message library on the sign computer's hard disk or send it directly to one or more DMS controllers for storage or display.

When a user sends a message to one or more signs, the sign computer shall automatically check to be sure that the message will fit on the sign. This checking shall take into account the selected fonts and the size of the sign's display. If the message won't fit, the computer shall alert the user and not post the message.

If a user chooses to send the same message to multiple signs, the software shall present the user with a list of all signs, so that the user can check off which signs the new message goes to. The screen shall also give the user a choice of "All Signs". The list shall identify signs by roadway and milepost. Using a single command, the user shall be able to cause the message to be stored in all the signs he specified, replacing those previously stored in the controllers. Similarly, the user shall be able to use a single command to have all the selected signs display the same message, or the same message number.

In addition to entering commands for immediate execution, a user may store commands in the sign computer for future execution. For example, the user may want to conduct a pixel test of every sign each night at 3:00 AM. A user shall be able to quickly and easily create, modify, suspend, or cancel a schedule of commands for the sign computer to issue to specified DMS controllers. The user shall be able to specify the same action at the same time for multiple signs, in the same way as was described in the preceding paragraph. A user shall also be able to schedule the printing of sign-related reports. A user shall not be able to schedule any command that he does not have the privilege to execute directly. The schedule shall show the name of the user who scheduled each command, based on his password. Actions that would be recorded in the event log if a user commanded them directly shall also be logged when they result from a scheduled command. The record shall include the user's name and an indication that the command was scheduled.

The software shall provide a single command that not only transmits a message to a sign (after confirming that it fits) but also causes the sign to immediately display that message on the sign (after confirming that the transmission was error free).

#### **4.7 Status Monitoring**

The sign server shall maintain an event log file on its hard disk with a record for each appearance or disappearance of an alarm from a DMS controller or sign. The file shall be

in ASCII format with fixed-length fields separated by spaces, suitable for transfer to spreadsheet and data base management software. The record shall include the date, time, sign id, and nature of the change. If the alarm indicates a change in the sign display, the log shall include the exact text of the message, the device from which it was commanded, and, if commanded via the sign computer, the name of the person posting the message, based on his password. The log file shall include this same information each time a message is downloaded to a sign's memory from the sign computer.

The log shall also record each time a user at a workstation or the sign computer does the following:

- a. Changes the priority of a message.
- b. Changes the schedule.
- c. Changes a message in the library on the computer's hard disk.

The record shall include the user's name based on his password.

The log shall also record the beginning and end of communication failures. The sign computer shall deem a communication failure to have occurred if it does not get an error-free response to two consecutive commands to a controller. The computer shall deem a controller recovered if it responds properly to a command.

## **4.8 Reports**

The system shall provide the following reports to the user's screen, a disk file named by the user, or to the printer, as specified by the user:

- a. Equipment Failures. Lists each sign that is currently malfunctioning, along with the time and date of failure and a phrase indicating the nature of the problem. Also lists each DMS controller that is off line, along with the date and time it was taken off line, the comment written by the user who took it off line, and the user's name based on his password.
- b. Sign System Configuration. Lists the current values of all configuration parameters stored in the sign computer, clearly labeled. It includes such things as communication line and drop assignments. It does not include operating parameters stored in the DMS controllers.
- c. Individual Sign Configuration. Lists the current values of all changeable parameters stored in a DMS controller, clearly labeled. It includes such things as temperature thresholds. This report shall cover all signs, or a particular sign, as specified by the user. The information displayed shall be uploaded from the DMS controllers at the time the report is requested. If the sign computer is unable to upload the data from a particular sign, it

shall use the corresponding data on its hard disk, but shall indicate in the report that the data is from the hard disk and may not be current.

d. Current Sign Status. Lists sign location, text of message currently displayed, whether it is an emergency message (new signs only), whether the message has priority status (new signs only), storage location of the message in the sign's memory, entity that caused the message to be displayed (new signs only), and controller status (failed, working, or off line) for each sign in the system. This report shall cover all signs, or a particular sign, as specified by the user. If the report covers multiple signs, the signs shall be grouped by roadway and listed in the order in which a motorist would see them.

e. Event Log. Lists all information in the event log file, with each field clearly labeled. The user shall be able to specify that only events between certain times, or pertaining to a certain sign, or pertaining to a certain type of event, or any combination of the foregoing, shall be included in the report. Events shall be listed chronologically.

f. Message Library. Lists the text of each frame of each message in the message library, along with the duration for which the frame is displayed. Also lists the message's file name and latest revision date. Each frame shall be displayed in the report in the same way it would appear on a sign, with regard to text centering, bolding, and justification. Flashing text shall be underlined. Messages shall be grouped by subdirectory, and a user shall be able to specify that only certain subdirectories be included.

g. Sign Server Schedule. Lists all information in the sign server's schedule, clearly labeled. The user shall be able to specify that only events between certain times, or pertaining to a certain sign, or pertaining to a certain type of event, or any combination of the foregoing, shall be included in the report. Events shall be listed chronologically.

h. Sign Memory. Lists sign ID and location and the text of each message stored in the sign. The message portion of the report shall indicate the message's memory location number and shall display the text of each frame of the message, along with the duration for which the frame is displayed. Each frame shall be displayed in the report in the same way it would appear on a sign, with regard to text centering, bolding, and justification. All information shall be clearly labeled. The user shall be able to specify that the report cover only a particular sign, or all signs. The information displayed shall be uploaded from the DMS controllers at the time the report is requested. If the sign computer is unable to upload the data from a particular sign, it shall use the corresponding data on its hard disk, but shall indicate in the report that the data is from the hard disk and may not be current.

i. Bad Pixel Maps. Consist of a matrix display indicating which display elements of a sign have failed, according to the DMS controller. The user shall be able to specify that the report cover only a particular sign or all signs with display problems. If the user specifies all signs with display problems, the report will cover all signs whose controllers are currently reporting malfunctioning drivers or display elements.

The time and date for which the information is current shall appear on every page of each printed report. All pages shall be numbered.

#### **4.9 Alarms**

The sign computer shall issue alarms by beeping and displaying a message clearly identifying the problem in a box that pops up on the user's screen. The box shall disappear when the user clicks on it and the beeping shall stop. If the alarm is of the type called "recurring", the beeping and screen message recur every 5 to 15 minutes as long as the condition persists. The sign computer shall issue a single alarm for the following situations:

- a. A new sign failure.
- b. The sign computer is unable to change a sign's display as scheduled because the currently displayed message has priority status.

#### **4.10 Timekeeping**

The software shall track and display the current date and time, and shall automatically adjust for standard and daylight savings time without operator intervention.

#### **4.11 Password Protection**

Only users, who have proper authorization, as indicated by their passwords, shall be able to undertake the following actions:

- a. Place equipment on standby.
- b. Change sign messages, blank signs, and change message priority.
- c. Replace or delete messages stored in a DMS controller's memory.
- d. Display test patterns on a sign.
- e. Change or delete the sign computer's schedule.
- f. Modify the message library on the sign computer's hard disk.
- g. Change sign configuration parameters.
- h. Delete the event log.
- i. View passwords.
- j. Change passwords and privileges.

Users may be granted or denied permission to use each protected command independently. Via an encrypted lookup table, the server shall determine which of the protected commands a user may use.

The software shall ask the user for his password at the time the protected command is entered. The computer shall not carry out these commands unless the user has the proper privileges.

#### **4.12 User Interface**

The user shall enter commands by selecting from menus. The user shall make selections from menus and from lists of signs, messages, and options using a mouse. The interface shall be easy to use, minimizing memorization and opportunities for errors. The interface shall automatically check commands for out-of-range values and other errors. When it checks an error, it shall beep, reject the command or data, and provide the user with a clear explanation.

The software shall have the complete text of the software operator's manual stored on disk, readily available to the user.

#### **5.0 On-Site System Training and Integration**

The manufacture shall provide on-site technical services for integration of their DMS software with the DMS servers located at Gateway Guide (St. Louis region). The on-site technical support also includes the installation of the DMS client software on MoDOT laptop computers and desktop computers at one of the TMC's listed above. The manufacturer is to demonstrate that the DMS software operates reliably and is in full compliance with the specifications. The manufacturer shall conduct the tests following the approved test plan. To be accepted, the software must pass all the tests.

The test plan shall test every interface, feature, and function of the central software that the manufacture provides. The testing shall also demonstrate that the software does the following:

- a. Operates with six workstations connected to the server that are simultaneously sending the server commands and data at maximum speed, while the sign computer is also continuously communicating with the signs.
- b. Meets the requirements of the specifications

Test equipment and supplies needed for the testing will not be paid for separately. The testing shall not present a danger to motorists nor give them misleading information.

The cost for on-site system integration services shall be included in the proposal on a per day basis, based on up to 30 days.

#### **6.0 SIGN TESTING**

All DMS furnished by the manufacturer shall be subject to testing and monitoring to determine conformance with all applicable requirements and to ensure proper operation of the equipment and subsystem. Test procedures shall be submitted to the MoDOT Engineer for review and approval within 4 weeks after award. MoDOT must approve the test procedures before testing is conducted. The manufacture shall provide at least 3 weeks notice of any planned field testing.

### **6.1 Factory Acceptance Testing**

The DMS factory test shall be held at the manufacturer's facility. The manufacturer shall provide all the necessary measurement devices, which can be utilized to verify that the assembly is compliant with the requirements. The test will be used to verify that the DMS conform to all of the specifications requirements. The manufacturer shall provide MoDOT at least 3 weeks advanced notice for the factory acceptance test. The factory acceptance test procedure shall be used for acceptance of all the DMS purchased from this proposal. The manufacturer's engineer shall sign the test procedure and initial and note the status of passed, failed or postponed for retesting on each sheet of the test procedure. If MoDOT is present at the factory acceptance test, they will initial each sheet as a witness. The manufacturer shall submit to MoDOT the original factory acceptance test checklist with each DMS that is shipped.

### **6.2 Field Delivery Acceptance Testing**

Upon delivery of the sign to the delivery sites as noted in the RFP, the manufacturer and a MoDOT representative shall conduct a visual inspection of the DMS to check for manufacturing and installation defects. The installation contractor may witness this testing if he or she chooses. MoDOT will provide electrical power to test the DMS. The test procedure shall be designed to determine if the DMS is operational, can display the pre-programmed messages and display new messages created on a laptop connected to the DMS in accordance with the specifications. This testing will also include the following:

- a. Run all diagnostic routines provided by the manufacturer.
- b. Determine proper operation of every pixel, including uniform brightness at all brightness levels and proper current consumption.
- c. Proper wiring of the display modules, checked by displaying a text message that identifies the modules proper row and column positions.
- d. Appropriate brightness for day and night conditions, and brightness from the sun at its worst condition for the location.
- e. Absence of leaks. This can be demonstrated by operating the blowers with the doors and exhaust vents closed to pressurize the sign enclosure, and checking for air bypassing the door or windows.
- f. Proper aiming of the display modules.
- g. Proper entry of memorized messages.
- h. Proper operation of sign monitoring.
- i. Proper operation of temperature sensors, blowers, defogging system, and lights.

- j. Proper grounding.
- k. Correct warning of sensors and alarms to the controller's inputs.
- l. Proper access and control using the laptop software provided in this project.

## **7.0 LAPTOP SOFTWARE**

The manufacturer shall provide laptop software that enables a technician to test all features and functions of the sign, and to set and change all of the sign's operating parameters in the field. The manufacturer shall provide MoDOT with the specifications for laptop computers that are needed to run this software. This software shall be delivered on a CD so that it can be installed on MoDOT's computers. The manufacturer shall provide the appropriate license and any dongles that may be required to use the software on up to 20 laptops. This cost shall be included in the proposal.

## **8.0 TESTING SIGN SIMULATOR**

The manufacturer shall provide eight copies of DMS simulator software that allows technicians to test DMS controller functionality. If the manufacturer does not have a DMS software simulator, a 10% scale replica of the actual DMS unit may be provided. The cost of this software or replica shall be included in the unit price of the DMS.

## **9.0 TRAINING**

**9.1 General Information** - Training shall be provided for MoDOT's engineering, maintenance and operations staff at facilities provided by MoDOT. The training shall include all material and manuals required for each participant.

At least 30 days prior to commencement of the training courses, the manufacturer shall submit detailed course curriculums, time requirements, draft handouts, and resumes of instructors. MoDOT will review and request modifications of that material as appropriate. The courses shall be conducted at a MoDOT provided location, and at a time and date mutually agreed upon by MoDOT and the manufacturer. The training material generated for each course shall contain manuals and other handouts for each attendee, which shall serve not only as subject guidance, but also as quick reference material for future use by the students. All course material, in reproducible form, shall be delivered to MoDOT immediately following course completion.

### **9.2 DMS Maintenance Training**

Two DMS maintenance training classes shall be provided by the manufacturer consisting of 12 hours of combined classroom and hands-on training time. The class locations are specified in the RFP. Each class will have up to twenty (20) maintenance personnel present with an electronics background. The training shall include operation instructions, theory of operation, circuit description, field adjustments, preventive maintenance procedures, troubleshooting, operation of diagnostic and configuration software (if applicable), and repair of components.

### **9.3 DMS Application Training**

The manufacturer shall provide two application training classes consisting of at least 6 hours of classroom training time. Each class will have up to twenty (20) engineering/operations personnel present. The training shall include a complete overview and details on the operations and capabilities of the DMS software. The training shall provide hands on demonstrations of the DMS application software. The training shall include at least an hour on the administrative features for the DMS software, i.e. assigning user access ID's, assigning and defining user access privileges for and control of DMS, assigning which DMS may be accessed by a user, etc. The location of the two training classes is specified in the RFP.

## **10.0 DOCUMENTATION AND WARRANTY**

### **10.1 Documentation and Drawings**

The manufacturer who is awarded the contract must provide MoDOT with five sets of complete shop drawings, subcomponent parts listing catalog cuts, schematics and maintenance manuals for each shipment of DMS's. Five DMS Central software manuals shall also be provided.

### **10.2 Warranty**

The complete DMS shall carry a two-year warranty from the date of acceptance against any imperfections in workmanship or materials. The central software shall also carry a two-year guarantee against defects. The manufacture shall provide free telephone technical assistance for DMS software users during this period. Any repairs made by the manufacturer or representative shall be documented and returned with units when warranty repaired. This documentation shall disclose exact repairs and identify the parts replaced by part number and serial number. All warranty repairs shall be completed within 30 days of delivery of the equipment to the designated repair depot.

## **11.0 ON-SITE DIAGNOSTICS AND REPAIR SERVICES**

The DMS manufacture shall provide on-site diagnostics and repair services to troubleshoot and repair reported problems with the DMS assemblies during the two year warranty period. The manufacturer representative must respond and be on-site within 8 hours after notification during weekdays. The response shall be by noon the next day for notifications received after hours during the week. For weekends and holidays the response shall be by noon the next workday. Repairs to the DMS that can be accomplished by replacement of defective parts shall be made on site on the same day of service. The time to complete repairs due to vandalism, accidents and other natural events will be determined on a case by case basis. The manufacture shall provide a contact name a phone number of the technical support technician(s).

Cost for technical support personnel shall be reimbursable on a time and materials basis and shall be included as line items in the proposal. The manufacture shall not be reimbursed for defective parts that are caused by imperfections in workmanship or materials. Replacement of parts that are damaged by accidents, acts of nature and vandalism will be reimbursable.

The DMS manufacture shall provide a spare parts price list that is valid for 3 years after the award of the contract.

## **12.0 SCHEDULE**

The manufacturer must submit with their proposal a delivery schedule that includes the shipment dates and delivery dates of the DMS, factory acceptance test, field test and training classes. The schedule must be updated if changes are made in the schedule.

In order to meet the delivery schedule requirements of the RFP, the manufacturer who is awarded the contract shall submit their submittal data within 7 calendar days after execution of the contract With MoDOT. MoDOT will review the submittal data and will provided comments or approval of the submittal within 5 calendar days after receipt of the submittal data.

## **13.0 BASIS OF PAYMENT**

Accepted dynamic message signs will be paid for at the unit or lump sum price for each of the pay items included in the contract. No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

## SCOPE OF WORK SECTION 2F

### **FUNCTIONAL SPECIFICATION FOR FULL MATRIX, FULL COLOR DYNAMIC MESSAGE SIGN SPECIFICATION C –OVERHEAD STRUCTURE MOUNT CONTROLLER HOUSING OUTSIDE OF THE SIGN- WALK-IN OR FRONT PANEL ACCESS**

#### **1.0 GENERAL**

#### **1.1 Description**

MoDOT has an **option** of purchasing and testing one full-matrix, full color and high resolution Dynamic Message Sign (DMS) at a location in St. Louis Metro Area

The DMS assembly shall include the DMS, horizontal structural brackets, mounting hardware, electrical distribution, surge suppression and all miscellaneous hardware and incidental components (including internal cables) required to deliver a fully operational subsystem. The entire assembly shall be housed in a fully wired aluminum weatherproof enclosure.

