DESCRIPTION
Under this item, the Contractor shall furnish and install Changeable Message Signs (CMS) displays, controller equipment, and all necessary associated hardware at locations as shown on the plans or as directed by the Engineer. The Contractor shall install the CMS on sign structures or sign poles as described on other items in the Contract Documents. The CMS shall be part of a Static Sign as shown in the Contract Documents.

MATERIALS
All materials to be furnished, assembled, fabricated or installed shall be new, corrosion-resistant and in strict accordance with the details as shown in the contract documents. The CMS assembly shall consist of a weatherproof housing, light emitting diodes and associated wiring, and a clear polycarbonate panel on the sign face. In order to insure maximum compatibility with existing VMS in use on the Verrazano Bridge, the CMS assemblies to be provided under this item shall be functionally, communication protocol, and central control system equivalent to the existing VMS equipment now in use in by MTAB&T at Verrazano Bridge facility.

General Requirements
The CMS equipment shall include, but is not limited to:

- Two CMS display panels, each capable of full matrix alphanumeric and/or graphic messages. Expendable with four additional panels.
- CMS controllers and equipment cabinets
- CMS display panel attachment hardware for panel assembly to the proposed static sign as shown on the Contract Documents.
- CMS software
- Power Supplies
- All required power and data cabling
- The CMS to be furnished shall be capable of being disassembled and reassembled with ease of construction using a bucket van, traffic cones, and a portable tool set.
- CMS messages shall be legible within a distance range of 150' to 1,100' from the LED panel face under the following conditions:
  - When the LED panel is mounted so its bottom side is positioned between 5' and 20' above a level roadway surface.
  - 24 hours per day and in most normally encountered weather conditions.
  - During dawn and dusk hours when sunlight is shining directly on the display face or when the sun is directly behind (silhouetting) the LED panel.
  - When viewed by motorists and travelers that have 20/20 corrected vision.
  - When the motorist eye level is 3' to 12' above the roadway surface.

CMS Display Panel Requirements
- The CMS display panels shall be a discrete amber LED technology.
The CMS display panel shall have a minimum dimension of 130" in length by 18" in height and a minimum pixel arrangement of 7 pixels high by 50 pixels wide utilizing a pixel pitch of 2.6" with 4 LEDs per pixel.

The front-to-back housing depth shall not exceed 2".

LEDs shall be amber, traceable to the manufacturer, with a typical luminous intensity of 9200 millicandela per LED when driven at 20 ma. The LEDs to be furnished shall be untinted, non-diffused; a high power aluminum indium gallium phosphide (AlInGaP) amber LED with a peak wavelength 590 ±5 nanometers with a minimum cone-viewing angle of 30 degrees.

The LEDs shall be protected from degradation due to sunlight. The method used shall not obstruct the view of the display from the roadway. The pixel construction technique shall not reduce display-viewing angles below that provided by the LED.

The CMS housing in conjunction with the static panel to which the structure mounted cabinet shall be designed and constructed to comply with all applicable sections of the most current AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals as well as the most current fatigue resistance requirements of NCHRP Report 412, Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports.

The LED panel shall protect LED modules from rain, ice, dust, and corrosion in accordance with NEMA enclosure Type 3R standards as described in NEMA Standards Publication 250-2003, Enclosures for Electrical Equipment (1000 Volts Maximum).

The design of the LED panel housing shall be such that no welding is required. Seams in the corners of the housing shall be sealed for water tightness.

The protective face of the LED panel shall be a high-contrast background for the LED panel matrix. The aluminum mask of each face panel shall be painted black and shall contain an opening for each pixel. Each face panel shall have a polycarbonate sheet attached securely to the inside of the aluminum panel. The polycarbonate sheet shall cover all of the pixel openings. The polycarbonate shall be sealed to prevent water and other elements from entering the LED panel. An aluminum mask shall be positioned over the polycarbonate sheet to maximize contrast and provide additional protection to the front face of the LED panel. No vinyl, silk-screened, or aluminum masking shall be located on the inside of the polycarbonate sheet for the intent of contract enhancement. Glare shall be reduced by placing the aluminum mask over the outside of the polycarbonate face sheet.

The polycarbonate shall contain UV inhibitors that protect the LED display matrix from the effects of ultraviolet light exposure and prevent premature aging of the polycarbonate itself.

The CMS panel housing shall consist of 0.090” thick formed sheet stock made from 5052-H32 aluminum.

The LED display panel must be constructed to withstand distortion from a mph wind load. Each LED display panel shall be identical and interchangeable.

