ITEM 683.85010111 - FULL MATRIX LED DYNAMIC MESSAGE SIGN ASSEMBLY
TYPE A

ITEM 683.85010211 - FULL MATRIX LED DYNAMIC MESSAGE SIGN ASSEMBLY
TYPE B

DESCRIPTION. This work item shall consist of the furnishing and installation of a complete Full Matrix LED Dynamic Message Sign Assembly Type A and B at locations indicated in the contract documents.

MATERIALS.

The Full Matrix LED Dynamic Message Sign Assembly Type A shall be the latest version of Daktronics® Vanguard® VF-2350-48x192-46-A with the access catwalk assembly platform.

The Full Matrix LED Dynamic Message Sign Assembly Type B shall be the latest version of Daktronics® Vanguard® VF-2350-32x96-46-A with the access catwalk assembly platform.

(a) General

The Full Matrix LED Dynamic Message Sign Assembly Type A shall be full-matrix and shall have a minimum display area of 2.415 M(h) X 8.708 M(w), with maximum housing size of 2.601 M(h) X 9.184 M(w) and a maximum weight of 1100 kg. When the sign is utilized to display textual messages with standard 457 mm-height characters, the display area must be nominally equivalent to a line-matrix dynamic message sign that displays three lines with approximately 18 characters per line.

The Full Matrix LED Dynamic Message Sign Assembly Type B shall be full-matrix and shall have a minimum display area of 1.74 M(h) X 4.32M(w), with maximum housing size of 1.92 M(h) X 4.85 M(w) and a maximum weight of 500 kg. When the sign is utilized to display textual messages with standard 457 mm-height characters, the display area must be nominally equivalent to a line-matrix dynamic message sign that displays three lines with approximately 18 characters per line.

- The Dynamic Message Sign shall utilize discrete LED (Light Emitting Diode) technology and shall be furnished with all necessary equipment. The LED Dynamic Message Sign Assembly shall consist of a light emitting diode dynamic message sign with enclosure, electronic components necessary for the display of messages, and auxiliary equipment that interface with a sign controller that is housed in a separate sign controller field cabinet at a location in front of the sign. The LED Dynamic Message Sign assembly shall be housed in
a complete and fully wired aluminum weatherproof cabinet, meeting AASHTO structural standards. The dynamic message sign shall provide a clear readable message in all normally encountered weather and lighting conditions.

- The Light Emitting Diode Dynamic Message Sign will be used as a traveler’s information sign.

- The complete LED Dynamic Message Sign Assembly shall conform to the requirements of current NEMA Standards No. TS-4, section 2, Environmental Standards and Test Procedures, except as amended and supplemented hereinafter. The manufacturer shall Supply certification for equipment compliance with NEMA environmental standards in accordance with NEMA testing procedures.

- Materials not specifically covered in these specifications shall be in accordance with the accepted standards of the National Electrical Manufacturers Association, The Underwriters Laboratories Inc., the National Electrical Code, and the American Society for Testing and Materials.

- The presence of ambient radio signals, magnetic or electromagnetic interference, including those from power lines, transformers, or motors within 0.3 meters 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 portions of the DMS display shall be clearly visible and legible from in-vehicle viewing distances between 30 meters and 330 meters under normal freeway operating conditions. The sign assembly shall be designed to operate in roadway configurations of at least five lanes.

(b) Light Emitting Diode Display

- The light emitted by the LED display shall be amber with a peak wavelength centered at approximately 592 nanometers.

- Each pixel shall be 40 candela at 20 mA. Forty candelas shall be attained by the sum of the brightness of the individual LED's in each pixel. The brightness of each LED shall be measured in accordance with the CIE Test method A, as described in CIE 127-1997,
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- Certification shall be provided from the LED manufacturer that demonstrates that the LED's were tested in accordance with CIE Test Method A.

- The LED’s used in the display shall be obtained from batches sorted for luminous output, where the highest luminosity LED shall not be more than fifty percent more luminous than the lowest luminosity LED. The sign shall be bridged in all lighting conditions for optimum viewing. It shall be bright enough to have a good target value, but not to the point where the pixels bloom, especially in low ambient light level conditions. The brightness and color of each pixel shall be uniform over the entire face of the sign within the 30° cone of vision from 335 m to 30 m in all lighting conditions. Non-uniformity of brightness or color over the face of the sign under these conditions shall be cause for rejection of the sign. The sign assembly shall be designed to operate in roadway configurations of at least five lanes.

- The LED MTBF (Mean Time Before Failure) shall be on at minimum 100,000 hours of permanent use, at an operating temperature of 100° Celsius or below. The LED MTBF shall be given for the specific forward current used to drive the LED.

- The LED manufacturer's technical specification sheet shall be supplied to document the technical requirements of the precedent Subsections of Section (b) Light Emitting Diode Display.

- The LED display shall have a minimum refreshment rate of approximately 100 frames per second.

- Continuous current drive 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 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. Brightness shall be manually settable from the front panel of the controller and remotely from the DMS Central Control System in 1% increments. Brightness control shall be able to be returned to automatic from the sign controller front panel and the central computer. The sign controller shall monitor the photo cell circuits in the sign and convert the measured light intensity into the desired pixel brightness. The photo circuit readings shall be correlated with a brightness table in the sign controller. The Brightness table shall have a minimum of 255 brightness levels. Automatic adjustment of the LED driving waveform
duty cycle shall occur in small enough increments so that brightness of the sign changes smoothly, with no perceivable brightness change between adjacent levels. The Brightness table in each individual sign controller shall be adjustable from the central controller and can be customized according to the requirements of the installation site. Each sign shall have its own, independent Brightness table.

The LED’s shall be grouped in pixels consisting of discrete LED’s arranged in a continuous matrix. LED’s shall be individually installed and separately connected to the circuit board. The matrix shall be organized as a continuous display with individual pixel addressability. The display shall be 1763 mm high and consist of a minimum of 27 rows (Horizontal) by minimum of 90 columns (Vertical) pixel matrix. The centers of all pixels on the display shall be spaced so as to maintain the same horizontal and vertical clearance between adjacent pixels. The LED grouping and mounting angle within a pixel shall be optimized for maximum readability.

- Each pixel shall have the same number of LED’s.

- Each pixel shall have a device attached to the printed circuit board (PCB) to hold and protect the LED’s. These devices shall:
  - Hold the LED’s perpendicular to the display modules within 0.5°,
  - Prevent the LED’s from being crushed or bent during handling,
  - Protect the LED’s from damage when the display module is laid on the front surface (the side that the LED lamps are located),
  - Be easily removable from the display module PCB without any tools,
  - Not put any stress on the LED’s due to differentials of expansion and contraction between the device and the LED’s over the herein specified temperature range,
  - Not become loose or fall off during handling or due to vibrations,
  - Not block airflow over the leads of the LED’s
  - Not block the light output of the LED’s at the required viewing angle,
  - Be black in color to maximize contrast.

- Two separate types of pixel status feedback shall be provided to the central controller from the local sign controller. These include a pixel test and a pixel read.

- Pixel Test: The pixel test shall be programmable by time of day and be performed from the DMS Central Control System on command and automatically once a day. During a pixel test, the full operational status of each string of LED’s in each pixel shall be tested
and then transmitted to the DMS Central Control System or laptop computer. A list of defective pixels shall be provided, listing pixel status, row number, column number and row number for each defective pixel. The pixel test may briefly disturb the displayed message for less than 0.5 seconds.

- Pixel Read: The pixel read shall be performed during a message download and during every sign poll from the DMS Central Control System or laptop computer. The pixel read shall perform a real-time read of the displayed message and shall return the state of each pixel to the central controller as it is currently displayed to the motorist, including any errors. This shall allow the central controller operator to see what is visibly displayed to the motorist on an individual pixel basis. During a pixel read, the state of each pixel (full-on, half-on or off) in the sign shall be read by the sign controller to allow the central controller or laptop computer to show the actual message, including static, flashing and alternating messages, that is visibly displayed on the sign in a What You See Is What You Get (WYSIWYG) format. This pixel reading shall take place while a message is displayed on the sign without disturbing the message in any way. Any flashing, flickering, blinking, dimming, or other disturbance of the message during this pixel read shall be cause for rejection of the sign.

- The LED display shall have the capability of displaying up to 3 main lines of 457 mm high characters. The full matrix display shall be in accordance with the contract documents to which this specification applies.

- The LED’s shall be protected from degradation due to sunlight. The method utilized shall not obstruct the view of the display from the roadway. The pixel construction technique shall not reduce the display-viewing angle below that provided by the LED. The device utilized to protect the sign from Ultra Violet (UV) radiation shall be constructed in a manner that prevents warping, sagging, and distortion for a period of 20 years or more.