The assembly also includes a sign controller to be mounted in a cabinet (provided by others) near the sign. In most cases, the cabinet will be mounted on concrete pad within close proximity to the sign structure.

All portions of the DMS display shall be clearly visible and legible from in-vehicle viewing distances between 200 ft (61 m) and 1000 ft (305 m) under normal roadway operating conditions. The DMS assembly shall be designed to operate in roadway configurations at least three travel lanes wide in the same direction.

All DMS equipment components, modular assemblies, and other materials located in the DMS housing shall be removable, transportable, and capable of being installed by a single technician utilizing a catwalk to an access door. Structural members and components thereof are not included in this requirement.

The sign shall have a viewing cone of 30 degrees.

All components furnished under this functional specification shall be current production equipment and of recent manufacture.

#### **1.2 Manufacturer Qualifications**

The DMS manufacturer proposed to furnish this full matrix, full color and high resolution sign and controller shall have been in business continuously for a minimum of five years prior to the date of bid opening. Further, the proposed manufacturer shall have furnished Full color LED DMS systems for a minimum of three projects. The names, current

addresses and phone numbers of individuals who can certify satisfactory operation of signs meeting the above stated requirements shall be provided with the initial material submittal.

### **1.3 General Specifications**

The DMS housing shall provide walk-in service access for all LED display modules, electronics, environmental control equipment, air filters, wiring, and other internal DMS components.

The DMS shall be of the full matrix type. The matrix shall be a minimum of 36 pixels high (rows) by a minimum 105 pixels wide (columns). The pixels shall be spaced uniformly with the same spacing vertically and horizontally to the rows (i.e., no pitch or slant is allowed). The outside border around the DMS display shall be approximately 12 inches (305 mm).

Each display pixel shall be composed of multiple red, green, and blue LEDs. Other pixel technologies, such as fiber optic, flip disk, combination flip disk-fiber optic, combination flip disk-LED, liquid crystal, LED Lenses and incandescent lamp will not be accepted. The full display color must meet the current AASHTO and MUTCD Standard Specification Requirements.

The pixel matrix shall be capable of displaying alphanumeric 18”(460mm) high characters in accordance with the definition defined by NEMA TS 4Hardware Standards for Dynamic Message Signs Standards.

The DMS shall be able to display messages composed of any combination of alphanumeric text, punctuation symbols, and graphic images across multiple frames.

### **1.4 Manufacturer Contract Material, Manufacturing, and Design Standards**

The full matrix, full color and high resolution DMS must comply with the following standards. If no revision date is specified, the most recent revision of the standard applies:

- **General DMS Requirements** – The DMS must be designed in accordance with *NEMA Standards Publication TS-4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements*.
- **Aluminum Welding** – The DMS housing must be designed, fabricated, welded, and inspected in accordance with the latest revision of *ANSI/AWS D1.2 Structural Welding Code-Aluminum*.
- **Electrical Components** – High-voltage components and circuits (120 VAC and greater) must be designed, wired, and color-coded per the National Electric Code.

- **Environmental Resistance** – The DMS housing must be designed to comply with type 3R enclosure criteria as described in the latest revision of *NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum)*
- **Product Electrical Safety** – The DMS and all associated equipment and enclosures must be listed by the Underwriters Laboratories (UL) and will bear the UL mark on the outside of the DMS enclosure. DMS will be listed as conformant to *UL 48 Standard for Electric Signs* and *UL 50 Enclosures for Electrical Equipment*. Control equipment and enclosures shall be listed as conformant to *UL 1433 Standard for Control Centers for Changing Message Type Electric Signs*. Failure to meet conformance will be cause for rejection.
- **Radio Frequency Emissions** – All equipment must be designed in accordance with Federal Communications Commission (FCC) Part 15, Subpart B as a “Class A” digital device.
- **Maintenance Access and Safety** – The DMS equipment provided must be compliant with all relevant OSHA requirements. The DMS must be equipped with OSHA compliant safety rails and fall arrest system at each entrance location.
- **Optical Performance** – The LED display must be designed to comply with the NEMA TS-4, Section 5, and Display Properties.
- **Structural Integrity** – The DMS housing must be designed and constructed to comply with all applicable sections of *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, latest standards*, as well as the fatigue resistance requirements of *NCHRP Report 412, Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports*.
- **Communication Protocols** – The sign controller hardware/firmware and DMS control software must conform to the applicable National Transportation Communication for ITS Protocol (NTCIP) standards. Refer to the NTCIP section of this specification for detailed NTCIP requirements for this contract.

### 1.5 Item Identification

Manufacturer model numbers shall be permanently affixed on all replaceable components. The manufacturer shall supply an Excel spreadsheet in the current MoDOT format containing the manufacturer's name, device type (i.e., DMS), Location Identifier, model number, part number and serial number as separate fields.

### 1.6 Environmental

Except where otherwise specified, all components of the DMS assembly shall meet the temperature, humidity, vibration, and electrical of NEMA TS-4 hardware standards with the NTCIP requirements. The DMS components shall be capable of continuous operation in a salt-laden atmosphere without degradation of material surfaces or

performance.

### **1.7 Mechanical**

The total weight of the DMS assembly shall not exceed 4500 lb (2050 kg).

### **1.8 Electrical**

The presence of ambient radio signals, magnetic or electromagnetic interference, including those from power lines, transformers, or motors within 1 ft (0.3 m) of any components of the system, shall not impair the performance of the system. The system shall not radiate any electrical or electromagnetic signals that could adversely affect any other electrical or electronic device.

All system electronics shall be 100 percent solid state technology with the exception of the ventilation fans.

All high voltage (exceeding 24 Volts DC) components used in the sign shall be UL listed.

## **2.0 DYNAMIC MESSAGE SIGN COMPONENTS**

### **2.1 DISPLAY ELECTRONICS**

#### **2.1.1 Driver Circuitry**

The driver circuitry shall be able to detect abnormal current values, including short circuits and open circuits, while a single pixel is being illuminated. The state of the LED's (on or off) in each pixel of the sign shall be read by the sign controller so it can report the actual message, including static, flashing and alternating messages, that is visibly displayed on the sign in a WYSIWYG format. This pixel read shall take place while a message is displayed on the sign without disturbing the message in any way and will include any half-out, full-out, half stuck on or fully stuck on pixels. Any flashing, flickering, blinking, dimming, or other disturbance of the message during this pixel status read shall be cause for rejection of the sign.

#### **2.1.2 Brightness Control**

Pulsed drive current shall be used at the maximum brightness level. Pulse Width Modulation (PWM) shall be used to dim the sign to achieve the proper brightness level for a given ambient light condition. As part of the shop drawing submittal, a complete schematic of the LED power and driver circuits shall be provided for review by the Engineer. Multiplexing of the LED's shall not be allowed.

The DMS shall have photocells that detect when the sun is directly in front of the DMS

or directly behind it. Those photocells, or a separate photocell, shall also distinguish night from day. These photocells shall not be affected by man-made light sources, such as highway lighting and/or headlights. They shall be easily accessible for maintenance.

### **2.1.3 Temperature Control**

The DMS shall be designed so that the air temperature on the back side of the display modules never exceeds 140 degrees F (60 degrees C). A thermostat located in the middle of the top line of display modules shall shut down the LED display if the temperature rises above 140 degrees F (60 degrees C) and restore power when the temperature has dropped to 120 degrees F (50 degrees C). This shall be independent of the controller.

The sign shall also have one or more temperature sensors that report the sign temperature to the sign controller, which shall in turn report the temperature to the central software.

The sign shall have a remote bulb thermometer located just inside the door of the sign. The thermometer's temperature sensor shall be at the same location as the thermostat, so that a technician can readily determine whether the thermostat is operating properly.

### **2.1.4 DMS Power Supplies**

The maximum operating temperature of all power supplies shall be at least 150 degrees F (65 degrees C). All regulated power supplies shall have a minimum power factor of 0.95.

The LED display modules shall be operated at low internal DC voltage not exceeding 24 Volts.

The power supplies shall be short circuit protected by DC power OFF, and shall reset automatically after 5 seconds of AC power OFF. The power supplies shall also be protected by a suitable inrush current allowance to be recommended by the manufacturer and approved by the Engineer.

The power supplies shall have an efficiency rating of at least 75 percent.

### **2.1.5 LED Pixels**

The pixels shall be made up of a mix of the primary colors - Red, Green and Blue LED's. Pixel pitch shall be 66mm vertical and horizontal. Pixels shall be able to display 24 bit RGB color.

The luminance intensity of the pixel shall meet or exceed the luminance intensity requirements of Section 5.4 within NEMA TS 4-2005.

The chromaticity limits and classifications of the pixel shall meet the requirements of Section 5.5 within NEMA TS 4-2005.

The Cone of Vision Type Classification of the display shall be type class “e” as defined and specified within Section 5.3 of NEMA TS 4-2005.

### **3.0 ENCLOSURE**

The DMS enclosure shall be a weatherproof walk-in type enclosure that houses all electrical, communication, and electronic control devices necessary for the operation of the DMS. Permanent lifting angles or lugs shall be attached to the DMS enclosure for moving and mounting. A shelf or workbench shall be provided inside the enclosure for a notebook computer and related equipment.

#### **3.1 Structural Performance**

The structural design of the LED DMS enclosure shall conform to current AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*. Additional design criteria are as follows:

- Wind Velocity = 80 mph (130 kilometers per hour)
- Gust Factor = 1.3

The performance and stability of the sign shall not be impaired due to vibration, wind, vacuum pressure, and/or other normally encountered forces created by the effects of traffic. The shop drawing submittal shall include structural design calculations for the enclosure, signed and stamped by a registered professional engineer in the state of Missouri. Include calculations demonstrating that wind gusts cannot cause the glazing to detach from the sign nor to contact the display modules.

#### **3.2 Dimensions**

The nominal dimensions of the sign enclosure shall be approximately 26 ft (8 m) in width x 10 ft (3.1 m) in height x 3 ½ ft (1.06 m) deep (this depth is only for walk-in service access).

#### **3.3 Material**

The DMS enclosure shall be assembled from a continuously welded aluminum alloy 3003-H14 or 5052-H34 skin of at least 1/8 inch (3.5 mm thick). The enclosure shall not have sharp edges or corners and the inside and outside edges shall be free of burrs. Internal supports shall be of extruded aluminum alloy 6061-T6 members welded to form a support structure to provide rigidity and structural integrity. All metallic parts shall be corrosion resistant.

The DMS case and facial area shall be treated with a flat-black, factory-applied, Kynar flouropolymer resin based coating providing a minimum life span of 10 years. As part of

the shop drawing submittal, the manufacturer may propose an alternate means of protecting the metal surfaces. Such alternates shall be subject to the approval of MoDOT.

### **3.4 Welding**

The DMS housing shall be fabricated, welded and inspected in accordance with the requirements of ANSI/WS D1.2-90 Structural Welding Code-Aluminum (1990). Compliance with this requirement shall include, but is not limited to:

All manufacturing personnel who perform welding on the DMS housing shall be certified to AWS D1.2-90 for all weld types required for housing fabrication. The DMS manufacturer's submittal shall contain a copy of each welder's certification and the manufacturer's certified welding procedures.

DMS housing welding shall be inspected on a daily basis by a Certified Welding Inspector (CWI), who shall complete daily written reports on DMS welding progress, housing weld integrity, and any corrective action taken. These reports shall be archived by the DMS manufacturer and shall be available for immediate review upon request by the Engineer.

### **3.5 Access Door**

Access to the interior of the sign enclosure shall be via a gasketed door measuring 75 inches (1905 mm) x 30 inches (762 mm) minimum. The door shall open outward onto a walkway and be located on the right or non-roadway side of the enclosure with the hinge toward the front or sign face of the sign.

Gaskets shall be provided on all door openings and shall be dust-tight. Gaskets shall be a minimum of ¼ inch (6 mm) thick closed cell neoprene and shall be permanently bonded to the metal. A gasket top channel shall be provided to support the top gasket on the door in order to prevent gasket gravitational fatigue.

The latching mechanism shall be a three point draw roller type. The pushrods shall be turned edgewise at the outward supports and have a minimum cross section of ¼ inch (6 mm) thick x ¾ inch (19 mm) wide. The mechanism shall have handles inside and outside the sign. A door hasp shall be provided to secure the door and it shall accommodate a ¼ inch (19mm) shank lock.

The door shall be provided with a catch mechanism to hold the door open at 90 degrees in a 60 mph (100 kph) wind acting at an angle perpendicular to the plane of the door.

### **3.6 Walkway and Ladder**

In case of Walk-In access, the DMS enclosure shall have an interior, nonskid walkway that extends the entire length of the sign enclosure. The walkway shall be free of obstructions and shall be at least 28 inch (711 mm) wide and provide minimum headroom

of 75 inch (1905 mm) throughout the length of the enclosure. The interior walkway shall have removable panels for access to the space below the walkway.

The interior walkway shall be capable of supporting a concentrated load of 500 pounds per square foot at any location, and a total load of 1000 pounds within any 10 foot section of the walkway.

The DMS enclosure shall be equipped with a non-conductive ladder which is suitable for safely servicing the upper lines of the sign and shall automatically lock in place when in use. A latching system shall be provided which will allow the ladder to be securely stored within the sign enclosure when it is not in use.

### **3.7 Ventilation**

The DMS enclosure ventilation shall include intake, exhaust, filtration, fan assembly and environmental control. Adequate ventilation shall be provided to allow climate control for DMS service technicians.

Vents shall be screened to keep out rodents and insects. The number and size of the vents shall be determined by the manufacturer to be of sufficient size to provide adequate ventilation. Intake vents shall use motorized louvers to prevent the entry of dirt and insects when the ventilation system does not require outside air. The exhaust vents shall be equipped with dampers for the same purpose. The intake vents shall be located to prevent the direct intake of truck exhaust.

A removable two stage air filter system shall be installed behind each intake vent. The filter filtration area shall completely cover the vent opening area such that no incoming air bypasses the filter. Brackets shall support the filter at the vents and be located to facilitate easy replacement.

The DMS enclosure shall be equipped with electric fans with ball or roller bearings. The capacity of each fan and the number of fans shall be sufficient to insure adequate ventilation if one fan becomes inoperable. An analysis shall be presented in the submittal material which shall document that the proposed system meets these requirements. The fans shall be mounted within the housing and vented. The number, placement, and size of the electric fans shall be determined by the manufacturer.

The fans shall be controlled by the DMS controller or a thermostat. If the fans are controlled by the DMS controller, there shall be parameters in the controller's database which will specify the turn-on temperature and the shut-down temperature. Both parameters shall be in the range of 70 degrees (20 degrees C) to 120 degrees F (48 degrees C).

The DMS shall have a window defogging system that is turned on and off by the DMS controller or a thermostat. The system shall use heated air blown on the inside of the windows. Heating strips on the windows or frames shall not be acceptable. The

defogging system shall be capable of removing all condensation from a completely fogged window within five minutes.

## **4.0 ELECTRICAL SERVICE**

### **4.1 Electrical Distribution Panel**

The primary electrical service panel shall be rated for 120/240 VAC, single phase, 3 wire and 100 amperes maximum with a 2 pole main circuit breaker and a 1 pole circuit breaker for each branch circuit and a copper ground bus. The panel shall have an interrupt rating of not less than 10 KA. The panel shall be General Electric Model AQF1121AB or AQF1121AT or an equivalent approved by MoDOT. Separate circuits shall be provided for the utility outlets. 120 VAC load shall be balanced. Incoming terminals shall be capable of a conductor range from 8 AWG (10 mm<sup>2</sup>) to a 4/0 AWG (120 mm<sup>2</sup>).

### **4.2 Radio Interference and Surge Protection**

Surge protection shall be provided on all ungrounded conductors leaving the sign housing. All devices shall be readily accessible for ease of replacement.

A two-stage surge protector and radio interference filter shall be on all incoming power lines. The two stages shall be electrically separate, so that the first stage protects all equipment using the power, while both the first and second stages protect electronic equipment. There shall be no maximum load for the first stage. The second stage shall be capable of protecting equipment drawing a total of 10 amps. The protector shall clamp both the main line and the main neutral at 250 volts, both relative to each other and relative to the cabinet ground. The response time shall be such that the actual voltage never exceeds 250 volts. The surge protector shall suppress surges of up to 20,000 amps (8 x 20 microsecond waveform). The clamping voltage shall change by no more than five percent after 20 such surges.

For each conductor used for communication and control, provide surge protection in the sign. Furnish a cable termination panel with surge protectors that match those in the sign, which the installation contractor can install in the cabinet along with the sign controller.