Each LED panel front face panels and front face border pieces shall be coated with semi-gloss black Kynar® 500 resin or an equivalent brand of oven-fired
ITEM 683.00360011 – CHANGEABLE MESSAGE SIGN ASSEMBLY

fluoropolymer coating which meets the AAMA 2605 standard and has an expected outdoor service life of 20 years. All other LED panel housing surfaces, including the LED panel mounting brackets, shall be natural, mill-finish aluminum.

- Each LED display panel shall be able to be removed and replaced without affecting the operation of the remaining panels.
- The LED display panel shall be easily removed from the sign-mounting frame using simple hand tools. The mounting design shall use mechanical fasteners that are resistant to vibration and vandalism. Mounting holes shall be formed into the LED panel housing on a flange on the top and bottom to facilitate attachment of the LED panel to the static panel. This mounting flange shall be accessible without opening the front access door of the CMS. The LED panel housing shall be able to mount to the static panel without a pre-installed rail system or bus bar used to aid in the attachment process. The design shall provide the means to attach the LED panel directly to the static panel and use standard stainless steel mounting hardware.
- The weight of the CMS panel shall not exceed 132 lb.

Circuit Board and Power Supply Requirements

Circuit Board
- Only FR-4 16 mm material shall be used. Inter-component wiring shall be copper clad track having a minimum weight of 2 ounces per square foot 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), and power supply PCBs shall be completely conformal coated with a 10 mil 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 10 mil minimum thickness silicone resin conformal coat. The material used to coat the PCBs shall meet the military specification: MIL-I-4605 8C Type SR.
- The LED panels shall contain LED display modules that include an LED pixel array, LED driver circuitry, and mounting hardware.
- Each module shall consist of one circuit board.
- Each LED module shall contain a minimum of 35 LED pixels configured in a 2-dimensional array. The pixel array shall measure a minimum of 7 pixels high by 5 pixels wide.
- The distance from the center of one pixel to the center of all adjacent pixels, both horizontally and vertically, shall measure 2.6".
- Each LED display module shall contain electronic driver circuitry that individually controls all pixels on that module. Each LED driver board shall be microprocessor-controlled and shall communicate with the CMS Sign controller on a communication network using an addressable network protocol. The
microprocessor shall process commands from the DDMS controller to display data, perform diagnostic tests, and report pixel and diagnostic status.

- The voltage of each power input on the LED display module shall be measured to the nearest tenth of a volt and reported to the CMS Sign controller upon request. Each driver circuit shall also contain one status LED for each power source that indicates if the power source is present or not.
- The LED pixels shall be directly driven using PWM of the drive current to control the display intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all ambient light conditions. The drive current pulse shall be modulated at a frequency high enough to provide flicker-free operation and a minimum of 200 brightness levels.

**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 an N+1 redundant parallel configuration that uses multiple supplies for the LED panel matrix.
- A bank of power supplies shall be arranged in an N+1 redundant pairs within the CMS cabinet. In the event that a single power supply fails the power supply shall be rated to operate 1 set (up to 6 LED panels) with 50% of the pixels on at 100% brightness when the internal air temperature is +140°F.
- Each power supply within each pair shall receive 120 VAC power from separate circuits on separate circuit breakers, so that a single tripped breaker will not disconnect power from both supplies.
- 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 shall be connected to multiple circuits that provide power to the LED modules. Each output circuit shall not exceed 15 amps and shall be fused using a breaker.
- Each group of power supplies shall be monitored by a microprocessor-controlled circuit. This circuit shall monitor the voltage of each power supply and its output voltage. The power supply voltages shall be reported via a CAN communication network to the CMS controller upon request.
- The power supplies used to power the LED pixel modules shall be identical and interchangeable.

- Regulated DC power supplies shall conform to the following specifications:
  - Nominal output voltage shall be 24 VDC ± 10%.
  - Nominal maximum output power rating shall be 1,000 watts.
  - Operating input voltage range shall be a minimum of 90 to 260 VAC.
  - Operating temperature range shall be a minimum of –30°F to +165°F.
  - Maximum output power rating shall be maintained over a minimum temperature range of –30°F to +140°F.
  - 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.

- Shall perform an automatic output shutdown and restart if the power supply overheats or if one of the following output faults occurs: over-
ITEM 683.00360011 - CHANGEABLE MESSAGE SIGN ASSEMBLY

- Voltage, short circuit, or over-current.
- Power supplies shall be UL listed.
- Printed circuit boards shall be protected by an acrylic conformal coating.