(c) Printed Circuit Boards

- Printed Circuit Board (PCB) design shall be such that components may be removed and replaced without damage to boards, traces or tracks.

- Only FR-4 16 mm material shall be used. Inter-component wiring shall be copper clad track having a minimum weight of 0.61 kg per square meter with adequate cross section for current to be carried. Jumper wires will not be permitted, except from plated-through
holes to component. The maximum number of jumper wires allowed per circuit board is two.

- All PCBs shall be finished with a solder mask and a component identifier silk screen.

- All Printed Circuit Boards (PCBs), except for the LED mother board, and power supply PCBs shall be completely conformal coated with a 0.25 mm minimum thickness silicone resin conformal coat. The LED mother boards shall be completely conformal coated, except at the pixels on the front of the PCB, with a 0.25 mm minimum thickness silicone resin conformal coat. The material used to coat the PCBs shall meet the military specification: MIL-I-46058C Type SR.

(d) Power Supply

Regulated DC Power Supplies
The LED pixel display modules shall be powered with auto-ranging regulated switching power supplies that convert the incoming AC to DC at a nominal voltage of 24 volts DC. Power supplies shall be wired in a redundant parallel configuration that uses multiple supplies for the VMS display matrix.

Power supplies shall be arranged in redundant pairs within the display such that each pair supplies power to a defined region of the sign. Each pair of power supplies shall contain two (2) physically and electrically independent supplies. Each pair of power supplies shall be parallel, but shall not be wired in a current sharing configuration.

Power supplies within each pair shall be redundant and rated such that if one supply fails, the remaining supply shall be able to operate 100% of the pixels in that display region at 100% brightness when the internal VMS air temperature is +140°F (60°C) or less.

The power supplies shall be sufficient to maintain the appropriate LED display intensity throughout the entire operating input voltage range.
The output of each power supply will be connected to multiple circuits that provide power to the LED modules. Each output circuit shall not exceed 15 amperes and shall be fused.

Each group of power supplies shall be monitored by a microprocessor-controlled circuit. This circuit shall monitor the voltage of each power supply and the status of each output circuit’s fuse. The power supply voltages and fuse states shall be reported via a CAN (controller area network) communication network to the sign controller upon request.

The power supplies used to power the LED pixel modules shall be identical and interchangeable throughout the VMS.

Regulated DC power supplies shall conform to the following specifications:

- Nominal output voltage of 24 VDC +/- 10%
- Nominal maximum output power rating of 1000 watts
- Operating input voltage range shall be a minimum of 90 to 260 VAC
- Operating temperature range shall be a minimum of –30ºF to +165ºF (-34ºC to +74ºC)
- Maximum output power rating shall be maintained over a minimum temperature range of –30ºF to +140ºF (-34ºC to +60ºC)
- Power supply efficiency shall be a minimum of 80%
- Power factor rating shall be a minimum of 0.95
- Power supply input circuit shall be fused
- Automatic output shut down and restart if the power supply overheats or one of the following output faults occurs: over-voltage, short circuit, or over-current
- Power supplies shall be UL listed
- Printed circuit boards shall be protected by an acrylic conformal coating
All LED module power supplies shall be continuously monitored by the sign controller. The sign controller shall provide the status to the DMS Central Control System or laptop computer when the sign controller is polled by the central controller or laptop computer.

There shall be a power distribution system that connects each display module to all power supplies and minimizes the voltage drop over the face of the sign. The voltage measured at the display modules shall not vary more than 50 millivolts over all the display modules in the sign with 17 pixels on at 100% intensity in each and every display module.

The Power Supplies shall be short circuit protected by Direct Current (DC) power OFF, and shall reset automatically after 5 seconds of Alternating Current (AC) power OFF. The power supplies shall also be protected by an overload allowance ranging from 105% to 135% and by a suitable inrush current allowance to be recommended by their manufacturer.

The Power Supplies shall have an efficiency rating of at least 75%.

The LED display operating range shall be -40 to +70° Celsius.

The technical data sheet for the power supply shall be supplied to document the technical requirements.

The components utilized in the Power Supplies shall be UL listed. Copies of UL product cards shall be supplied to document the listing.

(e) Electronics

All electronics shall be of 100% Solid State technology except for fans and thermostat.

All high voltage (Exceeding 24 Volt DC) electronic and electrical components used in the LED display or the digital control unit shall be UL listed. Copies of the UL product cards shall be supplied on request of the Engineer to document the listings.

The LED driver electronics shall not be mounted on the same board as the LED’s. The
driver board shall utilize socket-mounted chips that can be easily changed in the field. The driver board shall be easily separated from the LED board in the field using simple hand tools. Such update shall not require the use of solder. The mounting design shall utilize mechanical fasteners that are resistant to vibration.

- In order to protect all different parts of the dynamic message sign assembly and sign controller field cabinet from lightning and other electric and electromagnetic surges, all necessary equipment shall be supplied as part of the dynamic message sign assembly and sign controller field cabinet. AC input transient and surge protection shall meet or exceed the UL 1449 standard:
  - Separate surge suppressors for the LED display and the sign controller
  - Lightning arrester for the LED Dynamic Message Sign Enclosure.
  - Data line protector
  - Telephone line noise and surge protection
  - All electronic equipment within the Dynamic Message Sign Enclosure and sign controller field cabinet is to be grounded.

CONSTRUCTION DETAILS.

The Contractor shall submit the shop drawings, Professional Engineer calculations, analyses and certifications listed in this section to the Engineer for approval a minimum of 30 calendar days prior to construction of the Dynamic Message Signs.

The Contractor shall furnish and install minimum three 50 mm galvanized steel conduits between DMS sign controller cabinet and DMS sign. The contractor shall furnish and install all communication, control signal, grounding and power cables between the DMS Sign and the DMS sign controller cabinet. The payment for these conduits and cables shall be included under Full Matrix LED Dynamic Message Sign Item.

- Sign Enclosure
  a. The sign enclosure shall be side mounted on poles or structure along the highway where indicated on the plans. The sign enclosure shall be a front access Enclosure type and be a weatherproof enclosure that houses all electrical, communication, and electronic control devices necessary for the operation of the sign. The sign enclosure shall be attached to the support structure.
  b. The sign enclosure shall be assembled from anodized aluminum extrusions. Internal
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supports shall provide structural integrity, rigid enough to prevent deformation under a 130 km/h wind load. All metallic parts shall be protected against corrosion utilizing electrolytic treatment or metallic coating in accordance with New York State Department of Transportation, Construction and Materials, Section 719.

c. The Dynamic Message Sign Enclosure shall be assembled from a continuously welded aluminum skin of at least 3.1 mm minimum thickness. The enclosure shall meet or exceed all applicable latest AASHTO structural standards. Internal supports shall be of extruded aluminum members welded to form a structural framework to provide rigidity and structural integrity. All metallic parts shall be protected against corrosion. The sign case and facial area shall be treated with a flat-black, factory-applied, kynar fluoro polymer resin based coating providing a minimum life span of 20 years. As part of the shop drawing submittal, the vendor may propose an alternate means of protecting the metal surfaces. Such alternates shall be subject to the approval of the Engineer and shall provide equivalent protection.

d. The DMS housing shall also withstand a front face ice load of 190 N/square meter (4 psf). The DMS housing design shall be certified and sealed by a Professional Engineer registered in the State of New York. Professional Engineer calculations and a complete set of sealed DMS housing drawings shall be included with the DMS manufacturer’s submittal. In addition, the Contractor shall provide a Professional Engineer’s analysis and certification to verify that the DMS meets the requirements for fatigue resistance according to N.C.H.R.P., Report 412.

e. The housing shall contain an interior non-corrosive metal cage support frame to mount the display elements. The cage support frame shall withstand and minimize vibration when the sign is mounted with any number of display elements.

f. The housing and cage support frame shall be configured such that there will be a continuous unobstructed horizontal clearance from housing and cage supports to electrical components as required by the National Electric Code.

g. Dimensions of the sign enclosure shall allow for separation between lines equal to one-half (½) the character height if the sign is displaying textual messages that are 457 mm in height. Top, bottom and side borders shall be two-thirds the character height in width, given the vertical and horizontal constraints.

h. Two permanent (non-removable) lifting eyes shall be provided on the DMS housings to permit lifting of the sign housing on to the sign structure. Although the fully assembled sign will be lifted into place using both lifting eyes, each lifting eye shall be of sufficient structural strength to allow the sign to be lifted or moved without damage or permanent deformation to any part of the sign. A lifting mechanism shall be provided for transporting and installing the DMS and shall be a permanent, integral part of the DMS housing.
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structural frame. Professional Engineer analysis of the DMS housing design shall include certification of the DMS lifting mechanism

i. A cover shall be provided for the Dynamic Message Sign. This cover will be used to ensure that the sign is concealed prior to the acceptance of the sign for operation.