### **4.3 DMS Enclosure Interior Lighting**

In case of Walk-In Access, the DMS enclosure shall be equipped with a switch controlled set of at least five fluorescent light fixtures equipped with cold weather ballast (0 degrees F (-18 degrees C) minimum). The light switch shall be located near the entry door on the side opposite from the door hinges. The fixtures shall be complete with a guard. Each fixture shall have a 40-watt four-foot fluorescent lamp. The fixtures shall be equally spaced.

### **4.4 Utility Outlets**

The DMS enclosure shall be equipped with three, 20 amp, 120 VAC duplex (NEMA 5-20R) receptacles. These outlets shall be protected by ground-fault, circuit-interrupters. Two receptacles shall be located approximately three feet (1 m) from each end, and one receptacle shall be located in the center of the DMS enclosure. These are in addition to any outlets used by the equipment provided by the sign manufacturer.

#### **4.5 Conduit and Wiring**

All lighting and receptacle circuits shall use at least 12 AWG (4 mm<sup>2</sup>) wiring enclosed in thin wall metallic conduit.

### **5.0 CONTROLLER**

Furnish a sign controller for the installation contractor to install in an equipment cabinet near the sign. The sign controller installed in said cabinet shall provide full local control of the sign. The controller must have sufficient memory and processing power to perform all the functions described in the specifications, including full functionality of the service software. Sign controller shall be a 19 inch rack mountable and have a 15 inch maximum depth.

#### **5.1 Watchdog Timer**

The controller shall have a watchdog circuitry that automatically resets the controller when it locks up. There shall be a means for the controller to recognize and report the fact that it was reset by the watchdog timer.

#### **5.2 Memory**

The controller shall have nonvolatile memory. This memory shall contain the software and test messages.

The controller shall also have changeable memory that retains the data in memory for a minimum of one year following a power failure. It shall contain the library of messages, the message display schedule and changeable operating parameters.

#### **5.3 Clock**

The controller shall have a time-of-year clock with a lithium battery backup. The battery shall keep the clock operating properly for at least 10 years without external power. The clock shall automatically adjust for daylight savings time and leap year through hardware, software or a combination of both. It shall be set by the sign controller's microprocessor. The clock shall be accurate to within 1 minute per month.

#### **5.4 Communication Interfaces**

Communication between the central computer and the sign shall be by TCP or UDP Internet Protocol over Ethernet, so the controller must be IP addressable with an Ethernet port for this purpose.

The controller shall also have at an EIA-232 communication port for communication with a technician's laptop computer connected directly to the controller. The port shall be capable of operation at all standard data rates up to 19,200 bits per second and shall be set to 9600 bits per second.

In addition, the controller shall have communication interfaces with the equipment in the sign, for such things as sign control, temperature monitoring, and brightness adjustment.

## **6.0 CONTROLLER SOFTWARE**

### **6.1 Display Presentation**

The DMS controller shall control the driver modules in such a way as to create the desired display on the sign.

Messages shall be communicated and stored using the Markup Language for Transportation Information (MULTI), as defined in the most recently adopted edition of the NTCIP Standard 1203, National Transportation Communications for ITS Protocol (NTCIP) Object Definitions for Dynamic Message Signs (DMS). The sign's method of operation must be consistent with that standard.

Space allocated to each character shall be proportional to the character's true width. Software shall handle such details as centering text on a line, right justification, left justification, and appropriate spacing of letters and words. Software shall also control flash, and alternating between pages of a two and three-page display.

There shall be a default value for each parameter supported. The manufacturer shall pre-load these default parameters with values approved by the Engineer.

### **6.2 Modes of operation**

Signs shall be able to display a static message, a flashing message, or a multipage message as described below.

- **Static message:** The message chosen shall be displayed constantly on the sign face until the sign controller is instructed to do otherwise.
- **Flashing message:** A selected portion of the chosen message shall be displayed and blanked alternately at durations controllable in one second increments.

- **Multipage messages:** The chosen message shall display up to three different pages (each page consisting of up to four lines of text) alternately at durations separately controllable in one second increments.

### **6.3 Fonts**

A user shall be able to create and display messages using at least four fonts, each stored in the controller. Two of the fonts shall be stored in the controller by the manufacturer. Provide a font comparable to that shown in Figure 7-1 of Federal Highway Administration publication # FHWA-TS-90-043 or current Federal Highway Administration publications and NTCIP Standards. Also, provide a similar bold font. The user shall be able to create at least two additional fonts, download them to the controller, and store them there.

### **6.4 Display Selection**

In the absence of instructions to the contrary from the control ports, the controller shall implement a display selected from those stored in its memory based upon date and time as specified in the schedule. It shall use a schedule stored in random access memory plus its time-of-year clock to select the proper display. The schedule system shall permit different schedules for different days of the week plus special schedules for special days, such as holidays.

The display of the scheduled message may be over-ridden by instructions sent from the control ports. A computer shall be able to cause the controller to implement a particular display selected from the messages stored in its memory, or a new display sent from the computer using MULTI. The computer shall also be able to edit or completely replace a message stored in the controller's memory, or revise the message schedule. In addition, it shall be able to cause the controller to report its schedule or the text of any message stored in its memory.

Software shall incorporate fail-safe procedures to check messages received and shall not change a message stored in memory, the display currently on the sign, the schedule stored in memory, or the current time unless the message is received correctly and constitutes a valid command.

### **6.5 Schedule Operation**

The schedule is activated by activating a message (i.e., setting an object with the syntax of MessageActivationCode or MessageIDCode) with the dmsMessageMemoryType set to schedule(6), the dmsMessageNumber set to 1, and the dmsMessageCRC set to 0x00 00 (and a sufficiently high activation priority if it is a MessageActivationCode object).

During schedule operation, the run-time priority applies to the operation of the schedule and the run-time priority of the referenced message is ignored. Thus, the run-time priority is

constant for all scheduled messages and the central system can set this priority by modifying the value of `dmsRunTimePriority`.6.1.

The values of `dmsMessageMultiString`.6.1, `dmsMessageBeacon`.6.1, and `dmsMessagePixelService`.6.1 are copied from the message called by the most recently called action and thus reflect the most recently called message that would be called by the scheduler whether or not the scheduler is running.

The activation priority of any scheduled message shall be 200 in the absence of a potential future object to specifically set this value.

One may activate the schedule for a defined duration by setting the duration in the activation code.

To get the scheduler to blank the sign, a blank message must be scheduled.

## **6.6 Brightness Control**

Manual and automatic dimming modes shall be provided, enabling the user to select the desired mode of operation. The dimming system shall select one of several levels from the sensed ambient light. The set points for each of the ambient light levels shall be set by the user via software. A user shall be able to send a command via the control ports to select a specific brightness level or to direct the controller to select an appropriate brightness based on current lighting conditions.

For each brightness level, a technician shall be able to easily determine what fraction of the full brightness current is applied to the LED's. The technician must be able to set the current value for a given brightness level to any value between 25% and 100% of the maximum current in five percent increments, and must be able to easily change these settings via computer commands.

## **6.7 Communication**

Controller hardware and software shall permit the communication with the central computer using polled operation, in which the sign controller informs the central computer of its current status in response to a query from the central computer. The sign controller never communicates except when polled.

The controller shall be able to receive commands simultaneously over both ports (one for the central computer and one for a laptop), process the commands in the order received, and respond to each command only via the port on which it was received.

## **6.8 Diagnostic Test**

Upon command, the controller shall test all systems, including but not limited to the electrical operation of all drivers and check for over current and under current pixels,

photocells, ventilation, and displays. It shall communicate the result to the computer that issued the command using an NTCIP compliant method.

## 6.9 Power Interruptions

The contents of the controller's memory shall be preserved by battery power during power interruptions, and the controller shall resume operation automatically when power is restored. Upon recovering from a power interruption, the controller shall report to the central computer that it has just recovered from a power interruption. It shall also consult a configuration parameter set by the user to determine whether to blank its display or to display the message that it would have been displaying if no power failure had occurred. There shall be separate configuration parameters for long and short power failures, as well as a parameter specifying the maximum duration of a power failure classified as short.

## 6.10 Test Messages

Test messages shall be stored in the controller's permanent memory. The test messages shall be functionally equivalent to the following:

- **All pixels on simultaneously.** This is to determine whether there are pixels or display modules that are not the same brightness as the rest.
- **Each module shows a unique display indicating which row and column it is in.** This test display is to determine whether any module is displaying what a different module should be displaying.
- **A display that alternates the two previous displays** at approximately ten second intervals. This is to enable an observer to identify which display module has a brightness problem.
- **A display that illuminates every pixel, one at a time,** in rapid succession. This is to be used in conjunction with the current sensors to automatically test each pixel for abnormal current consumption.
- **One display for each font,** showing every character composing the font.

The test messages shall include any other displays required to carry out the manufacturer's recommended procedures for maintenance and troubleshooting.

## 6.11 Watchdog Timer Interface

The software shall regularly reset the watchdog timer so that it does not inappropriately reset the controller. When it starts operating, the software shall check the status of the watchdog timer and, if the timer indicates that it reset the controller, the controller shall report that fact to the central computer.

## 6.12 Temperature Monitoring

Via the communication ports, a user shall be able to set a temperature threshold. When the highest temperature reported by the temperature sensors in the sign exceeds this threshold, the controller shall issue a temperature warning to the central computer.

### **6.13 NTCIP Requirements**

The controller shall communicate using current NTCIP Standards. Supply full documentation of all manufacturer-specific objects supported by the sign controller. This shall be in the form of an electronic file containing ASCII versions of a MIB in ASN.1 format. The MIB shall contain accurate and meaningful description fields and supported ranges indicated in the syntax field of the object-type macros. The Department shall have the right to use the documentation described above for system integration purposes, regardless of what parties are involved in the system integration effort.

The controller must adhere to the version of the following standards that is current at the time of bidding. A later version may be used if approved by the Engineer.

#### **Information level:**

The following objects defined in NTCIP 1201:

- All objects in the Global Configuration Node.
- The following objects in the Global Time Management Node: globalTime; globalDaylightSaving; maxTimeBaseScheduleEntries; timeBaseScheduleTable; maxDayPlans; maxDayPlanEvents; timeBaseDayPlanTable.
- All objects in the Report Parameters Node.
- All objects in the PMPP Object Node.

NTCIP 1203, including all mandatory objects of the following optional conformance groups:

- dms Sign Configuration
- Font Configuration
- MULTI Configuration
- Default Message
- MULTI Error
- Illumination/Brightness
- Scheduling
- Auxiliary I/O
- Sign Status
- Status Error
- Pixel Error Status

Software shall also implement the following optional objects as defined in NTCIP 1201:

- eventConfigLogOID

- eventConfigAction
- eventClassDescription

Software shall also implement the following optional objects as defined in NTCIP 1203:

- dmsIllumLightOutputStatus
- watchdog-Failure-Count
- tempMaxSignHousing

The standardized range is defined by the size, range, or enumerated listing indicated in the object's syntax and/or through description text in the object's description field of the relevant standard. Every object required by these specifications shall support all values within its standardized range except:

OBJECT	MINIMUM PROJECT REQUIREMENTS
Max Time Base Schedule Entries	28
Max Day Plans	14
Max Day Plan Events	12
Max Event Log Configurations	50
Event Configuration Mode	2, 3, and 4
Max Event Log Size	200
Max Event Classes	16
Max Group Address	1
Number Fonts	4
Max. Font Characters	100
Number Action Table Entries	Equal to message capacity of sign

The module table required by Clause 2.2.3 of NTCIP 1201 shall contain at least one row with module Type equal to 3 (software).

Displaying a blank sign shall be achieved in the same way that any message is displayed (i.e., by using an object that has a syntax of either MessageActivationCode or

MessageIDCode). However, a new memory type, dmsMessageMemoryType equal to 'blank (7)', shall be created to support this operation. It shall function as follows:

- The dmsMessageNumber for this memory type shall be reflective of the RunTime Priority and shall be between 1 and 255, inclusive.
- The CRC for this memory type shall be 0x00 00 and the normal CRC algorithm shall not be applied to blank messages.
- The dmsMessageMultiString shall be an octet string of length 0.
- The activate priority for any MessageActivationCode using this type of memory shall be used as the actual activation priority.

The software shall implement the following tags (opening and closing where defined) of MULTI as defined in NTCIP 1203

- Fields for 12 hour time, day of month, month, and four digit year
- Flash
- Font
- Justification Line
- Justification Page
- Moving Text
- New Line
- New Page
- Page Time
- Hexadecimal Character

**Application level:** NTCIP Standard 1101, Conformance Level 1.

**Transport level:** NTCIP 2202.

**Subnetwork level:** NTCIP 2104

## 7.0 SIGN TESTING

All DMS components and assemblies furnished by the manufacturer shall be subject to testing and monitoring to determine conformance with all applicable requirements and to ensure proper operation of the equipment and subsystem.

Test procedures shall be submitted to the MoDOT Engineer for review and approval prior to conducting any testing.

### 7.1 Factory Testing

The DMS subsystem factory test shall be held at the manufacturer's facility. The manufacturer shall provide all the necessary measurement devices which can be utilized to

verify that the assembly is compliant with the requirements.

## **7.2 Field Testing**

Upon delivery of the sign to the jobsite, the manufacturer and a MoDOT representative shall conduct a visual inspection of the DMS to check for manufacturing and installation defects. The installation contractor may witness this testing if he or she chooses. The DMS shall be powered during this preliminary inspection. Provide a generator and all necessary power and communication cables. The test procedure shall be designed to uncover manufacturing and installation defects of all types. Among the aspects that must be tested are the following:

- All diagnostic routines provided by the manufacturer.
- Proper operation of every pixel, including uniform brightness at all brightness levels and proper current consumption.
- Proper wiring of the display modules, checked by displaying a text message that identifies the modules proper row and column positions.
- Appropriate brightness for day and night conditions and brightness from the sun at its worst condition for the location.
- Absence of leaks. This can be demonstrated by operating the blowers with the doors and exhaust vents closed to pressurize the sign enclosure, and checking for air bypassing the door or windows.
- Proper aiming of the display modules.
- Proper entry of memorized messages.
- Proper operation of sign monitoring.
- Proper operation of temperature sensors, blowers, defogging system, and lights.
- Proper grounding.
- Correct warning of sensors and alarms to the controller's inputs.
- Proper remote access and control using the central and laptop software provided in this project.

## **8.0 CENTRAL SIGN CONTROL SOFTWARE**

### **8.1 General**

This software shall enable a user to easily monitor and control not only the signs purchased under this procurement.

MoDOT will provide the computers, complete with operating systems, for this software. Provide MoDOT with a specification for the computers and operating system that MoDOT should supply.

The central software should enable multiple users to monitor and control the signs from workstations both local to the sign, and also from a remote office location.

### **8.2 Off Line Status**

A user at the sign server or a workstation shall be able to take a sign off line, causing it to be ignored by the sign computer. This will be used when a malfunctioning sign is generating an excessive number of alarms. When a user attempts to control an off line sign, a message shall appear on his screen informing him that the sign is out of service. When a user takes a sign off line, the software shall ask the user to type in a comment of up to 100 characters explaining the action. The comment field may be left blank. The computer shall also record the user's name, based on his password, and include the name and comment in the failure report described below.

### **8.3 Message Library**

The sign server shall store a library of at least 999 messages on its hard disk. In addition to the message text, the file shall contain all the MULTI control codes needed for a sign to properly display the message

When adding a message to the library, a user shall specify the message name. If a message with the same name already exists in the library, the software shall notify the user and give him the options of replacing the existing file or selecting a new name for the message he has just created. A user shall also be able to delete library messages from within the program. The program shall ask the user to confirm each message deletion before actually deleting the file.

If the user is seeking a message to display, the software shall present a list so that the user can choose one. When the user makes his selection, the software shall display the entire message, exactly as it would appear on a sign, and shall ask the user to confirm that this is the message desired. The user shall then be able to post the message on one or more signs, edit the message, or do nothing with it.

### **8.4 Sign Control**

Future signs may have different line lengths and heights (measured in pixels) than the signs provided in this project, and may have more or fewer lines. The software shall display messages as a matrix of dots that replicate the way the message will actually appear on a selected sign. The presentation should be based on the number of lines on the sign and the height and width (in pixels) of the lines, as stored in a data base maintained by the sign computer. This type of display will be used during message creation and editing, as well as when displaying to a user the message currently on a sign. If the user is displaying a message from the library or creating a message without specifying what sign it will go on, the display shall be based on the characteristics of the signs provided in this project.

Upon creating or revising a message, the user shall be able to save it in the message library on the sign computer's hard disk or send it directly to one or more DMS controllers for storage or display.