Power and Control Enclosure Requirements

- The ground- or pole-mounted control traffic cabinet shall be a 336-type cabinet. It shall be provided with 2 mounting brackets suitable for use with pole-mount straps or designed to mount on a concrete pad such that the conduit and wire length between the furthest LED panel and the traffic cabinet shall not exceed 350'. The cabinet shall enclose the CMS Sign controller, power supplies, panel board, 120 VAC electrical outlets, surge suppressor, terminal strips, and remote communication devices, as specified on the Contract document.

General Specifications

- The traffic cabinet shall measure 46" high by 24" wide by 24" deep. The front-to-back cabinet dimensions shall not exceed 28" at its widest point, including the door handles, louvers, and roof overhang.
- The traffic cabinet weight shall not exceed 200 lbs, including the ACP.

Enclosure Construction

- The power and control enclosure shall be constructed to have a neat, professional appearance. The enclosure shall protect all internal components from rain, ice, dust, and corrosion in accordance with NEMA enclosure Type 3R standards, as described in NEMA Standards Publication 250-1997, Enclosures for Electrical Equipment (1000 Volts Maximum).
- Internal component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from hot-dipped galvanized steel, stainless steel, aluminum, nylon, or other durable corrosion-resistant materials suitable for roadway signage applications.
- The enclosure shall be constructed using 0.125" thick aluminum alloy 5052-H32. The exterior of the enclosure shall be natural mill-finish aluminum.

Serviceability

- The cabinet shall provide safe and convenient access to all modular assemblies, components, wiring and other materials located within the cabinet. All internal components shall be removable and replaceable by a single technician.
- Two (2) vertically hinged doors shall be mounted on the cabinet for interior access. One door shall be located on the front face, and one door shall be located on the rear face of the cabinet. Each of the door openings shall not measure less than 36" high by 21" wide. Each opening shall be sealed with a closed-cell foam gasket.

Each door shall be attached to the cabinet by a full-length stainless steel hinge and mounting hardware. Both doors shall open outward. In the closed position, each door shall latch to a double-flanged door opening with a 3-point draw-roller mechanism. The door handle shall be stainless steel. Each door shall have a
doorstop to hold the door in the open position. The doors shall each be equipped with a Corbin #2 lock.

- A fluorescent lamp shall be located at the top of the cabinet to illuminate the cabinet interior. A switch mounted near the front and rear door shall automatically turn on the light when the door is opened.

Equipment Rack
- The cabinet shall contain a full-height standard EIA 19" rack. The rack shall be secured within the cabinet by mounts at the top and bottom.
- The rack shall contain a minimum of 1 pullout drawer. The drawer shall be suitable for storing manuals and small tools, such as screwdrivers. The drawer shall be able to latch in the out position to function as a laptop/utility shelf.

Electrical Systems
- The enclosure shall contain a power panel board and circuit breakers that meet the following minimum requirements:
  - Service entrance-rated
  - Minimum of 12 circuit breaker positions with the rated capability to load tandem breakers
  - Short circuit ratings of 22,000 amps and 10,000 amps for the main and branch circuits, respectively
  - UL listed
- The panel board shall be mounted in the equipment rack.
- The enclosure shall contain a utility outlet circuit consisting of a minimum of two (2) 15-A NEMA 15-R, 120 VAC duplex outlets with a minimum of 1 outlet having GFCI. The outlets shall be mounted inside the enclosure and located near the panel board.
- The enclosure shall include 1 earth ground lug that is electrically bonded to the enclosure. The lug shall be installed near the power entrance. The installation contractor shall provide the balance of materials and services needed to properly connect to earth ground. All earth grounding shall conform to the National Electrical Code.

Environmental Systems
- One (1) thermostatically-controlled 100 CFM exhaust fan shall be mounted near the top of the traffic cabinet.
- Filtered air intake ports shall be located on the bottom third of each access door. The fan and air filters shall be removable and replaceable from inside the cabinet.

Transient Protection

- The CMS controller signal and power inputs shall be protected from electrical spikes and transients as follows:
  - AC Power; The AC power feed for all equipment shall be protected at the panel board by a parallel-connection surge suppresser rated for a minimum
surge of 40 kA. This device shall conform to the following requirements:

- Withstand a peak 80,000-ampere surge current, 40kA L-N, 40kA L-G.
- Have less than 0.5 nanosecond response time.
- Have a temperature range of -40° F to +140° F
- Have approximate dimensions of 3” wide by 8” long by 3” high
- 5,000 category (C3 High) impulses with < 10% drift, short circuit current rating of 200,000 RMS symmetrical amps (UL listed).
- Be UL listed to UL 1449 200kA SCCR, UL 1283 4th Edition, and Canadian safety standards.