- Foundations:
  Pole foundations are to be provided under Type B Sign Post. Refer to MTAB&T Standard Specifications and the appropriate Standard Sheets for installation details and payment.

- The sign enclosure ventilation shall include intake, exhaust, filtration, fan assembly and environmental control. The ventilation system shall be a negative-pressure, filtered, force-air system which cools both the display modules and the sign housing interior.

- Louvered Vent Hood
  The Louvered vent hood shall be installed on the back wall of the sign enclosure, near the bottom. The louvered vent hood depth shall be a maximum of 76 mm. The number and size of the vent hoods shall be determined by the supplier to be of sufficient size to provide adequate ventilation. The bottom of each vent hood shall be screened to prevent animals from building nests inside the vent hood.

- Air Filters
  A removable, two-stage, air filter system shall be installed behind each louvered vent. The filter filtration area shall completely cover the vent opening area. A shell shall be used to provide mechanical support for the filter. The shell shall be louvered to direct the incoming air downward. The shell sides and top shall be bent to house the filter. The filter resident in its shell shall be held firmly in place with a bottom bracket and a spring loaded upper clamp. No incoming air shall bypass the filter. The bottom filter bracket shall be formed into a waterproof sump with drain holes to the outside housing. The two-stage filter shall remove all particles 500 microns in diameter and larger.

- Electric Fan
  The sign 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 ensure at least 25% spare capacity over that required to support the ambient temperature range over which the DMS shall operate. In addition, the spare capacity shall be sufficient to maintain 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.

- **Thermostatic Control**
  The fans shall be controlled from outputs driven by the sign controller. The sign controller shall include control parameters in the database which specify the turn-on temperature. Both parameters shall be in the range of 20 to 80° C. The ventilation system shall be activated by multiple temperature sensors. There shall be a minimum of two sensors located at each end of the display module and the lens panel. There shall be an additional temperature sensor located to accurately measure the ambient temperature outside the sign housing. The temperature sensors shall have an accuracy of ±1.5° C and a range from -40 to +70° C.

- The temperatures from the sensors shall be continuously measured and monitored by the sign controller. A temperature reading greater than a user selectable critical temperature shall cause the sign to go to blank and the sign controller shall report this error message to the DMS Central Control System.

- The ventilation system shall be equipped with a manual override timer to provide ventilation for service personnel. The timer shall have a minimum on-time of 1 hour.

- The LED modules and electronic equipment shall be protected by a fail-safe, back-up fan control system in the event of an electronic fan control failure or shutdown of the sign controller.

- **Humidity Control**
  A humidity sensor shall be provided and sensed by the sign controller from zero percent to 100 percent relative humidity in one percent or fewer increments. The sensor shall operate and survive from 0 percent to 100 percent relative humidity. The sensor shall have an accuracy that is better than ± five percent relative humidity.

The sign controller shall read the internal temperature sensors, external ambient temperature sensor and the humidity sensor. The sign controller shall use these readings in an algorithm that turns on the heat tape and/or the fans at the appropriate times to reduce either frost on the face of the sign or condensation on the display modules and other electronic circuitry.
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- No moving parts shall be used in the Dynamic Message Sign Enclosure construction, except for the cooling fans.

- The front face of the Dynamic message sign shall be made of clear, high-grade polycarbonate panels and feature the following minimal mechanical characteristics:
  - Resistance to traction: 55 N/mm²
  - Elasticity in flexion: 2,200 N/mm²
  - Elongation at the limit of elasticity: 6%
  - Elongation before rupture: 100%
  - Hardness: 95 N/mm²
  - UL94 fire rating: VO

  - The pigmentation of the polycarbonate and its optical characteristics shall guarantee the transmission of at least 85% of the light emitted by the LED’s.

  - The external face shall feature a non-glare finish.

  - The manufacturer's technical data sheet for the material utilized for the front face shall be provided as part of the submittal package.

  - The manufacturer shall consider darkening portions of the face through which the LED’s do not radiate. As an alternate, a metal screening constructed of dark metal may be utilized to improve LED contrast. However, such application shall not reduce the viewing angle of the LED display. The manufacturer shall include an analysis of both techniques in the submittal which shall document the advantages and disadvantages of either approach. The Engineer reserves the right to direct the shading alternative to be utilized at no additional cost, based on the data presented and accepted industry standards.

  - The rear face shall be made of one or several panels of aluminum with all seams continuously welded. The panels shall be at least 3 mm thick.
• The LED’s shall be arranged on a black non-glossy background or protected with a dark screening. All clearly visible electronic components shall be of black color or shall be coated with black non-glossy paint. The spacing between the display and the frame of sign enclosure shall be 305 mm minimum.

• The Dynamic Message Sign Enclosure shall be weatherproof, and drainage holes shall be drilled at the base of the enclosure. The bottom panel of the housing shall have a minimum of four drain holes in each section formed by internal structural members.

• A catwalk platform used to access the sign shall be provided with the sign as described by the Daktronics’ platform details. These details are available as information for the bidders. The platform shall be designed for the sign, tested and approved by the manufacturer.

• The display shall be assembled with modular LED boards less than 500 mm in length.

• The structural design of the LED sign enclosure shall conform to current AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals. Additional design criteria are as follows:
  • Wind Velocity = 130 km/h, minimum
  • 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.

• Certification by a Professional Structural Engineer, licensed in the State of New York, shall be supplied. This includes design calculations that verify that the sign enclosure meets all design criteria specified in this document.

• The LED display shall be equipped with three external light sensors. One sensor shall point downward. The other two sensors shall be oriented in opposite directions, perpendicular to the sign face. These sensors shall be scaled for up to 100,000 lux. These devices shall permit automatic light intensity measurement of light conditions at each sign location. The sensors shall be located in an easily accessible location for maintenance. The controller shall be able to automatically adapt the intensity of the LED display to match the
environmental luminosity by utilizing the PWM (Pulse Width Modulation) technique. Automatic adjustment of the LED brightness shall occur in small enough increments so that the brightness of the sign due to stray headlights shining upon the photo sensors at night will be sufficient to cause an incremental change in brightness.

The adjustable range for dimming shall be from 10 to 100% on a linear basis, and it shall be possible to disable the dimming via commands to the sign controller. The sign controller shall monitor the photocell circuits in the sign and convert the measured light intensity into the desired pixel brightness. The photo circuit readings shall be correlated with a brightness table in the sign controller.

- Physical Properties
  - Maintenance Access
    Access for all maintenance shall be from within the sign enclosure and from the side doors of the sign display. The sign design shall allow unobstructed and convenient access to all serviceable components between the sign display and the sign display cover.

- Modular Components
  All serviceable components shall be modular, interchangeable, and removable from within the sign enclosure. The sign display shall be composed of identical and readily interchangeable display modules. Each display module shall contain one or more display pixels. The replacement of any display module shall not require the use of any special tools. All wiring interconnecting individual display modules shall be modular harness assemblies with latching push-on/pull-off or twist on/off connectors.

- Display Module Removal
  The removal of any combination of one or more display modules shall not alter the structural integrity of the sign display assembly, nor of the sign enclosure. Nor shall the removal of any combination of display modules affect the operation of the remaining operational modules in any way. The display modules shall be removable without the use of any special tools.

- Environment
  The DMS shall be constructed to operate properly in accordance with these specifications under environmental conditions normally encountered on a freeway
in New York to include the following:
  • Ambient Temperature of -40 to +70° C
  • Humidity of 0% to 100% non-condensing

The design of the enclosure shall be to minimize the possibility of a relative humidity buildup exceeding 85%, non-condensing.

(a) Electrical Service

• Electrical Distribution Panel
  The primary electrical service panel shall be rated for 100 amperes minimum. The panel shall have an interrupt rating of not less than 10 kA RMS. Each utility outlet shall be provided with a separate circuit.

• Duplex Receptacle
  The sign enclosure shall be equipped with three, 20 amp, 120 VAC duplex (NEMA -15R) receptacles. Two receptacles shall be located approximately 1.20 m from each end, and one receptacle shall be located in the center of the sign enclosure.

• Ground-fault Protection
  The interior lighting circuits and the duplex receptacle circuits shall be protected by ground-fault, circuit-interrupters. Circuit interruption shall occur on 6 mA of ground-fault current and shall not occur on less than 4 mA of ground-fault current.

• Conduit and Wiring
  All lighting and receptacle circuits shall use at least #12 AWG wiring enclosed in thin wall 19 mm conduit.

• Surge Suppression and Protection
  All necessary equipment to protect all of the components of the Dynamic Message Sign assembly from electric and electromagnetic surges shall be supplied as part of the Dynamic Message Sign assembly. Such equipment shall consist of at a minimum, but not be limited to:

  Transient Protection
  The VMS and sign controller signal and power inputs shall be protected from electrical spikes and transients as follows:
SITE AC POWER

The AC power feed for all equipment shall be protected at the load center by a parallel-connection surge suppressor rated for a minimum surge of 10 kA.