When a user sends a message to one or more signs, the sign computer shall automatically check to be sure that the message will fit on the sign. This checking shall take into account

the selected fonts and the size of the sign's display. If the message won't fit, the computer shall alert the user and not post the message.

If a user chooses to send the same message to multiple signs, the software shall present the user with a list of all signs, so that the user can check off which signs the new message goes to. The screen shall also give the user a choice of "All Signs". The list shall identify signs by roadway and mile post. Using a single command, the user shall be able to cause the message to be stored in all the signs he specified, replacing those previously stored in the controllers. Similarly, the user shall be able to use a single command to have all the selected signs display the same message, or the same message number.

In addition to entering commands for immediate execution, a user may store commands in the sign computer for future execution. For example, the user may want to conduct a pixel test of every sign each night at 3:00 AM. A user shall be able to quickly and easily create, modify, suspend, or cancel a schedule of commands for the sign computer to issue to specified DMS controllers. The user shall be able to specify the same action at the same time for multiple signs, in the same way as was described in the preceding paragraph. A user shall also be able to schedule the printing of sign-related reports. A user shall not be able to schedule any command that he does not have the privilege to execute directly. The schedule shall show the name of the user who scheduled each command, based on his password. Actions that would be recorded in the event log if a user commanded them directly shall also be logged when they result from a scheduled command. The record shall include the user's name and an indication that the command was scheduled.

The software shall provide a single command that not only transmits a message to a sign (after confirming that it fits) but also causes the sign to immediately display that message on the sign (after confirming that the transmission was error free).

## 8.5 Status Monitoring

The sign server shall maintain an event log file on its hard disk with a record for each appearance or disappearance of an alarm from a DMS controller or sign. The file shall be in ASCII format with fixed-length fields separated by spaces, suitable for transfer to spreadsheet and data base management software. The record shall include the date, time, sign id, and nature of the change. If the alarm indicates a change in the sign display, the log shall include the exact text of the message, the device from which it was commanded, and, if commanded via the sign computer, the name of the person posting the message, based on his password. The log file shall include this same information each time a message is downloaded to a sign's memory from the sign computer.

The log shall also record each time a user at a workstation or the sign computer does the following:

- Changes the priority of a message.
- Changes the schedule.
- Changes a message in the library on the computer's hard disk.

The record shall include the user's name based on his password.

The log shall also record the beginning and end of communication failures. The sign computer shall deem a communication failure to have occurred if it does not get an error-free response to two consecutive commands to a controller. The computer shall deem a controller recovered if it responds properly to a command.

## 8.6 Reports

The system shall provide the following reports to the user's screen, a disk file named by the user, or to the printer, as specified by the user:

- **Equipment Failures.** Lists each sign that is currently malfunctioning, along with the time and date of failure and a phrase indicating the nature of the problem. Also lists each DMS controller that is off line, along with the date and time it was taken off line, the comment written by the user who took it off line, and the user's name based on his password.
- **Sign System Configuration.** Lists the current values of all configuration parameters stored in the sign computer, clearly labeled. It includes such things as communication line and drop assignments. It does not include operating parameters stored in the DMS controllers.
- **Individual Sign Configuration.** Lists the current values of all changeable parameters stored in a DMS controller, clearly labeled. It includes such things as temperature thresholds. This report shall cover all signs, or a particular sign, as specified by the user. The information displayed shall be uploaded from the DMS controllers at the time the report is requested. If the sign computer is unable to upload the data from a particular sign, it shall use the corresponding data on its hard disk, but shall indicate in the report that the data is from the hard disk and may not be current.
- **Current Sign Status.** Lists sign location, text of message currently displayed, whether it is an emergency message (new signs only), whether the message has priority status (new signs only), storage location of the

message in the sign's memory, entity that caused the message to be displayed (new signs only), and controller status (failed, working, or off line) for each sign in the system. This report shall cover all signs, or a particular sign, as specified by the user. If the report covers multiple signs, the signs shall be grouped by roadway and listed in the order in which a motorist would see them.

- **Event Log.** Lists all information in the event log file, with each field clearly labeled. The user shall be able to specify that only events between certain times, or pertaining to a certain sign, or pertaining to a certain type of event, or any combination of the foregoing, shall be included in the report. Events shall be listed chronologically.
- **Message Library.** Lists the text of each frame of each message in the message library, along with the duration for which the frame is displayed. Also lists the message's file name and latest revision date. Each frame shall be displayed in the report in the same way it would appear on a sign, with regard to text centering, bolding, and justification. Flashing text shall be underlined. Messages shall be grouped by subdirectory, and a user shall be able to specify that only certain subdirectories be included.
- **Sign Server Schedule.** Lists all information in the sign server's schedule, clearly labeled. The user shall be able to specify that only events between certain times, or pertaining to a certain sign, or pertaining to a certain type of event, or any combination of the foregoing, shall be included in the report. Events shall be listed chronologically.
- **Sign Memory.** Lists sign ID and location and the text of each message stored in the sign. The message portion of the report shall indicate the message's memory location number and shall display the text of each frame of the message, along with the duration for which the frame is displayed. Each frame shall be displayed in the report in the same way it would appear on a sign, with regard to text centering, bolding, and justification. Flashing text shall be underlined. All information shall be clearly labeled. The user shall be able to specify that the report cover only a particular sign, or all signs. The information displayed shall be uploaded from the DMS controllers at the time the report is requested. If the sign computer is unable to upload the data from a particular sign, it shall use the corresponding data on its hard disk, but shall indicate in the report that the data is from the hard disk and may not be current.
- **Bad Pixel Maps.** Consist of a matrix display indicating which display elements of a sign have failed, according to the DMS controller. The user shall be able to specify that the report cover only a particular sign or all signs with display problems. If the user specifies all signs with display problems, the report will cover all signs whose controllers are currently reporting malfunctioning drivers or display elements.

The time and date for which the information is current shall appear on every page of each printed report. All pages shall be numbered.

## **8.7 Alarms**

The sign computer shall issue alarms by beeping and displaying a message clearly identifying the problem in a prominent box that pops up on the user's screen. The box shall disappear when the user clicks on it and the beeping shall stop. If the alarm is of the type called "recurring", the beeping and screen message recur every 15 minutes as long as the condition persists. The sign computer shall issue a single alarm for the following situations:

- A new sign failure.

- The sign computer is unable to change a sign's display as scheduled because the currently displayed message has priority status.

A sign computer shall issue a repetitive alarm if its hard disk is over 90 percent full.

## **8.8 Timekeeping**

The software shall track and displays the current date and time, and shall automatically adjust for standard and daylight savings time without operator intervention.

## **8.9 Password Protection**

Only users, who have proper authorization, as indicated by their passwords, shall be able to undertake the following actions:

- Place equipment on standby.
- Change sign messages, blank signs, and change message priority.
- Replace or delete messages stored in a DMS controller's memory.
- Display test patterns on a sign.
- Change or delete the sign computer's schedule.
- Modify the message library on the sign computer's hard disk.
- Change sign configuration parameters.
- Delete the event log.
- View passwords.
- Change passwords and privileges.

Users may be granted or denied permission to use each protected command independently. Via an encrypted lookup table, the server shall determine which of the protected commands a user may use.

The software shall ask the user for his password at the time the protected command is entered. The computer shall not carry out these commands unless the user has the proper privileges.

## **8.10 User Interface**

The sign control software shall provide a graphical user interface with a GPS coordinate map of the signs. The user shall enter commands by selecting the sign icons and various menu options. The user shall make selections from menus and from lists of signs, messages, and options using a mouse. The interface shall be easy to use, minimizing memorization and opportunities for errors. The interface shall automatically check

commands for out-of-range values and other errors. When it checks an error, it shall beep, reject the command or data, and provide the user with a clear explanation.

The software shall have the complete text of the software operator's manual stored on disk, readily available to the user.

### **8.11 Testing**

The purpose of the sign computer software test is to demonstrate that the software operates reliably and is in full compliance with the specifications. The Contractor shall conduct the tests following the approved test plan but, if practical, shall also perform any supplemental tests requested by the MoDOT's representatives at the time of testing. To be accepted, the software must pass all the tests.

The test plan shall test every interface, feature, and function of the software, including features present but not required by these specifications. The testing shall demonstrate that the software does the following:

- Operates properly when multiply workstations are simultaneously sending the DMS controller commands and data at maximum speed.
- Deals appropriately with communication errors and operator errors.

Test equipment and supplies needed for the testing are part of testing and will not be paid separately.

The testing shall not present a danger to motorists nor give them misleading information.

## **9.0 TECHNICIAN LAPTOP SOFTWARE**

Provide laptop software that enables a technician to test all features and functions of the sign, and to set and change all of the sign's operating parameters. Provide MoDOT with the specifications for the computers to run this software. This software shall be delivered on a CD or other electronic form so that it can be installed on MoDOT's computers. Provide the appropriate license that may be required to use the software on up to 10 computers.

## **10.0 TRAINING**

### **10.1 General**

Training shall be provided for MoDOT's engineering, maintenance and operations staff at a facility provided by MoDOT. The training shall include all material and manuals required for each participant.

At least 30 days prior to commencement of the training courses, the manufacturer shall submit detailed course curriculums, time requirements, draft handouts, and resumes of instructors. MoDOT will review and request modifications of that material as appropriate. The courses shall be conducted at a MoDOT provided location, and at a time and date mutually agreed upon by MoDOT and the manufacturer. The training material generated for each course shall contain manuals and other handouts for each attendee who shall serve not only as subject guidance, but as quick reference material for future use by the students. All course material, in reproducible form, shall be delivered to the Engineer immediately following course completion.

#### **10.1.1 Maintenance Training**

The maintenance training shall be provided for a minimum of 8 hours for at least ten maintenance personnel with an electronics background. The training shall include operation instructions, theory of operation, circuit description, field adjustments, preventive maintenance procedures, troubleshooting, operation of diagnostic and configuration software (if applicable), and repair of components.

### **10.1.2 Engineering Training**

The engineering training shall be provided for a minimum of 4 hours for at least ten engineering and operations personnel. The training shall include a complete demonstration of the operation and capabilities of the equipment

## **11.0 INSTALLATION SUPPORT**

### **11.1 On-Site Training**

Train the installation contractor for the unpacking, assembly, mounting to the sign truss, positioning, and connection to the fiber optic communication cable, or spread spectrum radio integration and testing of the DMS assembly. Tell the contractor what types of cables to run between the controller cabinet and the sign, and how they should be terminated. The contractor shall not perform any work until the manufacturer has certified the contractor as qualified. A MoDOT representative shall be present to observe the training

### **11.2 Support during Installation**

Provide both on-site and remote factory support. Provide a technical assistance hot line from the hours of 8:00 AM to 5:00 PM CST Monday through Friday. Provide assistance to installation contractor on Acceptance Testing, including but not limited to viewing angle, tilt angle, and other sign performance specifications.

## **12.0 DELIVERY**

The bid price shall include delivery and off loading to the ground at a location in Missouri to be specified by the installation contractor. Coordinate the delivery time and location with both the contractor and the MoDOT Engineer.

## **13.0 DOCUMENTATION AND WARRANTY**

### **13.1 Documentation and Drawings**

Provide twelve sets of complete shop drawings, catalog cuts, schematics and operations/maintenance manuals for each component for evaluation. A software manual in both paper and electronic format shall be provided with each set, which also describes the required protocol for Advanced Transportation Management System (ATMS) software vendor. A section of each set of the maintenance manuals shall include complete subcomponent parts listing.

### **13.2 Warranty**

The complete DMS assembly shall carry a two-year warranty from the date of acceptance against any imperfections in workmanship or materials. The central software shall also carry a two year warranty against defects. Provide free telephone technical assistance for software users during this period.

Any repairs made by the manufacturer or representative shall be documented and returned with units when warranty repaired. This documentation shall disclose exact repairs and identify the parts replaced by part number and serial number. All warranty repairs shall be completed within 30 days of delivery of the equipment to the designated repair depot.

### **13.3 Technical Submittal**

The DMS manufacturer must provide a complete pre-build technical submittal with their Bid Proposal to MoDOT engineer. The DMS manufacturer shall provide five (5) copies of the submittal both in electronic format on CD and in paper format in three-ring binders.

The submittal must include:

- 1 DMS manufacturer qualification information, as specified herein
- DMS shop drawing, including an illustration of the recommended installation method
- DMS structural calculations and certification by a registered professional engineer from the state which the DMS is specified will be available within thirty days of submittal approval
- DMS site riser diagram
- AC site power requirements, including the number of legs, current draw per leg, and maximum and typical site power consumption
- Major DMS schematics in block diagram form, including AC power distribution inside and outside the DMS, DC power distribution within the DMS, and control signal distribution inside and outside the DMS
- Drawings of major DMS components, including LED display modules, driver boards, control/logic components, environmental control assemblies, DMS sign controller, control equipment cabinet assembly, and control cabinet mounting footprint
- Catalog cut sheets for major DMS components, including front face paint material, polycarbonate face material, LEDs, regulated DC power supplies, circuit board conformal coating material, hookup wire, signal cable, surge suppression devices, panel board, circuit breakers, utility outlets, sign controller, ventilation/cooling fans, heaters, ventilation filter, thermostats, and any other major system components
- Test reports and certification for all items identified in the “Product Testing” specifications herein,
- DMS control software operator’s manual

- Documentation that proves the DMS manufacturer complies with these specifications must be provided with the DMS manufacturer's pre-build technical submittal.

This submittal shall also include five (5) references from states that have had NTCIP-compliant DMS from the manufacturer installed for a minimum of five (5) years and project information for all of the manufacturer's DMS customers of the last five (5) years, including:

Equipment owner/operator agency name

- Contact person name, telephone number, fax number, and email address
- DMS system name and location of operations control center (project name/number, roadway name/number, state, county, and country)
  - DMS commissioning date (first date of successful on-site operation)
  - DMS quantity
  - DMS display pixel technology (LED, fiber optic, flip disk, etc.)
- DMS display matrix size (pixel rows by pixel columns) and type (full matrix, line matrix, or discrete character)
  - DMS housing access type (walk-in, front, rear, or other specific access type)
  - Communications protocol used (NTCIP or proprietary; if proprietary, provide a name or description)
  - Type of communications backbone used (telephone, fiber optic, direct, etc.)
  - NTCIP compliance test reports prepared by independent testing companies, including contact information
- The submittal shall also include the following background information about the DMS manufacturer:
  - Full corporate name
  - Corporate address
  - Contact person name, telephone number, fax number, and email address
  - Names and qualifications of the primary project team members, including the following:
    - sales person, project manager, product manager, application engineer, and manufacturing manager
  - Number of years in business under the current corporate name
  - Copy of the DMS manufacturer's in-house quality management system
  - Copy of the DMS manufacturer's certified welding procedure
  - Copy of welding certifications for all personnel who will perform welding of the

- DMS housing
- General corporate literature

#### **14.0 METHOD OF MEASUREMENT**

- Measurement of dynamic message signs, including all specified equipment, documentation, delivery, and testing, will be made per each.
- Measurement of the test sign, including all specified equipment, documentation, delivery, and testing, will be made per each.
- Measurement of the central sign control software, including all specified documentation and testing, will be made per lump sum.
- Measurement of the technician laptop software, including all specified equipment, documentation, and testing, will be made per lump sum.
- Measurement of maintenance training, including all specified documentation, will be made per class-hour.
- Measurement of engineering training, including all specified documentation, will be made per class-hour
- Measurement of installation support will be made per sign installed.

#### **15.0 BASIS OF PAYMENT**

Accepted dynamic message sign will be paid for at the unit or lump sum price for each of the pay items included in the contract. No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

## **SCOPE OF WORK SECTION 2G**

### **FUNCTIONAL SPECIFICATION FOR SPECIFICATION D (OVERHEAD MOUNT) DYNAMIC MESSAGE SIGN ASSEMBLY**

#### **1.0 GENERAL**

##### **1.1 Description**

MoDOT has an **option** of purchasing this type of the dynamic message sign (DMS). This specification describes a front access dynamic message sign (DMS) assembly. The DMS assembly shall include the DMS, horizontal structural brackets, mounting hardware, electrical distribution, surge suppression and all miscellaneous hardware and incidental components (including internal cables) required to deliver a fully operational subsystem. The entire assembly shall be housed in a fully wired aluminum weatherproof enclosure.

The assembly also includes a sign controller to be mounted in a cabinet mounted on the sign support structure or in a ground mounted cabinet located near the sign. In most cases, the cabinet will be ground mounted. Others will install the sign and provide the support structure and controller cabinet. Cables connecting the controller to the sign shall be provided, but will be installed by others.

The sign shall conform to NEMA TS 4, except for requirements of NEMA TS 4 that conflict with the requirements in this specification.