CONTROL EQUIPMENT AC POWER

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:

- Withstand a peak 50,000 ampere surge current for an 8x20 microsecond wave form
- Maximum continuous operating current of 15 amps at 120 VAC, 60 Hz
- Series inductance of 200 micro henrys (nominal)
- Temperature range of –40ºF to +158ºF (-40ºC to +70ºC)
- Approximate dimensions of 3-inches wide by 5-inches long by 2-inches high (76 mm by 127 mm by 50 mm)
- The device shall be UL-1449 recognized
- UL 1449 surge rating of 400 V or less

COMMUNICATION SIGNALS

Transient voltage surge suppressors shall protect all communication signals connecting to the control equipment from off-site sources using copper cables.

Transient voltage surge suppressors shall protect all copper communication lines used to pass data between the sign controller and sign.

- All components, circuits and accessories considered necessary by the manufacturer to adequately protect the controller assembly and associated equipment from damage due to voltage surge shall be furnished. All devices shall be readily accessible for ease of replacement and not mounted behind any panel or enclosure.
The system power shall be protected by two stages of transient voltage suppression devices as required in the AC Power Section of this specification. Tripping of each stage (or both if tripped simultaneously) of the surge protection shall cause the sign controller to call the DMS Central Control System and report the error condition (for dial-up operation) or report the error condition to central on the next poll (for multi-drop Operation). There shall be an option that is either enabled or disabled and is selected and downloaded from the central controller to the sign controller. When this option is enabled, tripping of the second stage of surge protection shall prevent power from reaching any components of the sign until the surge protection has been replaced. When this option is disabled, the sign shall continue to function normally after the second stage of surge protection is tripped.

(b) Sign Controller

- General Functions
  Front Panel User Interface
  The sign controller’s front panel shall include a keypad and LCD. These devices shall be used to perform the following functions with the sign controller and VMS:

  - Monitor the current status of the sign controller, including the status of all sensors and a monochromatic what-you-see-is-what-you-get (WYSIWYG) representation of the message visible on the display face
  - Perform diagnostics testing of various system components, including pixels, power systems, sensors, and more
  - Activate messages stored in memory
  - Configure display parameters, including display size and colors
  - Configure communications port settings and NTCIP options

  The front panel interface shall also include:

  - Power switch to turn the controller on and off
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- LED power “on” indicator
- “Local/remote” switch that places the controller in local mode such that it can be controlled from the front panel interface, instead of via the primary NTCIP communication channel
- LED to indicate state of the “local/remote” mode switch
- Reset switch to quickly restart the controller
- LED “Active” indicator that blinks when the controller is operating correctly
- LED to indicate when any of the NTCIP communication channels are active

The sign controller shall control the operation of all equipment housed at the Dynamic Message Sign site. The sign controller shall be installed within a separate field cabinet in front of the Dynamic Message Sign. The sign controller shall respond to the direct commands from the system computer, and it shall respond to commands from the MTAB&T Laptop that is to be used during field testing.

- Computer Commands
  The sign controller shall receive and interpret commands sent by a host device. The sign controller shall also allow a requested message to be displayed on the sign. Upon request from a host device, the sign controller shall provide a message to the host device indicating the status of the sign.

- Operation Monitoring
  The sign controller shall continuously monitor command messages from the system computer. When a computer system poll is not received within a user defined threshold period (retention parameter), the controller shall blank the message.

- Sign Messages
  The sign controller shall maintain a library of not less than 60 different display messages and related parameters. These messages shall be retained in non-volatile electronic memory. The sign controller shall support uploading and downloading the message library.

- LED Temperature Monitoring
  The sign controller shall monitor the internal temperature of the sign housing
and shall reduce light output (DC forward current) when the temperature exceeds unacceptable thresholds. At least three temperature levels, settable via the system interface, shall be supported which result in increasingly lower power output to the LED’s. The sign controller shall perform an automatic sign shutdown when the temperature exceeds an absolute threshold. The sign controller shall use an analog to digital converter to capture the current LED temperature. Current temperatures shall be reportable to the central controller or MTAB&T Laptop via the sign controller interface. At least one analog temperature sensor shall be mounted towards the vertical center on the LED matrix display. The sensors shall be equally spaced to cover each end and the middle of the sign. The controller shall utilize the most extreme temperature recorded. However, both the maximum and the minimum temperature readings within both the sign housing and the controller cabinet shall be reportable via the RS-232 or Ethernet interface.

- Electrical Power Monitoring
  The sign controller shall be capable of detecting power failures. Power failure is defined as when the power is out of limits for 3 or more cycles. When a power failure is detected, the active message shall be retained in non-volatile memory. When power is restored, the last message displayed shall be restored if the outage is less than a user-specified period or if the retention parameter specified when the message was implemented has not elapsed. Upon receiving the next status request from the central controller, the sign controller shall report the occurrence of the power failure and its duration. The sign display shall be blanked, if the power failure exceeded the user-defined length.

- The sign controller shall be housed in a separate field cabinet positioned in front of the sign, at a location which provides a clear view of the sign face. The location of the field cabinet shall be as shown on the plans, or as directed by the Engineer.

- The sign controller shall be microprocessor-based and contain multiple RS-232 interface ports and Ethernet 10/100 Base T port for access by a modem and a local port.

- The sign controller shall support the following software capabilities in addition to those specified in other sections:
  - Password protection
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TYPE B

- Fully programmable parameters for all functions
- One year schedule of program timing
- Dynamic message flash rate
- Auto centering on text insertion for sign
- Retention Threshold specified when a message is commanded which defines how long the current message should remain in effect, in the absence of communication with the central office.

- The base character fonts supplied with the controller shall be proportional and shall allow all printable ASCII characters as implemented in MSDOS computers.

- The LED display shall be able to implement variable flashing rates ranging from three flashes per second to 1 flash per minute.

- The manufacturer shall supply the software protocol to interface to the sign controller as part of the submittal process. This protocol shall not be proprietary and may be subsequently specified in future Electrical Bureau specifications. As part of the submittal, hexadecimal data dumps of all commands and responses obtained from the controller shall be provided for every command type. The manufacturer shall supply a software protocol that complies with the NEMA National Transportation Communication for ITS Protocol (NTCIP).

- Via the software protocol, the messages shall be indirectly selectable for immediate implementation. In addition, the messages shall be selectable from the manual control panel of the sign controller. The sign controller shall allow a direct download of an entire message for immediate implementation on the sign. As part of the command to implement a particular message, a retention threshold shall be specified which will define how long that message can be displayed, in the absence of subsequent communication with the central computer.

- Manual Reset, The sign controller shall have a momentary contact switch that can be used to reset the sign controller.

- Manual Test Switch
  The sign controller shall be capable of initiating a manual test of each pixel in the sign.
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- Functional Circuitry
  The sign controller shall have circuitry and the required software to perform the following functions:
  - Drive the sign display
  - Determine ambient lighting levels
  - Control pixel luminance levels
  - Monitor the temperature of the LED boards at three points (allow reporting of the maximum and minimum measurement to the central computer)
  - Control the Ventilation System
  - Positive Monitoring/Confirmation of each pixel group independent of the output circuitry.

- Hardware Watchdog Timer
  The sign controller shall have a hardware watchdog timer that shall check its own operation. While the sign controller program is running, the hardware watchdog timer shall be periodically reset. If the watchdog timer is not reset, the watchdog timer shall reset the sign controller.

- MTAB&T Laptop Computer Interface
  In addition to the Communication Interface to the System Computer, access shall be provided to the sign controller from a standard RS-232 port. The interface panel within the sign controller field cabinet shall also include a momentary push button switch and associated LED confirmation indicator that can be utilized to shutdown the message display. The switch shall be monitored by the controller. If the switch is engaged for a period exceeding three seconds, the manual override shall remain in effect until the controller is issued commands through any of the RS-232 ports to resume normal operation. In addition, the sign controller shall report the activation of this manual shutdown command as a failure alarm condition. The controller protocol and PC diagnostic program shall fully report the existence of such a shutdown state and be capable of resetting the condition (via a central override control mode).

- Communications
  The sign controller shall include separate serial interfaces for communication with the central controller and the laptop computer.
  The communication line circuits shall be dial up service, Ethernet Data service or leased lines, low speed data service.
The sign controller shall support dial-up capabilities, i.e., support the capability via a settable parameter to switch from Direct Connect to Dial-up. The dial up modem will be provided by the MTAB&T.

The sign controller shall have an Ethernet, RJ45, port for communication and network connection.

The communications protocol to be used over the communications infrastructure shall be as defined in the NTCIP Requirement defined below.

The DMS shall support the following control modes.

• Central (System) Control
  This is the normal mode of operation. The sign controller responds to commands from the system computer.

• Local Control
  This control mode is used to test the sign operation. In this mode, the sign controller responds to commands from a MTAB&T Laptop Computer that is interfaced to the sign controller via the second RS232 port or to a local switch/touchpad panel. This control mode shall be reportable via the RS232 interface.

• Central Override Control
  This control mode is used to allow a central system to re-gain control over a sign even if the sign controller has been set locally to ‘local control’. This control mode shall be reportable via the RS232 interface or the Ethernet port.

• RS-232 plug-in connection for the MTAB&T Laptop computer Sign Controller Cabinet
  The sign controller shall be installed in a Type 332 series cabinet with power supply, input and output files removed. The sign controller field cabinet shall be furnished and installed as indicated in the plans. If the sign display is not clearly visible from the cabinet location specified on the plans, the cabinet shall be moved to a location where the sign display is clearly visible from the cabinet, as specified by the Engineer.

The sign controller cabinet shall contain the following:

• Sign controller
• Modem
• Cabinet light and switch
- RS-232 cable a minimum of 1.20 m long to connect the MTAB&T Laptop computer to the sign controller
- Cabinet fan, heater, thermostat and filtered vent
- 2 GFI duplex utility outlet rated for 15 amps minimum
- Uninterruptible power supply
- A slide-out work tray, for the MTAB&T Laptop computer, mounted on ball bearing slides.

Cabinet lamps shall be used to illuminate the internal controller cabinet when the cabinet door is opened. The lamps shall be extinguished when the cabinet door is closed.

- Sign to Cabinet Interconnect
  The Contractor shall furnish and install power cable and data control cable between the sign controller field cabinet and DMS enclosure.
  The Contractor shall utilize cables specified by the manufacturer of the DMS.
  The Contractor shall submit cable specifications to the Engineer thirty (30) days prior to installation for approval by the Engineer.

- Power and Control cables shall be in separate conduits.

(c) NTCIP Requirements

The communications between the sign controller and the central controller or laptop computer shall comply with the following NTCIP requirements.

The following list provides the full reference to the current version of each of these standards. Each NTCIP Component covered by these project specifications shall implement the most recent version of the published standard that is available as of the contract advertisement date, including any Amendments. It is the responsibility of the Contractor/Vendor to monitor NTCIP activities to discover any more recent documents.

**Table 1: Applicable NTCIP Standards and Amendments**

<table>
<thead>
<tr>
<th>Abbreviated Number</th>
<th>Full Number</th>
<th>Title</th>
<th>Known Amendments</th>
</tr>
</thead>
</table>
ITEM 683.85010111 - FULL MATRIX LED DYNAMIC MESSAGE SIGN ASSEMBLY  
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ITEM 683.85010211 - FULL MATRIX LED DYNAMIC MESSAGE SIGN ASSEMBLY  
TYPE B

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NTCIP 2103</td>
<td>NTCIP 2103:2005 (formerly NEMA TS 3.SP-PPP)</td>
<td>Point-to-Point Protocol over RS – 232 Subnetwork Profile (SP-PPP)</td>
<td></td>
</tr>
<tr>
<td>NTCIP 2104</td>
<td>NTCIP 2104:2003 v01.11 (September 2005 edition)</td>
<td>Ethernet Subnetwork Profile</td>
<td></td>
</tr>
<tr>
<td>NTCIP 2201</td>
<td>NTCIP 2201:2003 v01.15 (September 2005 edition)</td>
<td>Transportation Transport Profile</td>
<td></td>
</tr>
<tr>
<td>NTCIP 2202</td>
<td>NTCIP 2202:2001 v01.05</td>
<td>Internet (TCP/IP and UDP/IP) Transport Profile</td>
<td></td>
</tr>
<tr>
<td>NTCIP 2301</td>
<td>NTCIP 2301:2001 v01.08</td>
<td>Simple Transportation Management Framework (STMF) Application Profile</td>
<td></td>
</tr>
</tbody>
</table>

**Application Level**

Each DMS shall conform to NTCIP 2301 as a Managed Agent and shall meet the requirements for Conformance Level 1 (NOTE - See Amendment to standard).

An NTCIP Component may support additional Application Profiles at the manufacturer's option. Responses shall use the same Application Profile used by the request. Each NTCIP Component shall support the receipt of Application data packets at any time allowed by the subject standards.

The implementation shall be provided with a completed PICS statement as contained in NTCIP 2301, Annex A to indicate which options of this NTCIP standard were implemented. The PICS statement is a listing of mandatory and optional elements specified within the
corresponding standard. Users can use the PICS statement to detail the optional items are to be supported as well as the required value ranges for the data elements. Vendors can use the PICS to indicate what the device actually supports.

**Transport Level**

For Communications over Dial-Up or Leased Lines in direct connect mode:

The communications link between the DMS Sign Controller and the DMS Control Computer shall be direct-connect, non-routable. The NTCIP Component shall conform to NTCIP 2201. (Transportation specific, bandwidth-efficient)

For Communications over Wireless Ethernet:

The communications link between the DMS Sign Controller and the DMS Control Computer shall use a routable protocol. The NTCIP Component shall conform to NTCIP 2202 and shall support the following options defined by the standard:

- TCP and UDP/IP

For all communications modes:

The implementation shall be provided with a completed PICS statement of the selected NTCIP standard (see Annex A of that standard) to indicate which options of the standard were implemented. The PICS statement is a listing of mandatory and optional elements specified within the corresponding standard. Users can use the PICS statement to detail the optional items that are to be supported as well as the required value ranges for the required data elements. Vendors can use the PICS to indicate what the device actually supports.

NTCIP Components may support additional Transport Profiles at the manufacturer's option. Response datagrams shall use the same Transport Profile used in the request.

Each DMS component shall support the receipt of datagrams conforming to any of the identified Transport Profiles at any time.
Subnet Level

For Communications over Leased Lines in direct connect mode:

The communications link between the DMS Sign Controller and the DMS Control Computer shall be serial communications. Each NTCIP Component shall conform to NTCIP 2101 with an RS-232 physical interface and data rates of 1200, 2400, 4800, 9600, and 19,200 bits per second.

For Communications over dial-up communications lines:

The communications link between the DMS Sign Controller and the DMS Control Computer shall be dial-up communications. Each NTCIP Component shall conform to NTCIP 2103 over both a null-modem connection and a contractor-provided, external dial-up modem connection. The dial-up modem shall support data rates of 14.4 kbps, 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps. The null-modem shall support the same speeds with a maximum of 19.2 kbps. Additionally, the NTCIP Component shall be able to make outgoing and receive incoming calls as necessary and support the following modem command sets:

- Hayes AT -Command Set
- MNP5
- MNP10
- V.42bis

For Communications over Wireless Ethernet:

The communications link between the DMS Sign Controller and the DMS Control Computer shall implement NTCIP 2104.

For all communications modes:

The implementation shall be provided with a completed PICS statement of the selected NTCIP standard (see Annex A of that standard) to indicate which options of the standard were implemented. The PICS statement is a listing of mandatory and optional elements specified within the corresponding standard. Users can use the PICS statement to detail the optional items to be supported as well as the required value ranges for the data elements. Vendors can use the PICS to indicate what the device actually supports.
NTCIP components may support additional Subnet Profiles at the manufacturer's option.

At any one time, only one Subnet Profile shall be active on a given serial port. If the component has a serial port that supports multiple Subnet Profiles, it shall be configurable to allow the field technician to activate the desired Subnet Profile and shall provide a visual indication of the currently selected Subnet Profile.

**Information Level**

Each NTCIP Component shall provide Full, Standardized Object Range Support of all objects required by these procurement specifications unless otherwise indicated below. The maximum Response Time for any object or group of objects shall be 200 milliseconds.

Each DMS shall support all mandatory objects of all mandatory Conformance Groups as defined in NTCIP 1201 and NTCIP 1203 as well as their amendments. The following list indicates the modified object requirements for these mandatory objects.