The sign shall be fully compatible with MoDOT's existing Gateway Guide software. The full cost for any software modifications required to allow the sign to be fully compatible is the responsibility of the sign manufacturer. For information on the Gateway Guide software, contact Gateway Guide staff directly.

When displaying 12-inch characters, the sign shall be readable from any point on the approach roadway up to 560 feet away under all normal weather and lighting conditions.

All DMS equipment components, modular assemblies, and other materials located in the DMS housing shall be removable, transportable, and capable of being installed by a single technician in a bucket truck. Structural members and components thereof are not included in this requirement. Like items shall be identical, both within and among signs.

All components furnished under this functional specification shall be current production equipment and of recent manufacture. To ensure overall system compatibility, all DMS's shall be from the same manufacturer.

##### **1.2 Manufacturer Qualifications**

The DMS manufacturer proposed to furnish displays and controllers for this project shall have been in business continuously for a minimum of five years prior to the date of bid opening. Further, the proposed manufacturer shall have furnished permanently installed LED DMS systems similar to the system specified here in for a minimum of three projects, each with at least five signs and controllers. Each of these signs and controllers shall have satisfactorily operated for a minimum of one year prior to the date of bid opening. The names,

current addresses and phone numbers of individuals who can certify satisfactory operation of signs meeting the above stated requirements shall be provided with the bid.

## **2.0 Item Identification**

Manufacturer model numbers shall be permanently affixed on all replaceable components. The manufacturer shall supply an Excel spreadsheet in the current MoDOT format containing the manufacturer's name, device type (i.e., DMS), Location Identifier, model number, part number and serial number as separate fields.

### **2.1 Mechanical**

The total weight of the DMS assembly shall not exceed 2000 lb (909 kg).

### **2.2 Electrical**

The presence of ambient radio signals, magnetic or electromagnetic interference, including those from power lines, transformers, or motors within 1 ft (0.3 m) of any components of the system, shall not impair the performance of the system. The system shall not radiate any electrical or electromagnetic signals that could adversely affect any other electrical or electronic device.

All system electronics shall be 100 percent solid-state technology with the exception of the ventilation fans.

All high voltage (exceeding 24 Volts DC) components used in the sign shall be UL listed.

## **3.0 DYNAMIC MESSAGE SIGN COMPONENTS**

### **3.1 DISPLAY ELEMENTS**

#### **3.1.1 Display**

Each DMS shall be of the full matrix type. The matrix shall be a minimum of 27 pixels high (rows) by a minimum 105 pixels wide (columns). The pixels shall be spaced uniformly with the same spacing vertically and horizontally to the rows (i.e., no pitch or slant is allowed). The outside border around the DMS display shall be approximately 12 inches (305 mm).

#### **3.1.2 Light Emitting Diodes**

Display pixels shall incorporate amber LED technology. The discrete LED's shall have a viewing cone of 30 degrees. The shop drawing submittal for the sign shall include the manufacturer's procedure for ensuring that the NEMA TS-4 requirements for uniform brightness and uniform color are met.

#### **3.1.3 Display Modules**

All module surfaces, which are visible from outside the DMS, excluding the LED pixels, shall be painted flat black in order to provide maximum display contrast and readability. There shall be a minimum of two pixels per module.

Display modules shall be removable from the DMS with either simple hand tools or without any tools. All

wiring interconnecting the individual display modules shall be modular harness assemblies with latching push- on/pull-off or twist on/off connectors.

The removal of any combination of one or more display modules shall not alter the structural integrity of the DMS assembly. Nor shall the removal of any combination of display modules affect the operation of the remaining operational modules in any way.

Pixels shall consist of two interlaced strings of LEDs.

LED's shall be soldered to circuit boards with through-hole type of circuit board mounting. Surface mounting of LED's will not be allowed.

To minimize the chance of LEDs being pushed out of alignment with the sign's optical axis, LED's must be mounted no more than 1/100 inch from the front side of the printed circuit board. The LED's must be mechanically protected, so that there is no contact with them when the module is gripped or dropped.

Display modules shall be attached to the support frame with captive fasteners in such a way that their position does not change when the sign is subjected to severe vibration.

The LED leads and the circuit board traces shall dissipate heat produced by the LEDs. Circuit traces that connect to the LEDs shall be two ounce copper plating or thicker. The width of traces that connect to those LED leads that carry heat from the LED chip shall be maximized.

Both sides of the board shall be protected with acrylic conformal coating. The coating on the front of the board is to seal the gap between the LEDs and the board, and shall be applied so as not to coat the LED housing above the gap. The LEDs may not be potted.

The peak current provided at maximum brightness must be 20 mA or, if adjustable, must be set at 20 mA when installed. If the maximum current is adjustable, the adjustment mechanism shall not permit values above 30 mA.

The top of the display modules shall tilt forward seven degrees. The amount of the forward tilt may be adjustable, in which case the adjusting mechanism must be calibrated and each position labeled. The mechanism that adjusts the tilt must rely on pins or bolts, not friction, to hold the modules at the desired angle.

## **4.0 DISPLAY ELECTRONICS**

### **4.1 Driver Circuitry**

The driver circuitry shall be able to detect abnormal current values, including short circuits and open circuits, while a single pixel is being illuminated. The state of the LED's (on or off) in each pixel of the sign shall be read by the sign controller so it can report the actual message, including static, flashing and alternating messages, that is visibly displayed on the sign in a WYSIWYG format. This pixel read shall take place while a message is displayed on the sign without disturbing the message in any way and will include any half-out, full-out, half stuck on or fully stuck on pixels. Any flashing, flickering, blinking, dimming, or other disturbance of the message during this pixel status read shall be cause for rejection of the sign. This functionality shall be specifically demonstrated during factory acceptance testing along with other testing as

required in Section 5.

#### **4.2 Brightness Control**

Pulsed drive current shall be used at the maximum brightness level. Pulse Width Modulation (PWM) shall be used to dim the sign to achieve the proper brightness level for a given ambient light condition. As part of the shop drawing submittal, a complete schematic of the LED power and driver circuits shall be provided for review by the Engineer. Multiplexing of the LED's shall not be allowed.

The DMS shall have photocells that detect when the sun is directly in front of the DMS or directly behind it. Those photocells, or a separate photocell, shall also distinguish night from day. These photocells shall not be affected by man-made light sources, such as highway lighting and/or headlights. They shall be easily accessible for maintenance.

#### **4.3 Temperature Control**

The DMS shall be designed so that the air temperature on the backside of the display modules never exceeds 140 degrees F (60 degrees C). A thermostat located in the middle of the top line of display modules shall shut down the LED display if the temperature rises above 140 degrees F (60 degrees C) and restore power when the temperature has dropped to 120 degrees F (50 degrees C). This shall be independent of the controller.

The sign shall also have one or more temperature sensors that report the sign temperature to the sign controller, which shall in turn report the temperature to the central software.

#### **4.4 DMS Power Supplies**

The maximum operating temperature of all power supplies shall be at least 150 degrees F (65 degrees C). All regulated power supplies shall have a minimum power factor of 0.95.

The LED display modules shall be operated at low internal DC voltage not exceeding 24 Volts.

The power supplies shall be short circuit protected by DC power OFF, and shall reset automatically after 5 seconds of AC power OFF. The power supplies shall also be protected by a suitable inrush current allowance to be recommended by the manufacturer and approved by the Engineer.

The power supplies shall have an efficiency rating of at least 75 percent.

### **5.0 ENCLOSURE**

The sign shall be designed so that all service is performed from the front of the sign by one technician using a bucket truck. Permanent lifting angles or lugs shall be attached to the DMS enclosure for moving and mounting.

#### **5.1 Structural Performance**

The structural design of the LED DMS enclosure shall conform to current AASHTO *Standard Specifications*

*for Structural Supports for Highway Signs, Luminaires and Traffic Signals.* Additional design criteria are as follows:

- Wind Velocity = 80 mph (130 kilometers per hour)
- Gust Factor = 1.3
- Housing shall support a front face ice load of four pounds per square foot.

The performance and stability of the sign shall not be impaired due to vibration, wind, vacuum pressure, and/or other normally encountered forces created by the effects of traffic. The shop drawing submittal shall include structural design calculations for the enclosure, signed and stamped by a registered professional engineer in the state of Missouri. Include calculations demonstrating that wind gusts cannot cause the glazing to detach from the sign nor to contact the display modules.

## **5.2 Dimensions**

The nominal dimensions of the sign enclosure shall not exceed 20 ft (6.1m) in width x 6.5 ft (2 m) in height x 2.5 ft (0.75 m) deep. The depth includes any rear ventilation hoods.

## **5.3 Material**

The DMS enclosure shall be assembled from a continuously welded aluminum alloy 3003-H14 or 5052-H34 skin of at least 1/8 inch (3.5 mm thick). The enclosure shall not have sharp edges or corners and the inside and outside edges shall be free of burrs. Internal supports shall be of extruded aluminum alloy 6061-T6 members welded to form a support structure to provide rigidity and structural integrity. All metallic parts shall be corrosion resistant.

The DMS facial area shall be treated with a flat-black, factory-applied, Kynar flouropolymer resin based coating providing a minimum life span of 10 years. The rest of the housing shall be white UV protected and weatherproof enamel. Company or vendor logos may not appear anywhere on the exterior of the sign housing. As part of the shop drawing submittal, the manufacturer may propose an alternate means of protecting the metal surfaces. Such alternates shall be subject to the approval of MoDOT.

## **5.4 Welding**

The DMS housing shall be fabricated, welded and inspected in accordance with the requirements of ANSI/WS D1.2-90 Structural Welding Code-Aluminum (1990). Compliance with this requirement shall include, but is not limited to:

- All manufacturing personnel who perform welding on the DMS housing shall be certified to AWS D1.2-90 for all weld types required for housing fabrication. The DMS manufacturer's submittal shall contain a copy of each welder's certification and the manufacturer's certified welding procedures.
- DMS housing welding shall be inspected on a daily basis by a Certified Welding Inspector (CWI), who shall complete daily written reports on DMS welding progress, housing weld integrity, and any corrective action taken. These reports shall be archived by the DMS manufacturer and shall be available for immediate review upon request by the Engineer.

## 5.5 Display Face

The front face of the DMS shall be composed of hinged windows that can be easily opened to give access to all serviceable components within the sign. The seams between windows shall not detract from the appearance of the sign nor interfere with the legibility of the message.

Windows shall be made of clear polycarbonate panels with black aluminum masks. The polycarbonate shall be at least 1/8-inch thick. The polycarbonate shall transmit at least 85 percent of the light emitted by the LED's. The manufacturer's technical data sheet for the material utilized for the front face shall be provided as part of the submittal package. The polycarbonate manufacturer shall warranty that:

- The yellowness index (ASTM test D-1925) of the material shall remain below 5.0 for three years from the date of purchase, and below 10.0 for five years.
- The light transmission (ASTM test D-1003) of the material shall not decrease more than three percent in three years from the date of purchase, or more than seven percent in five years.

The mask over each window shall be at least 0.04 inches thick. The aluminum mask shall have the same finish as the rest of the front of the sign and shall provide openings directly in front of each pixel. Pixel openings shall be of sufficient size as to not interfere with LED light output.

## 5.6 Ventilation

The DMS enclosure ventilation shall include intake, exhaust, filtration, fan assembly and environmental control.

The number and size of the vents shall be determined by the manufacturer to be of sufficient size to provide adequate ventilation. Intake vents shall use louvers that close to prevent the entry of dirt and insects when the ventilation system does not require outside air. The exhaust vents shall be equipped with dampers for the same purpose. The intake vents shall be located to prevent the direct intake of truck exhaust.

A removable two-stage air filter system shall be installed behind each intake vent. The filter filtration area shall completely cover the vent opening area such that no incoming air bypasses the filter. Brackets shall support the filter at the vents and be located to facilitate easy replacement. Filter replacement shall not require the use of tools.

The DMS enclosure shall be equipped with electric fans with ball or roller bearings. The capacity of each fan and the number of fans shall be sufficient to insure adequate ventilation if one fan becomes inoperable. An analysis shall be presented in the submittal material, which shall document that the proposed system meets these requirements. The fans shall be mounted within the housing and vented. The number, placement, and size of the electric fans shall be determined by the manufacturer. Fans shall be replaceable without the need to remove other components.

The fans shall be controlled by the DMS controller or a thermostat. If the fans are controlled by the DMS controller, there shall be parameters in the controller's database, which will specify the turn-on temperature and the shutdown temperature. Both parameters shall be in the range of 70 degrees (20 degrees C) to 120 degrees F (48 degrees C).

The DMS shall have a window defogging system that is turned on and off by the DMS controller or a thermostat. The system shall use heated air blown on the inside of the windows. Heating strips on the windows or frames shall not be acceptable. The defogging system shall be capable of removing all condensation from a completely fogged window within five minutes.

### **5.7 Mounting Brackets**

Housing shall be provided with multiple mounting brackets in the form of I-beams or Z-extrusions which shall be bolted to the housing exterior rear wall, to facilitate attachment of the DMS to its support structure. Mounting brackets shall be extruded aluminum. Mounting brackets shall be attached to the DMS structural frame members, not just the exterior sheet metal. Mounting brackets shall be attached to the DMS using galvanized high-strength steel bolts. The attachment points shall be sealed and watertight. The mounting brackets shall be designed and fabricated such that the installing contractor can drill into them without penetrating the DMS housing and compromising the housing's ability to shed water.

### **5.8 Weep Holes**

Provide screened weep holes in the bottom of the sign.

## **6.0 ELECTRICAL SERVICE**

### **6.1 Electrical Distribution Panel**

The primary electrical service panel shall be rated for 120/240 VAC, single phase, 3 wire and 100 amperes maximum with a 2 pole main circuit breaker and a 1-pole circuit breaker for each branch circuit and a copper ground bus. The panel shall have an interrupt rating of not less than 10 KA. The panel shall be General Electric Model AQF1121AB or AQF1121AT or an equivalent approved by MoDOT. Separate circuits shall be provided for the utility outlets. 120 VAC load shall be balanced. Incoming terminals shall be capable of a conductor range from 8 AWG (10 mm<sup>2</sup>) to a 4/0 AWG [DD3](120 mm<sup>2</sup>).

### **6.2 Radio Interference and Surge Protection**

Surge protection shall be provided on all ungrounded conductors leaving the sign housing. All devices shall be readily accessible for ease of replacement.

A two-stage surge protector and radio interference filter shall be on all incoming power lines. The two stages shall be electrically separate, so that the first stage protects all equipment using the power, while both the first and second stages protect electronic equipment. There shall be no maximum load for the first stage. The second stage shall be capable of protecting equipment drawing a total of 10 amps. The protector shall clamp both the main line and the main neutral at 250 volts, both relative to each other and relative to the cabinet ground. The response time shall be such that the actual voltage never exceeds 250 volts. The surge protector shall suppress surges of up to 20,000 amps (8 x 20 microsecond waveform). The clamping voltage shall change by no more than five percent after 20 such surges.

For each conductor used for communication and control, provide surge protection in the sign. Furnish a cable termination panel with surge protectors that match those in the sign, which the installation contractor can install in the cabinet along with the sign controller.

### **6.3 Conduit and Wiring**

Wiring and other electrical work shall comply with the *National Electrical Code*. Wires and cables shall be neatly held in place.

### **6.4 Grounding**

Provide two grounding lugs, each electrically bonded to the sign housing. They shall be near the lower left and lower right corners of the sign housing's rear wall.

## **7.0 CONTROLLER**

Furnish a sign controller for the installation contractor to install in an equipment cabinet on or near the sign support structure. The sign controller installed in said cabinet shall provide full local control of the sign. The controller must have sufficient memory and processing power to perform all the functions described in the specifications, including full functionality of the service software. Sign controller shall be a 19-inch rack mountable and have a 15-inch maximum depth.

### **7.1 Watchdog Timer**

The controller shall have a watchdog circuitry that automatically resets the controller when it locks up. There shall be a means for the controller to recognize and report the fact that it was reset by the watchdog timer.

### **7.2 Memory**

The controller shall have nonvolatile memory that contains the operating DMS software and messages.

The controller shall also have changeable memory that retains the data in memory for a minimum of one year following a power failure. It shall contain the library of messages, library of fonts, message display schedule and changeable operating parameters.

### **7.3 Clock**

The controller shall have a time-of-year clock with a lithium battery backup. The battery shall keep the clock operating properly for at least 10 years without external power. The clock shall automatically adjust for leap year through hardware, software or a combination of both. It shall be set by the sign controller's microprocessor. The clock shall be accurate to within 1 minute per month.

### **7.4 Communication Interfaces**

Communication between the central computer and the sign shall be by UDP Internet Protocol over Ethernet or through an RS-232 serial connection. The controller must be IP addressable with an Ethernet port to allow for the Ethernet connection. The controller shall have an EIA-232 communications port to allow for the serial connection. This port shall be capable of operation at all standard data rates up to 19,200 bits per second and shall be set to 9600 bits per second.

The controller shall also have a second EIA-232 communication port for communication with a technician's laptop computer connected directly to the controller. The port shall be capable of operation at all standard data rates up to 19,200 bits per second and shall be set to 9600 bits per second.

In addition, the controller shall have communication interfaces with the equipment in the sign, for such things as sign control, temperature monitoring, and brightness adjustment.

## **8.0 EXTERNAL CABLING**

Cables running between the cabinet with the controller and the sign shall be as required to produce a fully functional system. The cables shall be rated for outdoor use.

## **9.0 CONTROLLER SOFTWARE**

### **9.1 Display Presentation**

The DMS controller shall control the driver modules in such a way as to create the desired display on the sign.

Messages shall be communicated and stored using the Markup Language for Transportation Information (MULTI), as defined in the most recently adopted edition of the NTCIP Standard 1203, National Transportation Communications for ITS Protocol (NTCIP) Object Definitions for Dynamic Message Signs (DMS). The sign's method of operation must be consistent with that standard.

Space allocated to each character shall be proportional to the character's true width. Software shall handle such details as centering text on a line, right justification, left justification, and appropriate spacing of letters and words. Software shall also control flash, and alternating between pages of a two and three-page display.

There shall be a default value for each parameter supported. The manufacturer shall pre-load these default parameters with values approved by the Engineer.

### **9.2 Modes of operation**

Signs shall be able to display a static message, a flashing message, or a multi-page message as described below.

- **Static message:** The message chosen shall be displayed constantly on the sign face until the sign controller is instructed to do otherwise.
- **Flashing message:** A selected portion of the chosen message shall be displayed and blanked alternately at durations controllable in one-second increments.
- **Multi-page messages:** The chosen message shall display up to three different pages (each page consisting of up to three lines of text) alternately at durations separately controllable in one-second increments.

### **9.3 Fonts**

A user shall be able to create and display messages using at least four fonts, each stored in the controller. Two of the fonts shall be stored in the controller by the manufacturer. Provide a font comparable to that shown in Figure 7-1 of Federal Highway Administration publication # FHWA-TS-90-043 or current Federal Highway

Administration publications and NTCIP Standards. Also, provide a similar bold font. The user shall be able to create at least two additional fonts, download them to the controller, and store them there.

#### **9.4 Display Selection**

In the absence of instructions to the contrary from the control ports, the controller shall implement a display selected from those stored in its memory based upon date and time as specified in the schedule. It shall use a schedule stored in random access memory plus its time-of-year clock to select the proper display. The schedule system shall permit different schedules for different days of the week plus special schedules for special days, such as holidays.

The display of the scheduled message may be over-ridden by instructions sent from the control ports. A computer shall be able to cause the controller to implement a particular display selected from the messages stored in its memory, or a new display sent from the computer using MULTI. The computer shall also be able to edit or completely replace a message stored in the controller's memory, or revise the message schedule. In addition, it shall be able to cause the controller to report its schedule or the text of any message stored in its memory.

Software shall incorporate fail-safe procedures to check messages received and shall not change a message stored in memory, the display currently on the sign, the schedule stored in memory, or the current time unless the message is received correctly and constitutes a valid command.

#### **9.5 Schedule Operation**

The schedule is activated by activating a message (i.e., setting an object with the syntax of MessageActivationCode or MessageIDCode) with the dmsMessageMemoryType set to schedule(6), the dmsMessageNumber set to 1, and the dmsMessageCRC set to 0x00 00 (and a sufficiently high activation priority if it is a MessageActivationCode object).

During schedule operation, the run-time priority applies to the operation of the schedule and the run-time priority of the referenced message is ignored. Thus, the run-time priority is constant for all scheduled messages and the central system can set this priority by modifying the value of dmsRunTimePriority.6.1.

The values of dmsMessageMultiString.6.1, dmsMessageBeacon.6.1, and dmsMessage PixelService6.1 are copied from the message called by the most recently called action and thus reflect the most recently called message that would be called by the scheduler whether or not the scheduler is running.

The activation priority of any scheduled message shall be 200 in the absence of a potential future object to specifically set this value.

One may activate the schedule for a defined duration by setting the duration in the activation code.

To get the scheduler to blank the sign, a blank message must be scheduled.

#### **9.6 Brightness Control**

Manual and automatic dimming modes shall be provided, enabling the user to select the desired mode of operation. The dimming system shall select one of several levels from the sensed ambient light. The set points

for each of the ambient light levels shall be set by the user via software. A user shall be able to send a command via the control ports to select a specific brightness level or to direct the controller to select an appropriate brightness based on current lighting conditions.

For each brightness level, a technician shall be able to easily determine what fraction of the full brightness current is applied to the LED's. The technician must be able to set the current value for a given brightness level to any value between 25% and 100% of the maximum current in five percent increments, and must be able to easily change these settings via computer commands.

### **9.7 Communication**

Controller hardware and software shall permit the communication with the central computer using polled operation, in which the sign controller informs the central computer of its current status in response to a query from the central computer. The sign controller never communicates except when polled.

The controller shall be able to receive commands simultaneously over two ports (one for the central computer and one for a laptop), process the commands in the order received, and respond to each command only via the port on which it was received.

### **9.8 Diagnostic Test**

Upon command, the controller shall test all systems, including but not limited to the electrical operation of all drivers and check for over current and under current pixels, photocells, ventilation, and displays. It shall communicate the result to the computer that issued the command using an NTCIP compliant method.

### **9.9 Power Interruptions**

The contents of the controller's memory shall be preserved by battery power during power interruptions, and the controller shall resume operation automatically when power is restored. Upon recovering from a power interruption, the controller shall report to the central computer that it has just recovered from a power interruption. It shall also consult a configuration parameter set by the user to determine whether to blank its display or to display the message that it would have been displaying if no power failure had occurred. There shall be separate configuration parameters for long and short power failures, as well as a parameter specifying the maximum duration of a power failure classified as short.

### **9.10 Test Messages**

Test messages shall be stored in the controller's permanent memory. The test messages shall be functionally equivalent to the following:

- **All pixels on simultaneously.** This is to determine whether there are pixels or display modules that are not the same brightness as the rest.
- **Each module shows a unique display indicating which row and column it is in.** This test display is to determine whether any module is displaying what a different module should be displaying.
- **A display that alternates the two previous displays** at approximately ten second intervals. This is to enable an observer to identify which display module has a brightness problem.

- **A display that illuminates every pixel, one at a time**, in rapid succession. This is to be used in conjunction with the current sensors to automatically test each pixel for abnormal current consumption.
- **One display for each font**, showing every character composing the font.

The test messages shall include any other displays required to carry out the manufacturer's recommended procedures for maintenance and troubleshooting.

### **9.11 Watchdog Timer Interface**

The software shall regularly reset the watchdog timer so that it does not inappropriately reset the controller. When it starts operating, the software shall check the status of the watchdog timer and, if the timer indicates that it reset the controller, the controller shall report that fact to the central computer.

### **9.12 Temperature Monitoring**

Via the communication ports, a user shall be able to set a temperature threshold. When the highest temperature reported by the temperature sensors in the sign exceeds this threshold, the controller shall issue a temperature warning to the central computer.

### **9.13 NTCIP Requirements**

The controller shall communicate using NTCIP. Supply full documentation of all manufacturer-specific objects supported by the sign controller. This shall be in the form of a CD-ROM containing ASCII versions of a MIB in ASN.1 format. The MIB shall contain accurate and meaningful description fields and supported ranges indicated in the syntax field of the object-type macros. MoDOT shall have the right to use the documentation described above for system integration purposes, regardless of what parties are involved in the system integration effort.

The controller must adhere to the version of the following standards that is current at the time of bidding. A later version may be used if approved by the Engineer.

#### **Information level:**

The following objects defined in NTCIP 1201:

- All objects in the Global Configuration Node.
- The following objects in the Global Time Management Node: globalTime; globalDaylightSaving; maxTimeBaseScheduleEntries; timeBaseScheduleTable; maxDayPlans; maxDayPlanEvents; timeBaseDayPlanTable.
- All objects in the Report Parameters Node.
  - eventConfigLogOID
  - eventConfigAction
  - eventClassDescription

The following objects, if defined in NTCIP 1203

- Sign Configuration and Capability Objects

- dmsSignAccess
- dmsSignType
- dmsSignHeight
- dmsSignWidth
- dmsSignTechnology
- vmsCharacterHeightPixels
- vmsCharacterWidthPixels
- vmsSignHeightPixels
- vmsSignWidthPixels
- vmsHorizontalPitch
- vmsVerticalPitch
- vmsMaxNumberPages
- vmsMaxMultiStringLength
  - Font Objects
- numFonts
- fontTable and subsidiary objects
- maxFontCharacters
- characterTable and subsidiary objects
- fontMaxCharacterSize
- MULTI Configuration Objects
  - defaultFlashOn
  - defaultFlashOff
  - defaultFont
  - defaultJustificationLine
  - defaultJustificationPage
  - defaultPageOnTime
  - defaultPageOffTime
  - defaultCharacterSet
  - dmsColorScheme
  - dmsSupportedMultiTags
    - Message Objects
  - messageIDCode
  - messageActivationCode

- dmsNumPermanentMsg
- dmsNumChangeableMsg
- dmsMaxChangeableMsg
- dmsFreeChangeableMemory
- dmsNumVolatileMsg
- dmsMaxVolatileMsg
- dmsFreeVolatileMemory
- dmsMessageTable and subsidiary objects
- dmsValidateMessageError
  
- Sign Control Objects
  - dmsControlMode
  - dmsSWReset
  - dmsActivateMessage
  - dmsMessageTimeRemaining
  - dmsMsgTableSource
  - dmsMsgRequesterID
  - dmsMsgSourceMode
  - dmsShortPowerRecoveryMessage
  - dmsLongPowerRecoveryMessage
  - 
  - dmsResetMessage
  - dmsCommunicationLossMessage
  - dmsTimeCommLoss
  - dmsPowerLossMessage
  - dmsEdDurationMessage
  - dmsActivateMsgError
  - dmsMultiSyntaxError
  - dmsMultiSyntaxErrorPosition
  - dmsMultiOtherErrorDescription
  - dmsActivateMessageState
  
- Brightness Objects
  - dmsIllumControl
  - dmsIllumMaxPhotocellLevel

- dmsIllumPhotoCellLevelStatus
- dmsIllumManLevel
- dmsIllumBrightnessValues
- dmsIllumBrightnessValuesError
- dmsIllumLightOutputStatus
- Scheduling Action Objects
  - numActionTableEntries
  - dmsActionTable and subsidiary objects
- Sign Status Objects, to the extent supported by the sign hardware.
  - statMultiFieldRows
  - statMultiFieldTable and subsidiary objects
  - watchdogFailureCount
  - dmsStatDoorOpen
  - shortErrorStatus
  - controllerErrorStatus
  - dmsPowerStatusMap
  - dmsPowerNumRows
  - dmsPowerStatusTable and subsidiary objects
  - fanFailures
  - pixelFailureTableNumRows
  - pixelFailureTable and subsidiary objects
  - pixelTestActivation
  - dmsPixelStatusTable and subsidiary objects
  - dmsPixelFailureTestRows
  - dmsPixelFailuresMessageRows
  - dmsLightSensorStatusMap
  - dmsLightSensorNumRows
  - dmsLightSensorStatusTable and subsidiary objects
  - dmsTempSensorStatusMap
  - dmsTempSensorNumRows
  - dmsTempSensorStatusTable and subsidiary objects
  - powerSource
  - tempMinAmbient

- temptMaxAmbient
- tempMinSignHousing
- tempMaxSignHousing
- tempSensorWarningMap
- tempSensorCriticalTempMap
- Graphic Definition Objects
  - dmsGraphicMaxEntries
  - dmsGraphicNumEntries
  - dmsGraphicVertSpacing
  - dmsGraphicHorzSpacing
  - dmsGraphicMaxSize
  - availableGraphicMemory
  - dmsGraphicBlockSize
  - dmsGraphicTable and subsidiary Objects
  - dmsGraphicsBitmapTable and subsidiary objects

Any mandatory objects that are required by NTCIP1203 but that are missing from the above list shall also be supported.

The standardized range is defined by the size, range, or enumerated listing indicated in the object's syntax and/or through description text in the object's description field of the relevant standard, every object required by these specifications shall support all values within its standardized range except:

OBJECT	MINIMUM PROJECT REQUIREMENTS
Max Time Base Schedule Entries	28
Max Day Plans	14
Max Day Plan Events	12
Max Event Log Configurations	50
Event Configuration Mode	2, 3, and 4
Max Event Log Size	200

Max Event Classes	16
Max Group Address	1
Number Fonts	4
Max. Font Characters	100
Number Action Table Entries	Equal to message capacity of sign

The module table required by Clause 2.2.3 of NTCIP 1201 shall contain at least one row with moduleType equal to 3 (software).

Displaying a blank sign shall be achieved in the same way that any message is displayed (i.e., by using an object that has a syntax of either MessageActivationCode or MessageIDCode). However, a new memory type, dmsMessageMemoryType equal to 'blank (7)', shall be created to support this operation. It shall function as follows:

- The dmsMessageNumber for this memory type shall be reflective of the RunTime Priority and shall be between 1 and 255, inclusive.
- The CRC for this memory type shall be 0x00 00 and the normal CRC algorithm shall not be applied to blank messages.
- The dmsMessageMultiString shall be an octet string of length 0.
- The activate priority for any MessageActivationCode using this type of memory shall be used as the actual activation priority.

The software shall implement the following tags (opening and closing where defined) of MULTI as defined in NTCIP 1203

- Fields for 12 hour time, day of month, month, and four digit year
- Flash
- Font
- Justification Line
- Justification Page
- Moving Text
- New Line
- New Page
- Page Time
- Hexadecimal Character

**Application level:** NTCIP 1102 and NTCIP 1103. Communication with the signs shall use SNMP only.

**Transport level:** NTCIP 2202.

**Subnetwork level:** NTCIP 2104

## **10.0           TECHNICIAN LAPTOP SOFTWARE**

Provide laptop software that enables a technician to test all features and functions of the sign, and to set and change all of the sign's operating parameters. Provide MoDOT with the specifications for the computers to run this software. This software shall be delivered on a CD or DVD so that it can be installed on MoDOT's computers. Provide the appropriate license that may be required to use the software on up to 10 computers.

## **11.0           TESTING**

All DMS components and assemblies furnished by the manufacturer shall be subject to testing and monitoring to determine conformance with all applicable requirements and to ensure proper operation of the equipment and subsystem. Test procedures shall be submitted to the Engineer for review and approval prior to conducting any testing.

### **11.1           Factory Testing**

The DMS subsystem factory test shall be held at the manufacturer's facility. The manufacturer shall provide all the necessary measurement devices, which can be utilized to verify that the assembly is compliant with the requirements.

### **11.2           Compatibility Testing**

Unless the sign controller uses firmware identical to that already used in a DMS controller by the Gateway Guide system, demonstrate that the proposed controller and firmware are 100 % compatible with the gateway Guide central software. Gateway Guide operators shall be able to use all features of the proposed signs to the same extent that they can monitor and control the existing signs. Any cost associated with central software changes other than database changes must be paid by the manufacturer. The demonstration shall be conducted at the Gateway Guide Transportation Management Center using the proposed controller and software and a testbed composed of a few display modules, a photocell, a temperature sensor, and a fan.

### **11.3           Field Testing**

Upon delivery of the sign to the jobsite, the manufacturer and a MoDOT representative shall conduct a visual inspection of the DMS to check for manufacturing and installation defects. The installation contractor may witness this testing if he or she chooses. The DMS shall be powered during this preliminary inspection. Provide a generator and all necessary power and communication cables. The test procedure shall be designed to uncover manufacturing and installation defects of all types. Among the aspects that must be tested are the following:

- All diagnostic routines provided by the manufacturer.
- Proper operation of every pixel, including uniform brightness at all brightness levels and proper current consumption.
- Proper wiring of the display modules, checked by displaying a text message that identifies the modules proper row and column positions.
- Appropriate brightness for day and night conditions, and brightness from the sun at its worst condition for the location.
- Absence of leaks.

- Proper aiming of the display modules.
  - Proper entry of memorized messages.
  - Proper operation of sign monitoring.
  - Proper operation of temperature sensors, fans, defogging system, and lights.
  - Proper grounding.
  - Correct wiring of sensors and alarms to the controller's inputs.
- Proper control using the laptop software provided in this project.

#### **11.4 Software Testing**

Demonstrate that the laptop software works exactly as described in the user manual, and that it is able to utilize all features and functions of the signs.