<table>
<thead>
<tr>
<th>OBJECT Name</th>
<th>Object Range Limits</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>globalMaxModules</td>
<td>0-255</td>
<td>1(^1)</td>
</tr>
<tr>
<td>communityNamesMax(^2)</td>
<td>1-255</td>
<td>2</td>
</tr>
<tr>
<td>communityNameAccessMask(^2)</td>
<td>0-4294967295</td>
<td>0,4294967295</td>
</tr>
<tr>
<td>dmsNumPermanentMsg</td>
<td>0-65535</td>
<td>0(^3)</td>
</tr>
<tr>
<td>dmsMaxChangeableMsg</td>
<td>0-65535</td>
<td>60</td>
</tr>
<tr>
<td>dmsFreeChangeableMemory</td>
<td>0-4 billion</td>
<td>5,000</td>
</tr>
<tr>
<td>dmsMaxVolatileMsg(^4)</td>
<td>0-65535</td>
<td>0</td>
</tr>
<tr>
<td>dmsFreeVolatileMemory(^4)</td>
<td>0-4 billion</td>
<td>0</td>
</tr>
<tr>
<td>dmsMessageMultiString</td>
<td>OCTET STRING</td>
<td>The DMS shall support any valid MULTI string containing any subset of those MULTI tags specified below.</td>
</tr>
<tr>
<td>dmsControlMode(^5)</td>
<td>1-6</td>
<td>2, 3, 4, 5</td>
</tr>
</tbody>
</table>

\(^1\) The Module Table shall contain at least one row with moduleType equal to 3 (software). The
moduleMake shall specify the name of the manufacturer, the module Model shall specify the manufacturer's name of the component and the modelVersion shall indicate the model version number of the component.

2 The support of the Security Conformance Group is MANDATORY for NTCIP 2103. For other NTCIP Subnetwork Profile, it is OPTIONAL.

3 Permanent messages are messages stored in memory that cannot be changed by the user. Messages stored in this memory area can include test messages or user-defined, pre-defined, factory-installed messages. These messages shall either be defined within the procurement specifications or be suggested by the VENDOR (however, this latter method would need to be specified in the procurement specifications).

4 Changeable memory and changeable messages in excess of the project requirements are considered to meet or exceed the specification for an equivalent amount of volatile memory and volatile messages.

5 The values for dmsControlMode have the following meanings:
   1 – other
   2 – local control (e.g., via the controller’s interface)
   3 – external control (e.g., by a connected laptop in the field)
   4 – central control
   5 – the local/central switch is set to local, but central is overriding this setting
   6 – simulation (i.e., the commands are only simulated and not displayed on the sign)

Software shall also implement all mandatory objects of the following optional conformance groups.

1.) Time Management, as defined in NTCIP 1201

2.) Timebase Event Schedule, as defined in NTCIP 1201. The following list indicates the modified object requirements for this conformance group...

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>Object Limits</th>
<th>Range</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>maxTimeBaseScheduleEntries</td>
<td>0-65535</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>maxDayPlans</td>
<td>1-255</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>maxDayPlanEvents</td>
<td>1-255</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

3.) Report, as defined in NTCIP 1201. The following list indicates the modified object requirements for this conformance group.
4.) PMPP, as defined in NTCIP 1201. The following list indicates the modified object requirements for this conformance group.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>Object Range Limits</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>maxGroupAddresses</td>
<td>0-255</td>
<td>1</td>
</tr>
</tbody>
</table>

5.) Font Configuration, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>Object Range Limits</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>numFonts</td>
<td>0-255</td>
<td>5</td>
</tr>
<tr>
<td>maxFontCharacters</td>
<td>0-65535</td>
<td>50</td>
</tr>
</tbody>
</table>

1 Each font shall support character numbers from 32 (0x20) to 90 (0x5A), inclusive. Upon delivery, each character shall be set to a bit pattern that resembles the associated ASCII character.

The Font Definition Conformance Group allows a central system to configure the fonts supported by the sign. This feature is desirable if an agency wants to ensure that all signs use a common font set within its jurisdiction. As a minimum, the following ASCII (ASCII NVT) characters shall be supported:

- A, B, C, D, ..., X, Y, Z
- 1, 2, 3, ... 9, 0
6.) Multi Configuration, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>Object Limits</th>
<th>Range Limits</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>defaultLineJustification</td>
<td>1-5</td>
<td>2, 3, 4</td>
<td></td>
</tr>
<tr>
<td>defaultPageJustification</td>
<td>1-4</td>
<td>2, 3, 4</td>
<td></td>
</tr>
<tr>
<td>defaultPageOnTime(^2)</td>
<td>1-255</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>defaultPageOffTime(^2)</td>
<td>0-255</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>defaultCharacterSet</td>
<td>1-2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

\(^2\) The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds.

Additionally, the software shall implement the following tags (opening and closing, where defined) of MULTI as defined in NTCIP 1203.
- Flash - allows the message to contain flashing text
- Font - allows the message to choose one or more fonts for the display
- Justification Line - allows the message to be centered on a line
- Justification Page - allows the message to be centered on a page (i.e., vertically)
- New Line - specifies a line break; should be supported by all multi-line signs
- New Page - allows a single message to consist of multiple pages (e.g., if the message is large)
- Page Time - identifies duration to display a given page; should be supported when above is supported
- Spacing Character - allows a message to alter the number of pixels between characters

7.) Multi Error Configuration, as defined in NTCIP 1203

8.) Illumination/Brightness Control, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.
OBJECT | Object Range Limits | Project Requirements
---|---|---
dmsIllumControl | 1-4 | 2, 4
DmsIllumBrightnessValues | Table of up to 255 rows each row defining a brightness level | Table shall support at least 255 rows

9.) Scheduling, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>Object Range Limits</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>numActionTableEntries</td>
<td>1-255</td>
<td>50</td>
</tr>
</tbody>
</table>

10.) Sign Status, as defined in NTCIP 1203
11.) Status Error, as defined in NTCIP 1203
12.) Pixel Error Status, as defined in NTCIP 1203
13.) Power Status, as defined in NTCIP 1203
14.) The NTCIP Component shall also implement the following optional objects.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>Project Requirements</th>
</tr>
</thead>
</table>
globalSetIDParameter | FSOR |
eventConfigLogOID | FSOR |
eventConfigAction | FSOR |
eventClassDescription | FSOR |
defaultFlashOn | The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds |
defaultFlashOff | The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds |
dmsSWReset | FSOR |
dmsMessageTimeRemaining | FSOR |
dmsShortPowerRecoveryMessage | FSOR |
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TYPE A

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TYPE B

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>dmsLongPowerRecoveryMessage</td>
<td>FSOR</td>
</tr>
<tr>
<td>dmsShortPowerLossTime</td>
<td>FSOR</td>
</tr>
<tr>
<td>dmsResetMessage</td>
<td>FSOR</td>
</tr>
<tr>
<td>dmsCommunicationsLossMessage</td>
<td>FSOR</td>
</tr>
<tr>
<td>dmsTimeCommLoss</td>
<td>FSOR</td>
</tr>
<tr>
<td>dmsPowerLossMessage</td>
<td>FSOR</td>
</tr>
<tr>
<td>dmsEndDurationMessage</td>
<td>FSOR</td>
</tr>
<tr>
<td>dmsMemoryMgmt</td>
<td>The DMS shall support the following Memory Management Modes: - normal - clearChangeableMessages</td>
</tr>
<tr>
<td>dmsMultiOtherErrorDescription</td>
<td>If the vendor implements any manufacturer-specific MULTI tags, the DMS shall provide meaningful error messages within this object whenever one of these tags generates an error</td>
</tr>
<tr>
<td>dmsIllumLightOutputStatus</td>
<td>FSOR</td>
</tr>
<tr>
<td>watchdogFailureCount</td>
<td>FSOR</td>
</tr>
<tr>
<td>dmsStatDoorOpen</td>
<td>FSOR</td>
</tr>
<tr>
<td>fanFailures</td>
<td>FSOR</td>
</tr>
<tr>
<td>fanTestActivation</td>
<td>FSOR</td>
</tr>
<tr>
<td>signVolts</td>
<td>FSOR</td>
</tr>
<tr>
<td>lineVolts</td>
<td>FSOR</td>
</tr>
<tr>
<td>tempMinCtrlCabinet</td>
<td>FSOR</td>
</tr>
<tr>
<td>tempMaxCtrlCabinet</td>
<td>FSOR</td>
</tr>
<tr>
<td>tempMinAmbient</td>
<td>FSOR</td>
</tr>
<tr>
<td>tempMaxAmbient</td>
<td>FSOR</td>
</tr>
<tr>
<td>tempMinSignHousing</td>
<td>FSOR</td>
</tr>
<tr>
<td>tempMaxSignHousing</td>
<td>FSOR</td>
</tr>
</tbody>
</table>

In addition to those conformance groups defined in NTCIP 1201 and NTCIP 1203, the following groups are defined for this procurement specification. In order to claim compliance to these conformance groups, all of the indicated objects shall be supported, even if they are marked optional in the base standard.

15.) Flashing Text Conformance Group
- defaultFlashOn - indicates the default on time for flashing text.
- defaultFlashOff - indicates the default off time for flashing text.

16.) Pixel Service Conformance Group

The Pixel Service Conformance Group shall include the following objects:
- dmsMessagePixelService - indicates whether or not pixel service is activated during a given message.
- vmsPixelServiceDuration - indicates how long a pixel service period will last. This parameter shall be supported if the Pixel Service Conformance Group is selected.
- vmsPixelServiceFrequency - The frequency at which pixel service is performed as measured from the pixel service time.
- vmsPixelServiceTime - The time of day at which the pixel service starts.