#### **12.0 MAINTENANCE TRAINING**

Train MoDOT's maintenance staff, providing all material and manuals required for each participant. The maintenance training shall be provided for a minimum of 8 hours for at least twenty maintenance personnel with an electronics background. The training shall include operation instructions, theory of operation, circuit description, field adjustments, preventive maintenance procedures, troubleshooting, operation of diagnostic and configuration software (if applicable), and repair of components.

At least 30 days prior to commencement of the training courses, submit detailed course curriculums, time requirements, draft handouts, and resumes of instructors. MoDOT will review and request modifications of that material as appropriate. The courses shall be conducted at a MoDOT provided location, and at a time and date mutually agreed upon by MoDOT and the manufacturer. The training material generated for each course shall contain manuals and other handouts for each attendee, which shall serve not only as subject guidance, but also as quick reference material for future use by the students. All course material, in reproducible form, shall be delivered to the Engineer immediately following course completion.

#### **13.0 INSTALLATION SUPPORT**

##### **13.1 On-Site Training**

Train the installation contractor for the unpacking, assembly, mounting to the sign truss, positioning, connection to the communication network and testing of the DMS assembly. Tell the contractor what types of cables are to be run between the controller cabinet and the sign, and how they should be terminated. The contractor shall not perform any work until the manufacturer has certified the contractor as qualified. A MoDOT representative shall be present to observe the training

##### **13.2 Support during Installation**

Provide both on-site and telephone support. Provide a technical assistance hot line from the hours of 8:00 AM to 5:00 PM CST Monday through Friday. Provide assistance to installation contractor on Acceptance Testing, including but not limited to viewing angle, tilt angle, and other sign performance specifications. On-site assistance shall be provided to the installation contractor on final connections, configuration and Acceptance Testing of each sign.

## **14.0 DELIVERY**

The bid price shall include delivery and off loading to the ground at a location in Missouri to be specified by the installation contractor in coordination with the Engineer. Coordinate the delivery time and location with both the contractor and the Engineer.

Delivery of replacement components will be to the Gateway Guide TMC. Delivery date and time shall be coordinated with the Engineer.

## **15.0 DOCUMENTATION AND WARRANTY**

### **15.1 Documentation and Drawings**

Provide twelve sets of complete shop drawings, catalog cuts, schematics and operations/maintenance manuals for each component for evaluation. as well as a manual for the laptop software. A section of each set of the maintenance manuals shall include complete subcomponent parts listing.

### **15.2 Warranty**

The complete DMS assembly shall carry a two-year warranty from the date of acceptance against any imperfections in workmanship or materials.

Any repairs made by the manufacturer or representative shall be documented and returned with units when warranty repaired. This documentation shall disclose exact repairs and identify the parts replaced by part number and serial number. All warranty repairs shall be completed within 30 days of delivery of the equipment to the designated repair depot.

## **16.0 METHOD OF MEASUREMENT**

- Measurement of dynamic message signs, including all specified equipment, documentation, technician laptop software, delivery, installation support, and testing, will be made per each.
- Measurement of maintenance training, including all specified documentation, will be made per lump sum.
- Measurement of the replacement components will be made per each.

## **17.0 BASIS OF PAYMENT**

Accepted work will be paid for at the unit or lump sum price for each of the pay items included in the contract. No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

**SECTION (3):  
AGREEMENT REQUIREMENTS**

This RFP shall be governed by the following contract provisions. The award of this RFP is subject to a post-award negotiated contract. These same contract provisions will appear in the post-award negotiated contract. If the parties are unable to agree to terms in the post-award contract, MHTC shall reserve the right to cancel the award of the RFP and contract and select a different offeror.

- (A) MHTC's Representative:** MoDOT's District Engineer-D6, is designated as MHTC's representative for the purpose of administering the provisions of the Agreement as defined in Paragraph (E) of this section. MHTC's representative may designate by written notice other persons having the authority to act on behalf of MHTC in furtherance of the performance of the Agreement. The Offeror shall fully coordinate its activities for MHTC with those of the District Engineer-D6. As the work of the Offeror progresses, advice and information on matters covered by the Agreement shall be made available by the Offeror to the District Engineer-D6 throughout the effective period of the Agreement.
- (B) Release to Public:** No material or reports prepared by the Offeror shall be released to the public without the prior consent of MHTC's representative.
- (C) Assignment:** The Offeror shall not assign or delegate any interest, and shall not transfer any interest in the services to be provided (whether by assignment, delegation, or novation) without the prior written consent of MHTC's representative.
- (D) Status as Independent Contractor:** The Offeror represents itself to be an independent contractor offering such services to the general public and shall not represent itself or its employees to be an employee of MHTC or MoDOT. Therefore, the Offeror shall assume all legal and financial responsibility for taxes, FICA, employee fringe benefits, workers' compensation, employee insurance, minimum wage requirements, overtime, or other such benefits or obligations.
- (E) Components of Agreement:** The Agreement between MHTC and the Offeror shall consist of: the RFP and any written amendments thereto, the Standard Solicitation Provisions and General Terms and Conditions that are attached to this RFP, the proposal submitted by the Offeror in the response to the RFP and the post-award contract agreement signed between the parties. However, MHTC reserves the right to clarify any relationship in writing and such written clarification shall govern in case of conflict with the applicable requirements stated in the RFP or the Offeror's proposal. The Offeror is cautioned that its proposal shall be subject to acceptance by MHTC without further clarification.
- (F) Amendments:** Any change in the Agreement, whether by modification or supplementation, must be accompanied by a formal contract amendment signed and approved by the duly authorized representative of the Offeror and MHTC.
- (G) DBE/WBE Participation Encouraged:**
1. Bidders are encouraged to submit copies of existing affirmative action programs, if any. Bidders are also encouraged to directly hire minorities and women as direct employees of the bidder. MHTC reserves the right to consider the use of minority and female employee when making the award of the Agreement.

2. Offerors are encouraged to obtain minority business enterprise (MBE) and women business enterprise (WBE) participation in this work through the use of subcontractors, suppliers, joint ventures, or other arrangements that afford meaningful participation for M/WBEs. Offerors are encouraged to obtain 10% MBE and 5% WBE participation.
  3. Regardless of which persons or firms, if any, that the Offeror may use as subcontractors, subofferors, or suppliers of goods or services for the services to be provided, the Offeror ultimately remains responsible and liable to MHTC for the complete, accurate and professional quality/performance of these services.
- (H) **Nondiscrimination:** The Offeror shall comply with all state and federal statutes applicable to the Offeror relating to nondiscrimination, including, but not limited to, Chapter 213, RSMo; Title VI and Title VII of Civil Rights Act of 1964 as amended (42 U.S.C. Sections 2000d and 2000e, *et seq.*); and with any provision of the “Americans with Disabilities Act” (42 U.S.C. Section 12101, *et seq.*).
- (I) **Executive Order:** The Offeror shall comply with all the provisions of Executive Order 07-13, issued by the Honorable Matt Blunt, Governor of Missouri, on the sixth (6<sup>th</sup>) day of March, 2007. This Executive Order, which promulgates the State of Missouri’s position to not tolerate persons who contract with the state engaging in or supporting illegal activities of employing individuals who are not eligible to work in the United States, is incorporated herein by reference and made a part of this Agreement.
1. By signing this Agreement, the Offeror hereby certifies that any employee of the Offeror assigned to perform services under the contract is eligible and authorized to work in the United States in compliance with federal law.
  2. In the event the Offeror fails to comply with the provisions of the Executive Order 07-13, or in the event the Commission has reasonable cause to believe that the Offeror has knowingly employed individuals who are not eligible to work in the United States in violation of federal law, the Commission reserves the right to impose such contract sanctions as it may determine to be appropriate, including but not limited to contract cancellation, termination or suspension in whole or in part or both.
- (J) **Incorporation of Provisions:** The Offeror shall include the provisions of Section (3), paragraph I of this Agreement in every subcontract. The Offeror shall take such action with respect to any subcontract as the Commission may direct as a means of enforcing such provisions, including sanctions for noncompliance.
- (K) **Non-employment of Unauthorized Aliens:** Pursuant to Section 285.530, RSMo., no business entity or employer shall knowingly employ, hire for employment, or continue to employ an unauthorized alien to perform work within the State of Missouri. As a condition for the award of any contract or grant in excess of five thousand dollars by the State or by any political subdivision of the State to a business entity, or for any business entity receiving a state-administered or subsidized tax credit, tax abatement, or loan from the state, the business entity shall:
- 1) By sworn affidavit and provision of documentation, affirm its enrollment and participation in a federal work authorization program with respect to the employees working in connection with the contracted services. E-Verify is an example of a federal work authorization program. The business entity must affirm its enrollment and participation in the E-Verify federal work authorization program with respect to the employees proposed to work in connection with the services requested herein by providing

acceptable enrollment and participation documentation consisting of **completed** copy of the E-Verify Memorandum of Understanding (MOU). For business entities that are not already enrolled and participating in a federal work authorization program, E-Verify is available at [http://www.dhs.gov/xprevprot/programs/gc\\_1185221678150.shtm](http://www.dhs.gov/xprevprot/programs/gc_1185221678150.shtm).

2) By sworn affidavit, affirm that it does not knowingly employ any person who is an unauthorized alien in connection with the contracted services. A copy of the affidavit referenced herein is provided within this document, attached as Exhibit C.

**Proof of Lawful Presence For Sole Proprietorships and Partnerships:** If the business entity is a sole proprietorship or partnership, pursuant to Section 208.009, RSMo., each sole proprietor and each general partner shall provide affirmative proof of lawful presence in the United States. Such sole proprietorship or partnership is eligible for temporary public benefits upon submission by each sole proprietor and general partner of a sworn affidavit of his/her lawful presence on the United States until such lawful presence is affirmatively determined, or as otherwise provided by Section 208.009, RSMo. A copy of the affidavit reference herein is provided within this document, attached as Exhibit D.

- (L) **Bankruptcy:** Upon filing for any bankruptcy or insolvency proceeding by or against the Offeror, whether voluntarily, or upon the appointment of a receiver, Offeror, or assignee, for the benefit of creditors, MHTC reserves the right and sole discretion to either cancel the Agreement or affirm the Agreement and hold the Offeror responsible for damages.
- (M) **Law of Missouri to Govern:** The Agreement shall be construed according to the laws of the state of Missouri. The Offeror shall comply with all local, state and federal laws and regulations relating to the performance of the Agreement.
- (N) **Cancellation:** MHTC may cancel the Agreement at any time by providing the Offeror with written notice of cancellation. Should MHTC exercise its right to cancel the Agreement for such reasons, cancellation will become effective upon the date specified in the notice of cancellation sent to the Offeror.
- (O) **Venue:** No action may be brought by either party concerning any matter, thing or dispute arising out of or relating to the terms, performance, nonperformance or otherwise of the Agreement except in the Circuit Court of Cole County, Missouri. The parties agree that the Agreement is entered into at Jefferson City, Missouri, and substantial elements of its performance will take place at or be delivered to Jefferson City, Missouri, by reason of which the Offeror consents to venue of any action against it in Cole County, Missouri.
- (P) **Ownership of Reports:** All documents, reports, exhibits, etc. produced by the Offeror at the direction of MHTC's representative and information supplied by MHTC's representative shall remain the property of MHTC.
- (Q) **Confidentiality:** The Offeror shall not disclose to third parties confidential factual matters provided by MHTC's representative except as may be required by statute, ordinance, or order of court, or as authorized by MHTC's representative. The Offeror shall notify MHTC immediately of any request for such information.

(R) **Nonsolicitation:** The Offeror warrants that it has not employed or retained any company or person, other than a bona fide employee working for the Offeror, to solicit or secure the Agreement, and that it has not paid or agreed to pay any percentage, brokerage fee, gift, or any other consideration, contingent upon or resulting from the award or making of the Agreement. For breach or violation of this warranty, MHTC shall have the right to annul the Agreement without liability, or in its discretion, to deduct from the Agreement price or consideration, or otherwise recover the full amount of such fee, commission, percentage, brokerage fee, gift or contingent fee.

(S) **Conflict of Interest:** The Offeror covenants that it presently has no actual conflict of interest or appearance of conflict of interest and shall not acquire any interest, directly or indirectly, which would conflict in any manner or degree with the performance of the services under this Agreement. The Offeror further covenants that no person having any such known interest shall be employed or conveyed an interest, directly or indirectly, in this Agreement.

(T) **Maintain Papers:** The Offeror must maintain all working papers and records relating to the Agreement. These records must be made available at all reasonable times at no charge to MHTC and/or the Missouri State Auditor during the term of the Agreement and any extension thereof, and for three (3) years from the date of final payment made under the Agreement.

1. MHTC's representative shall have the right to reproduce and/or use any products derived from the Offeror's work without payment of any royalties, fees, etc.
2. MHTC's representative shall at all times have the right to audit any and all records pertaining to the services.

(U) **Indemnification:** The Offeror shall defend, indemnify and hold harmless the Commission, including its members and department employees, from any claim or liability whether based on a claim for damages to real or personal property or to a person for any matter relating to or arising out of the Offeror's performance of its obligations under this Agreement.

(V) **Insurance:**

The Contractor shall maintain or cause to be maintained at Contractor's own expense commercial general liability, automobile liability, worker's compensation insurance against negligent acts, errors or omissions of the Contractor, or its subcontractors and anyone directly or indirectly employed by any of them. Any insurance policy required as specified in this Section shall be written by a company that is licensed and authorized to issue such insurance in the state of Missouri and shall provide insurance coverage for not less than the following limits of liability:

- a. General Liability: Not less than \$500,000 for any one person in a single accident or occurrence, and not less than \$3,000,000 for all claims arising out of a single occurrence;
- b. Automobile Liability: Not less than \$500,000 for any one person in a single accident or occurrence, and not less than \$3,000,000 for all claims arising out of a single occurrence;
- c. Missouri State Workmen's Compensation policy or equivalent in accordance with state law.

Upon request from the Commission, the Contractor shall provide the Commission with certificates of insurance evidencing the required coverage and that such insurance is in effect.

**(W) Liquidated Damages:**

- a. In the event the successful Contractor fails to deliver the material within the time specified, the Department and the public will sustain damages because of such delay in delivery, the exact extent of which would be difficult to ascertain, and in order to liquidate such damage in advance it is agreed that the sum of 5000-thousand dollars (\$5000.00) per day, per item, for each assessable calendar day on which the delivery has not been completed, is reasonable and the best estimate which the parties can arrive as liquidated damages, and it is therefore agreed that said amount will be withheld from payments due the Contractor or otherwise collected from the Contractor as liquidated damages.
- b. Saturdays, Sundays, holidays and days whereas the Department has suspended work shall not be assessable days.

**(X) Bid/Proposal Guaranty and Contract Bond:**

- a. Each bid shall be accompanied by a Bid Bond, Certified Check, Cashier's Check or Bank Money Order payable to the Director of Revenue – Credit State Road Fund for an amount equal to Five Percent (5%) of the amount of the BID submitted. This is to act as a warranty that the bidder, if awarded the contract, will furnish an acceptable performance and payment bond (Contract Bond) or a cashier's check, a bank money order or a certified check made payable to "Director of Revenue--Credit State Road Fund" in an amount equal to One Hundred (100%) of the contract price.
- b. If a BID BOND is used (in lieu of a certified check, cashier's check, or bank money order), it must be in the form provided and executed by the bidder as principal and by a surety company authorized to do business in the State of Missouri as surety. The agent executing the same on behalf of the surety company must attach a current Power of Attorney setting forth his authority to execute the bond involved.
- c. Certified Checks, Cashier's Checks or Bank Money Orders of unsuccessful bidders will be returned as soon as the award is made. The checks or bank money orders of the successful bidder(s) will be retained until the contract is executed and a satisfactory Performance and Payment (Contract Bond) is furnished. Bid Bonds will not be returned except on specific request of the bidder.
- d. Failure to execute the contract and file acceptable performance payment (Contract Bond) or cashier's check, bank money order or certified check within **15 days** after the contract has been mailed to the bidder shall be just cause for the cancellation of the award and the forfeiture of the proposal guaranty. Award may then be made to the next lowest responsible bidder, or the work may be re-advertised and performed under contract or otherwise, as the Commission may decide. No contract shall be considered effective until it has been executed by all parties thereto.

**SECTION (4):  
PROPOSAL SUBMISSION INFORMATION**

**(A) SUBMISSION OF PROPOSALS**

1. **Pricing and Signature:** Proposals should be priced, signed and returned (with necessary attachments) to attention: Teresa ( Terri) Mount, Senior Procurement Agent, as provided in this RFP. Specifically, any form containing a signature line in this RFP and any amendments, pricing pages, etc., must be manually signed and returned as part of the proposal.
2. **Submission of All Data Required:** The Offeror must respond to this RFP by submitting all data required in paragraph (B) below for its proposal to be evaluated and considered for award. Failure to submit such data shall be deemed sufficient cause for disqualification of a proposal from further consideration.
3. **Public Inspection:** The Offeror is hereby advised that all proposals and the information contained in or related thereto shall be open to public inspection and that MHTC does not guarantee nor assume any responsibility whatsoever in the event that such information is used or copied by individual person(s) or organization. Therefore, the Offeror must submit its proposal based on such conditions without reservations.
4. **Clarification of Requirements:** Any and all questions regarding specifications, requirements, competitive procurement process, or other questions must be directed to Teresa (Terri) Mount, Senior General Services Specialist, email: teresa.mount@modot.mo.gov, (314) 301-1431 telephone, Missouri Department of Transportation, 2309 Barrett Station Road, Ballwin, MO 63021. All written questions must be addressed to Teresa (Terri) Mount no later than **10:00 a.m., CST, March 12, 2012** Once all the questions are gathered, MoDOT will issue an addendum and post the responses to all questions on-line for Offerors to retrieve, **March 16, 2012.**

**(B) REQUIRED ELEMENTS OF PROPOSAL**

1. **Specifications.** The proposal must clearly identify the Offeror's products in all technical areas of the specifications, indicating on a line by line basis if the products so offered meet the specifications as written.
2. **Proposed method of performance:** Proposals will be evaluated based on the offeror's distinctive plan for performing the requirements of the RFP.

**(C) EVALUATION CRITERIA AND PROCESS**

1. **Evaluation Factors:** Any agreement for services resulting from this RFP shall be awarded to the Offeror providing the best proposal to MHTC. After determining responsiveness, proposals will be evaluated in accordance with the following criteria:

- A. Meeting all areas of Specifications 50 %
- B. Proposed Method of Performance; 25 %  
Overall technical approach and quality control plan
- C. Cost, Fees and Expenses; 25 %

2. **Historic Information:** MHTC reserves the right to consider historic information and facts, whether gained from the Offeror's proposal, question and answer conferences, references, or other sources, in the evaluation process.

3. **Responsibility to Submit Information:** The Offeror is cautioned that it is the Offeror's sole responsibility to submit information related to the evaluation categories and that MHTC's representative is under no obligation to solicit such information if it is not included with the Offeror's proposal. Failure of the Offeror to submit such information may cause an adverse impact on the evaluation of the Offeror's proposal.

**(D) PRICING**

1. **Fee Schedule:** The Offeror must submit a proposed fee for all items defined in the Scope of Work. This fee must be shown on Section (5), Price Page, of this proposal which must be completed, signed and returned with the Offeror's proposal.

**AWARD**

Award will be based on Best Value. Award will be made to the most responsive and responsible bidder whose proposal is determined to be most advantageous to MoDOT, taking into consideration all evaluation factors. Bidders should submit proposals for each type of board requested.

**SECTION (5):  
PRICE PAGE (1)**

**(A) FEE SCHEDULE:** The Offeror shall indicate below all fees for providing items in accordance with the provisions and requirements stated herein. Total cost shall be submitted with the response.

DMS TYPE	Quantity	Unit Cost	Extended Cost	Required Delivery
Specification Type A Indicate Model/Brand/ Manufacturer of proposed unit(s) below:  Training	11 Each  Lump Sum	\$  \$	\$  \$	<b>August 15, 2012</b> (1 each) <b>December 31, 2012</b> (2 each) <b>August 15, 2013</b> (7 each) <b>December 31, 2013</b> (1 each)
Specification Type B Indicate Model/Brand/ Manufacturer of proposed unit(s) below:  Training	6 Each  Lump Sum	\$  \$	\$  \$	<b>December 31, 2013</b> (4 each) <b>August 15, 2013</b> (2 each)
Specification Type C- full color ( optional) Indicate Model/Brand/ Manufacturer of proposed unit(s) below:  Training	1  Lump Sum	\$  \$	N/A  \$	TBD
Specification Type D (optional) Indicate Model/Brand/ Manufacturer of proposed unit(s) below:  Training	1  Lump Sum	\$  \$	N/A  \$	TBD

\_\_\_\_\_  
Offeror's Authorized Signature:

\_\_\_\_\_  
Date:

\_\_\_\_\_  
Company Name:



**(D) PRICE PAGE (2)**

**REPLACEMENT COMPONENTS:**

**SPECIFICATION A** Indicate recommended number of “on site” replacement parts.

Indicate Model/Brand/ Manufacturer of proposed unit(s) below:

Description	Unit Cost	Lead Time	Recommended “on site”
Display Module			
Module Driver Assembly			
Power Supply Assembly			
Surge Device Sets			
Sign Controller			
Thermostat Assembly			
Light Level Detector Assy			
Fan Assembly			

**SPECIFICATION B**

Indicate Model/Brand/ Manufacturer of proposed unit(s) below:

Description	Unit Cost	Lead Time	Recommended “on site”
Display Module			
Module Driver Assembly			
Power Supply Assembly			
Surge Device Sets			
Sign Controller			
Thermostat Assembly			
Light Level Detector Assy			
Fan Assembly			

**SPECIFICATION C**

Indicate Model/Brand/ Manufacturer of proposed unit(s) below:

Description	Unit Cost	Lead Time	Recommended “on site”
Display Module			
Module Driver Assembly			
Power Supply Assembly			
Surge Device Sets			
Sign Controller			
Thermostat Assembly			
Light Level Detector Assy			
Fan Assembly			

**SPECIFICATION D**

Indicate Model/Brand/ Manufacturer of proposed unit(s) below:

Description	Unit Cost	Lead Time	Recommended "on site"
Display Module			
Module Driver Assembly			
Power Supply Assembly			
Surge Device Sets			
Sign Controller			
Thermostat Assembly			
Light Level Detector Assy			
Fan Assembly			

\_\_\_\_\_  
Offeror's Authorized Signature:

\_\_\_\_\_  
Date:

\_\_\_\_\_  
Company Name:

(E) COOPERATIVE AGREEMENT NOTICE  
SL12-071-RW DYNAMIC MESSAGE SIGN ASSEMBLIES

The Department is interested in assisting Missouri governmental entities, etc. in purchasing equipment, various materials and supplies that meet the Highway and Transportation Department specifications.

Each bidder is asked to indicate below whether they would be willing to offer **Dynamic Message Sign Assemblies** listed in the attached "Request for Proposal" for sale to these local political entities at the same proposal price offered to this Department.

It is understood the Department will not issue purchase orders, accept delivery nor make payment for these items ordered by any of these agencies. It is further understood the price is based on the Dynamic Message Assemblies meeting the Department specifications. Any added options, deletions, or extra freight costs would be negotiated between the local agency and the successful vendor.

Indicate below whether your company is willing to offer such cooperative purchasing for Missouri counties, cities or other political entities.

YES \_\_\_\_\_ NO \_\_\_\_\_

If the price varies throughout the state on Department bids because of different delivery destinations, please indicate the price f.o.b. your location that would be offered as described.

F.O.B. Location \_\_\_\_\_

Indicate the deadline date that orders will be accepted. \_\_\_\_\_

COMPANY NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

PHONE NUMBER \_\_\_\_\_

SIGNATURE \_\_\_\_\_

TITLE \_\_\_\_\_

DATE \_\_\_\_\_

(Each vendor should complete the appropriate sections of their form and submit with their bid.)

**EXHIBIT I**  
**MISSOURI SERVICE-DISABLED VETERAN BUSINESS PREFERENCE**

By virtue of statutory authority, RSMo 34.074, a preference will be given all contracts for the performance of any job or service to service-disabled veteran business either doing business as Missouri firms, corporations, or individuals; or which maintain Missouri offices or places of business, when the quality of performance promised is equal or better and the price quoted is the same or less or whenever competing bids, in their entirety, are comparable.

Definitions:

**Service-Disabled Veteran** is defined as any individual who is disabled as certified by the appropriate federal agency responsible for the administration of veterans' affairs.

**Service-Disabled Veteran Business** is defined as a business concern:

- a. Not less than fifty-one (51) percent of which is owned by one or more service-disabled veterans or, in the case of any publicly owned business, not less than fifty-one (51) percent of the stock of which is owned by one or more service-disabled veterans; and
- b. The management and daily business operations of which are controlled by one or more service-disabled veterans.

If an offeror meets the definitions of a service-disabled veteran and a service-disabled veteran business as defined in 34.074 RSMo and is either doing business as a Missouri firm, corporation, or individual; or maintains a Missouri office or place of business, the offeror **must** provide the following with the proposal in order to receive the Missouri service-disabled veteran business preference over a non-Missouri service-disabled veteran business when the quality of performance promised is equal or better and the price quoted is the same or less or whenever competing proposals, in their entirety, are comparable:

- a. A copy of a letter from the Department of Veterans Affairs (VA), or a copy of the offeror's discharge paper (DD Form 214, Certificate of Release or Discharge from Active Duty) from the branch of service the offeror was in, stating that the offeror has a service-connected disability rating ranging from 0 to 100% disability; and
- b. A completed copy of this exhibit

(NOTE: For ease of evaluation, please attach copy of the above-referenced letter from the VA or a copy of the offeror's discharge paper to this Exhibit.)

By signing below, I certify that I meet the definitions of a service-disabled veteran and a service-disabled veteran business as defined in 34.074 RSMo and that I am either doing business as a Missouri firm, corporation, or individual; or maintain Missouri offices or places of business at the location(s) listed below.

Veteran Information

Business Information

\_\_\_\_\_  
 Service-Disabled Veteran's Name, (Please Print)

\_\_\_\_\_  
 Service-Disabled Veteran Business Name

\_\_\_\_\_  
*Service-Disabled Veteran's Signature*

\_\_\_\_\_  
 Missouri Address of Service-Disabled Veteran Business





I am aware and recognize that, unless certain contract and affidavit conditions are satisfied pursuant to Section 285.530, RSMo, the aforementioned business entity may be held liable under Sections 285.525 through 285.550, RSMo, for subcontractors that knowingly employ or continue to employ any unauthorized alien to work within the state of Missouri.

I acknowledge that I am signing this affidavit as a free act and deed of the aforementioned business entity and not under duress.

\_\_\_\_\_  
Affiant Signature

Subscribed and sworn to before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_.

\_\_\_\_\_  
Notary Public

My commission expires:

*[documentation of enrollment/participation in a federal work authorization program attached]*



I am aware that Missouri law provides that any person who obtains any public benefit by means of a willfully false statement or representation, or by willful concealment or failure to report any fact or event required to be reported, or by other fraudulent device, shall be guilty of the crime of stealing pursuant to Section 570.030, RSMo, which is a Class C felony for stolen public benefits valued between \$500 and \$25,000 (punishable by a term of imprisonment not to exceed 7 years and/or a fine not more than \$5,000 – Sections 558.011 and 560.011, RSMo), and is a Class B felony for stolen public benefits valued at \$25,000 or more (punishable by a term of imprisonment not less than 5 years and not to exceed 15 years – Section 558.011, RSMo).

I recognize that, upon proper submission of this sworn affidavit, I will only be eligible for temporary public benefits until such time as my lawful presence in the United States is determined, or as otherwise provided by Section 208.009, RSMo.

I understand that Missouri law requires MHTC/MoDOT to provide assistance in obtaining appropriate documentation to prove citizenship or lawful presence in the United States, and I agree to submit any requests for such assistance to MHTC/MoDOT in writing.

I acknowledge that I am signing this affidavit as a free act and deed and not under duress.

\_\_\_\_\_  
\_\_\_\_\_

Affiant Signature

Affiant's Social Security Number or  
Applicable Federal Identification Number

Subscribed and sworn to before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_.

\_\_\_\_\_  
Notary Public

My commission expires:

**MISSOURI DOMESTIC PRODUCTS PROCUREMENT ACT**

The bidder’s attention is directed to the Missouri Domestic Products Procurement Act, Sections 34.350 to 34/359, RsMO, which requires all manufactured goods or commodities used or supplied in the performance of this contract or any subcontract to be manufactured or produced in the United States.

Section 34.355, RsMO, requires the vendor or contractor to certify his compliance with Section 34.353 and, if applicable, Section 34.359, RsMO, at the time of bidding **and** prior to payment. Failure to comply with Section 34.353, RsMO, during the performance of the contract **and** to provide certification of compliance prior to payment will result in nonpayment for those goods or commodities.

Section 34.353.2, RsMO, specifies that it does not apply where the total contract is less than Twenty-Five Thousand Dollars (\$25,000.00). If your total bid is Twenty-Five Thousand Dollars (\$25,000.00) or more, you **must** complete this form as directed below.

**Failure to complete and return this document with this bid will cause the State to presume the manufactured goods or products listed in the bid are not manufactured or produced in the United States, and the bid will be evaluated on that basis. Please read the certification appearing below on this form.**

[ ] If all the goods or products specified in the attached bid which the bidder proposes to supply to the State shall be manufactured or produced in the “United States” as defined in Section 34.350, RsMO, check the box at left.

[ ] If only one item of any particular goods or products specified in the attached bid is manufactured or produced in the “United States” as defined in Section 34.350, RsMO, check the box at left and list the items (or item number) here:

\_\_\_\_\_

\_\_\_\_\_

[ ] If any or all of the goods or products specified in the attached bid which the bidder proposes to supply to the State are **not** manufactured or produced in the “United States” as defined in Section 34.350, RsMO, then: (a) check the box at left; (b) list below, by item (or item number), the country other than the United States where each good or product is manufactured or produced; and (c) check the boxes to the left of the paragraphs below if applicable and list the corresponding items (or item numbers) in the spaces provided.

Item (or item number)	Location Where Item Manufactured or Produced

(attach an additional sheet if necessary)

[ ] The following specified goods or products cannot be manufactured or produced in the United States in sufficient quantities or in time to meet the contract specifications. Items (or item numbers):

\_\_\_\_\_

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[ ] The following specified goods or products must be treated as manufactured or produced in the United States, in accordance with an existing treaty, law, agreement, or regulation of the United States, including a treaty between the United States and any foreign country regarding export-import restrictions or international trade. Items (or item numbers):

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**CERTIFICATION**

**By submitting this document, completed as directed above, with a bid, the bidder certifies under penalty of making false declaration (Section 575.060, RsMO) that the information contained in this document is true, correct and complete, and may be relied upon by the State in determining the bidders qualifications under and in compliance with the Missouri Domestic Products Procurement Act.**

The bidder's failure to complete and return this document with the bid as directed above will cause the State to presume the manufactured goods or products listed in the bid are not manufactured or produced in the United States, and the bid will be evaluated on that basis pursuant to Section 34.353.3(2), RsMO.

**EXHIBIT VI**  
SL12-071-RW DMS

**BID BOND**

**KNOW ALL MEN BY THESE PRESENTS**, that  
we \_\_\_\_\_

\_\_\_\_\_,  
as Principal and \_\_\_\_\_, as Surety are held  
and firmly bound  
unto the **STATE OF MISSOURI** (acting by and through the **Missouri Highways and  
Transportation Commission**) in the penal sum of:

\_\_\_\_\_ Dollars (\$ \_\_\_\_\_) to be paid to the **State of Missouri or to the  
Missouri Highways and Transportation Commission**, to be credited to the State Road Fund,  
the Principal and Surety binding themselves, their heirs, executors, administrators, successors,  
and assigns, jointly and severally, firmly by these presents.

Sealed with our seals and dated this \_\_\_\_\_

**THE CONDITION OF THIS OBLIGATION** is such that:

**WHEREAS**, the Principal is submitting herewith a bid to the Missouri Highways and  
Transportation Commission for furnishing Arterial DMS Boards as set out in the bid to which  
this bond is attached.

**NOW THEREFORE**, if the Missouri Highways and Transportation Commission shall accept  
the bid of the Principal and if said Principal shall properly execute and deliver to the Missouri  
Highways and Transportation Commission the contract and contract bond in compliance with the  
requirements of the proposal, the specifications and the provisions of law, to the satisfaction of  
the Highways and Transportation Commission, then this obligation shall be void and of no  
effect, otherwise to remain in full force and effect.

In the event the said Principal shall, in the judgment of the Missouri Highways and  
Transportation Commission, fail to comply with any requirement as set forth in the preceding  
paragraph, then the State of Missouri acting through the Missouri Highways and Transportation  
Commission shall immediately and forthwith be entitled to recover the full penal sum above set  
out, together with court costs, attorney's fees and any other expense of recovery.

(SEAL)

\_\_\_\_\_  
Principal

By \_\_\_\_\_  
Signature

(SEAL) \_\_\_\_\_  
Surety

By \_\_\_\_\_  
Attorney-in-Fact

NOTE: This bond must be executed by the PRINCIPAL and by a CORPORATE SURETY authorized to conduct surety business in the State of Missouri.