17.) Enhanced Sign Control Conformance Group

The Enhanced Sign Control Conformance Group shall include the following objects:
- dmsSWReset - allows central to force a software reset of the controller.
- dmsMessageTimeRemaining - identifies how much longer the current message will remain displayed.
- dmsMemoryMgmt - allows a management station to clear portions of the message table.

18.) Default Message Conformance Group

The Default Message Conformance Group shall include the following objects:
- dmsPowerLossMessage - indicates the message to be displayed after power is lost until power is restored.
- dmsShortPowerLossTime - allows the user to specify what amount of time distinguishes a short power loss from a long power loss.
- dmsShortPowerRecoveryMessage - allows the user to specify a message that will appear after recovery from a short power loss.
- dmsLongPowerRecoveryMessage - allows the user to specify a message that will appear after recovery from a long power loss.
- dmsResetMessage - allows the user to specify what message will be displayed after the controller is reset.
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- dmsTimeCommLoss - identifies the maximum amount of time between subsequent communications prior to determining that communications have been lost.
- dmsCommunicationsLossMessage - indicates the message to be displayed when communications are lost.
- dmsEndDurationMessage - indicates the message to be displayed after the duration of the current message expires.

19.) Enhanced Error Conformance Group
The Enhanced Error Conformance Group shall include the following objects:
- dmsMultiOtherErrorDescription - this object provides additional data as to what caused the "other" error in the display text string.

20.) Enhanced Illumination Conformance Group
The Enhanced Illumination Conformance Group shall include the following objects:
- dmsIllumLightOutputStatus - indicates the current light output (i.e., brightness).

21.) Enhanced Sign Status Conformance Group
The Enhanced Sign Status Conformance Group shall include the following objects:
- watchdogFailureCount – a counter that indicates the number of watchdog failures that have occurred.
- dmsStatDoorOpen – indicates whether any of the doors to the controller cabinet or the sign housing are open.

22.) Fan Conformance Group
The Fan Conformance Group shall include the following objects:
- fanFailures – indicates whether each fan (system) within a DMS is capable of operating
- fanTestActivation – indicates the state of the fan testing.

23.) AC Power Conformance Group
The AC Power Conformance Group shall include the following objects:
- lineVolts – indicates the DMS line voltage as measured in (1.0) volts.

24.) Temperature Conformance Group
The Temperature Conformance Group shall include the following objects:

- **tempMinCtrlCabinet** – indicates the current temperature for a single sensor, or the current minimum temperature for multiple sensors, within the DMS Control Cabinet in degrees Celsius.

- **tempMaxCtrlCabinet** – indicates the current temperature for a single sensor, or the current maximum temperature for multiple sensors, within the DMS Control Cabinet in degrees Celsius.

- **tempMinAmbient** – indicates the current outside ambient temperature for a single sensor, or the current minimum outside ambient temperature for multiple sensors in degrees Celsius.

- **tempMaxAmbient** – indicates the current outside ambient temperature for a single sensor, or the current maximum outside ambient temperature for multiple sensors in degrees Celsius.

- **tempMinSignHousing** – indicates the current temperature for a single sensor, or the current minimum temperature for multiple sensors in the sign housing in degrees Celsius.

- **tempMaxSignHousing** – indicates the current temperature for a single sensor, or the current maximum temperature for multiple sensors in the sign housing in degrees Celsius.

**Documentation**

Software shall be supplied with full documentation, including a CD-ROM containing ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:

The relevant version of each official standard MIB Module referenced by the device functionality.

If the device does not support the full range of any given object within a Standard MIB Module, a manufacturer-specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro shall be provided. The filename of this file shall be identical to the standard MIB Module, except that it shall have the extension “.man”.

A MIB Module in ASN.1 format containing any and all manufacturer-specific (or agency-
specific) objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.

A MIB containing any other objects supported by the device.

Intellectual Property Rights

The manufacturer shall allow the use of any and all of this documentation by any party authorized by the Procuring Agency for systems integration purposes at any time initially or in the future, regardless of what parties are involved in the systems integration effort.

MTAB&T Laptop Software – NTCIP Requirements

The Contractor shall provide DMS Maintenance/Diagnostics Laptop software, which shall be able to execute all commands and monitor/modify all settings available within the sign controller using the same NTCIP object definitions required above. The software shall be the latest version available by the sign manufacturer. The vendor shall identify whether the same NTCIP Communications Profiles (and their selected options) are supported.

Interpretation Resolution

If the Project Engineer or DMS component developer discovers an ambiguous statement in the standards referenced by this procurement specification, the proper interpretation shall be decided by the relevant NTCIP working group. If a resolution to an ambiguous statement cannot be obtained from the relevant NTCIP Working Group within 3 weeks, the Project Engineer and the DMS component developer shall jointly determine how to address this problem to avoid schedule delays.

(d) Testing

The Dynamic Message Signs shall be tested as defined below.

General

- Test Plan
  The manufacturer shall provide a test plan, 30-days prior to each test, to the Engineer for review and approval that covers all three (3) different types of acceptance testing: Factory
Acceptance Testing, Stand-alone Testing, and System Acceptance Testing. The test plan shall account for the different conditions that will be present at these different types of acceptance testing and shall identify which test procedure applies to which acceptance test.

The test plan shall clearly identify each function and element being tested, the setup conditions, the steps to be followed during the test, and the anticipated test results. The test plan shall exercise all functions of the hardware and software and demonstrate that all other requirements not exercised are met.

The following is a typical, but non-exhaustive list of the type of requirements that the test plan shall verify:

- Downloading, uploading, displaying, entering, editing, and deleting sign messages and fonts.
- Displaying of all characters, all messages, and all symbols on the sign.
- Switching between several different messages and blinking a part on one line of a message.
- Recovery from simulated communications errors, simulated watchdog timer errors, and simulated sign controller errors.
- Demonstration of the operation of the thermostatically controlled fans, automatic LED temperature shutdown and dimming, and heat related LED power reductions.
- Demonstration of automatic restart after a simulated short-term and simulated long-term power failure.
- Demonstration of the operation of the variation of the LED intensity based on various levels of ambient light.
- Demonstration of the operation of all manual switches and optional modes of operation.

- Test Equipment
  The test plan shall clearly identify all test equipment required to perform the tests. This equipment shall be made available for the duration of the testing program. As a minimum, the test equipment shall include the latest version of the “Device Tester for NTCIP”, which has been purchased by MTAB&T, for testing purposes. Additionally, a protocol analyzer tool capable of analyzing the implemented communications protocols, as required within the NTCIP Requirement section of these specifications, shall be used. The protocol analyzer shall be proposed and be provided by the Contractor at least two (2) weeks prior to the Factory Acceptance Testing date, and shall be approved prior to the commencement of the testing by the Engineer. The utilized software shall all be in recording/capturing mode while performing the test procedures. Any tests found to be in non-compliance to
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These specifications shall result in the rejection of the DMS. Any software/firmware modifications that are necessary shall imply full retesting for NTCIP compliance as defined within these specifications.

- Test Reports
  The Supplier shall maintain a complete record of each test performed including the results of the test and a record of who witnessed the test. At the completion of each test, the test forms shall be completed and provided to the Engineer for review. This document shall be the basis for acceptance or rejection. All test reports shall be signed by the Supplier's authorized representative.

- Test Performance
  The Supplier shall conduct all tests. All tests shall be performed in the presence of the Engineer and/or up to two (2) other representatives. The Engineer may waive the right to witness certain tests.

- Modified Units
  If a unit is modified as a result of any test or demonstration failure, a report shall be prepared and delivered to the Engineer prior to shipment of the unit. The report shall describe the nature of the failure and the corrective action taken. If a failure pattern is identified, the Engineer may direct the modifications be made to all similar units without additional cost. A failure shall be defined as any test procedure that cannot be executed as defined in the agreed-upon test plan. A failure pattern is defined as a series of failures of a similar problem that occurred in subsequent test procedures; however, the Engineer, at his/her discretion, might determine during the execution of the test procedures that failures occurring during the tests are related and therefore must be considered a failure pattern.

- Test Witnessing
  Neither the witnessing of a test by the Engineer, nor the waiving of the right to witness a test, shall relieve the Supplier of the responsibility of providing DMS equipment that is in compliance with this specification. The witness of any tests by the Engineer, or a representative of the Engineer, shall not be deemed as acceptance of the equipment or systems under test. MTAB&T reserves the right to send up to three (3) representatives to witness a particular test. The test shall be coordinated with MTAB&T at least three (3) weeks prior to the actual date. In the event that a sign does not pass the agreed-upon test procedures and re-testing is required, the vendor shall pay for both time and materials for any and all client representatives.
**Factory Acceptance Test**
The purpose of this test is to demonstrate that each type or category of equipment to be supplied is in compliance with these specifications. The Factory Acceptance Test shall be performed at the equipment manufacturer's facility. The test shall be performed on each of the DMS assemblies that will be supplied for this project. This approved test procedures for the Factory Acceptance Test part of the overall test plan shall be executed.

**Stand-Alone Acceptance Test**
The purpose of this test is to demonstrate that each type or category of equipment to be supplied is in compliance with these specifications once the DMS assembly is installed in its final location. The test shall be performed on all of the DMS assemblies that are being installed under this project. The approved test procedures for the Stand-Alone Acceptance Test part of the overall test plan shall be executed.

**System Acceptance Test**
The purpose of this test is to demonstrate that each type or category of equipment to be supplied is in compliance with these specifications once the DMS assembly is installed in its final location and after the DMS assemblies have been connected to the communications infrastructure. The test shall be performed on all of the DMS assemblies that are being installed under this project. The System Acceptance Test shall consist of two (2) parts: one is the actual test performed on the DMS using the communications system and the other a six (6)-month ‘burn-in’ period. The actual test shall have been passed without failure before the burn-in period will begin. The System Acceptance Test shall be approved after the 6-month burn-in period of the equipment has elapsed without any failure. Failure shall be defined as any interruption of operation that can be contributed to the DMS. If a failure occurs, the 6-month period shall be stopped until the failure has been resolved. If the same failure occurs three (3) times, the failure shall be resolved and the 6-month burn-in period shall begin anew.

(e) **DMS Central Control System**
The Contractor shall also provide a DMS Central Control System for management of the DMS utilizing manufacturer-supplied software.

The DMS Central Control System shall:
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- Permit the installation of a system computer that can communicate via a TCP/IP network or connect to the DMS via dial-up communications, or leased data service.
- The central control system software shall contain all the elements required to operate the DMS system and to provide the features described in this item.
- The software shall provide an exact animated simulation of an LED display in order to permit the dynamic visualization of the message prior to actual display.
- The software shall also be able to automatically broadcast specific messages to a minimum of 100 remote variable Dynamic Message Signs according to pre-determined schedules, or immediately in case of emergencies.
- The software shall also provide non-volatile storage for 64 pre-programmed message scenarios, each scenario being able to simultaneously broadcast a set of preprogrammed messages to up to 12 pre-selected DMS signs.
- The software shall permit access by up to 100 users. Each user shall be identified by name, password, and access rights.
- The software shall support a communications system monitoring function that will display, on the screen of the MTAB&T notebook laptop, commands received by the sign controller from the system computer. The software shall also display the response transmitted by the sign controller to the system computer. This function shall be real-time and be functional when the sign controller is operating in the system control mode.
- The software shall support the uploading and downloading of the message library. The software shall support displaying, creating, editing, and deleting all messages. The software shall keep a record of all changes to the database in a logging file.
- The software shall support commanding the display of any message in the library.
- The software shall support the running of sign controller and display diagnostics. At a minimum, the software shall initiate a test pattern that energizes and verifies each individual pixel in the sign. The software shall be able to report any failed pixels and shall utilize both a graphic and text display to identify the failures. The test pattern shall be supported by a test report that documents the results of the test. The test report shall also be directable to a standard text file.
- The software shall support a facility for creating and updating fonts. The font creation program shall allow the user to define the grid pattern for each ASCII symbol. The program shall allow the specification of a different horizontal width (in pixels) for each character. The program shall allow the fonts to be created off-line via a user-friendly...
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graphical interface and stored in a disk-based library. This library shall be easily transferable between MSDOS computers via a USB memory device. Once a font has been completed and stored in the library, the program shall allow it to be retrieved and downloaded to one or more individual sign controllers for storage in non-volatile memory in the controller.

(f) Training

After the successful completion of the first part of the System Acceptance Test (the actual test) of the first DMS unit, training shall be provided for the Department's engineering, maintenance and operations staff, at a facility provided by the Department. The training shall include all material and manuals required for each participant. The training shall be as follows:

- Maintenance Training
  The training shall be provided for a minimum of sixteen (16) hours for at least ten (10) personnel with an electronics background. The training shall include operation instructions, theory of operation, circuit description, field adjustments, preventive maintenance procedures, troubleshooting and repair of all components. Any additional training deemed necessary by MTAB&T shall be provided at a fixed price.

- Engineering/Operators Training, The training shall be provided for a minimum of sixteen (16) hours for at least twenty (20) engineering and operations personnel. The training shall include a complete demonstration of the operation and capabilities of the DMS equipment. This session shall include a complete review of any field adjustments or calibration that may be required by the LED’s or any sign component. Particular attention shall be given to the operation of the software packages to be provided including procedures for configuring the signs, displaying messages, and diagnosing faults.

(g) Instructions and Guarantees

- No changes or substitutions in these requirements shall be acceptable unless authorized in writing. Inquiries regarding this equipment shall be addressed to the MTAB&T.

- The Supplier shall furnish any and all equipment that is deemed necessary for safe and reliable operation of the LED Dynamic Message Sign.

- The company shall provide free software upgrades for a period of two (2) years from
acceptance of the components.

- All major components shall be identified with a label containing the serial number and a bar code identification.

(h) Documentation

The documentation for the Dynamic Message Signs shall consist of manuals detailing the Communications Protocol, Operations, Maintenance Procedure Manual, Equipment Drawings, and Electrical Schematic Diagrams. Each manual/drawing shall be delivered with each sign assembly in both electronic and hardcopy format. Two (2) hardcopies of each manual/drawing shall be provided, one of which shall be stored within the sign controller cabinet.

- Communications Protocol, This document shall clearly describe the communications protocol that must be used to gain access using each technique.

- Operator's Manual, This document shall fully describe the operation of the Dynamic Message Signs using the software that shall run on a workstation in the central location and/or on the MTAB&T laptop computer. This document shall clearly define all functions that are supported by the software. The manual shall define the normal operation of the signs and the software including resetting and restarting the software package.

- Maintenance Procedure Manual, This manual shall document the preventive and corrective maintenance procedures that should be followed to maintain the Dynamic Message Signs at the highest level of operational efficiency. The manual shall include step-by-step fields and bench trouble-shooting procedures to isolate and repair faults. The document shall include descriptions of normative waveforms and test voltages. A detailed parts list shall be included. For each part or assembly, a circuit diagram or pictorial shall be provided.

- Equipment Drawings and Diagrams, A pictorial drawing showing the physical location and identification of each component shall be provided for each different DMS assembly and each different subassembly. Wiring diagrams shall be provided for each sign enclosure. These diagrams shall depict the location and interface of all components located within the sign enclosure.

- Electrical Schematic Diagrams, An electrical schematic, wiring diagram, and a logic
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diagram shall be provided for each different type of equipment. A stage-by-stage explanation of the circuit theory shall be provided with the circuit wiring diagrams. Connection diagrams for each DMS subsystem including block diagrams, terminal numbers, and conductor color codes shall be provided. Three copies of these diagrams shall be supplied.

- The Amber DMS assembly to be provided shall be manufactured by a firm experienced in the design and production of LED signs for use on freeways. This experience shall have included the successful design, manufacturer, and installation of at least two similar sign assemblies to those required by this specification. As part of the shop drawing submittal, the name, address, and telephone number of at least two managers of the operating agency with responsible charge over the unit shall be provided.

METHOD OF MEASUREMENT.
This work will be measured as the number of Full Matrix LED Dynamic Message Sign Assemblies of the type shown on the plans satisfactorily furnished, installed, activated, tested, integrated, and accepted.

BASIS OF PAYMENT.
Payment will be made at the contract unit price for each Full Matrix LED Dynamic Message Sign Assembly Type A or B which shall include all equipment, material, conduit and cables between DMS sign and field controller cabinet, testing, documentation, and labor detailed in the contract documents for this bid item. Conduit and wire required connecting the DMS Cabinet to power service and communications system shall be paid for under other work items as identified on the plans. All other conduit and wiring required to connect internal components of the assembly shall be included as part of this bid item.

Progress payments will be made in the following percentages of the bid price for each item after each milestone is reached. See System Integration specification for definition of milestones.

1. Approval of Shop Drawings          - 10%
2. Successful Factory Test/Field Inspection of Each Assembly - 30%
3. Operational Stand-Alone Test of Assembly     - 40%
4. Successful Completion of System Acceptance Test - 20%
   Including provision of all specified and required documentation, drawings, warranties, and other deliveries
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Payment will be made under:

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<td>683.85010111</td>
<td>Full Matrix LED Dynamic Message Sign Assembly Type A</td>
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<tr>
<td>683.85010211</td>
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