- Communication Signal: Transient voltage surge suppressors shall protect all copper communication lines when used in place of fiber to pass data between the CMS controller and all LED panels.

- The door shall be attached to the enclosure with lift-off hinges. In the closed position, the door shall latch to a double-flanged door opening with a 3-point draw-roller mechanism. The door handle shall be stainless steel or powder-coated zinc die cast. The door shall each be equipped with a Corbin #2 lock.

- A fluorescent lamp shall be located at the top of the enclosure to illuminate the enclosure interior. A switch mounted near the front door shall automatically turn on the light when the door is opened.

Environmental Systems

- One (1) thermostatically controlled 100 CFM exhaust fan shall be mounted near the top of the enclosure.

- Filtered air intake ports shall be located on the bottom third of the access door. The fan and air filters shall be removable and replaceable from inside the enclosure.
CMS Controller Requirements

- Display Presentation, CMS controller shall control the panels in such a way as to create the desired display on the sign.
- NTCIP Requirements: The communications between the sign controller and the central controller or MTAB&T’s laptop computer shall comply with the NTCIP v2 compliant control system requirements.
- The CMS SIGN controller shall provide all the necessary functions to control and monitor the CMS locally and from the Verrazano Bridge Facility Operation Center.
- The CMS 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 CMS:
  - 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
  - Power switch to turn the controller on and off
  - 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 CMS sign controller shall control the operation of all equipment housed at the CMS.
- The CMS controller shall be installed within a separate field cabinet in front of the Dynamic Message Sign. The CMS 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 CMS sign controller shall receive and interpret commands sent by a host device. The CMS 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 CMS 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 500 different display messages and related parameters. These messages shall be
ITEM 683.00360011 - CHANGEABLE MESSAGE SIGN ASSEMBLY

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 CMS 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 CMS sign controller shall support the following software capabilities in addition to those specified in other sections:
  - Password protection
  - 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 CMS 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 CMS sign controller shall have a momentary contact switch that can be used to reset the CMS sign controller.

Manual Test Switch, The sign controller shall be capable of initiating a manual test of each pixel in the sign.

Functional Circuitry, The sign controller shall have circuitry and the required software to perform the following functions:
- Drive the CMS sign display
- Determine ambient lighting levels
- Control pixel luminance levels
- Monitor the temperature of the LED boards.
- 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).
CMS sign 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 CMS 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 NYSDOT. 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 Requirements.

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 CMS sign controller shall be installed in a NYSDOT Type C 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. This cabinet may house of additional ITS devices as shown on plan and specified on the contract Documents.

The sign controller cabinet shall contain the following:

- CMS Sign controller
- Gigabit Ethernet Switch
- Cabinet light and switch
- RS-232 cable a minimum of 4’ 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.
- Other ITS equipment as shown on the plan.
- 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.
- CMS Display Panels to Cabinet Interconnect
- The Contractor shall furnish and install power cable and data control cable between the CMS sign controller field cabinet and CMS Display panels.
- The Contractor shall utilize cables specified by the manufacturer of the CMS.
- 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.

**Environmental Requirements**

The equipment shall meet all of its specified requirements during and after subjection to any combination of the following requirements:

- Ambient Temperature: Range of \(-40^\circ F\) to \(+140^\circ F\).
- Temperature Shock: Not to exceed 62°F per hour, during which the relative humidity: shall not exceed 95%.
- Relative Humidity Range: Not to exceed 95\% over the temperature range of 40°F to 110°F.
- Moisture Condensation: On all surfaces caused by temperature changes.

The Contractor shall furnish cut sheets, shop drawings and block and schematic diagrams which show in detail all proposed materials, dimensions, electronic layouts, part numbers, part values and operation parameters prior to construction of the CMS for the approval of the Engineer.

**Documentation Requirements**

The documentation for the CMS assembly 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.

Ten (10) complete sets of operation and maintenance manuals shall be provided for each assembly type utilized in the contract. The manuals shall, as a minimum, include the following:

- Complete and accurate Equipment drawing and diagrams, A pictorial drawing showing the physical location and identification of each component shall be provided for each different CMS 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.
- Complete and accurate Electrical Schematic Diagrams, An electrical schematic, wiring diagram, and a logic 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 CMS subsystem including block diagrams, terminal numbers, and conductor color codes shall be provided. Three copies of these diagrams shall be supplied.

- Complete and Customized Operator's Manual, This document shall fully describe the operation of the CMS assembly 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.

- Complete and Customized 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

- Complete installation procedures.

- Complete performance specifications (Functional, electrical, mechanical and environmental) on the equipment,

- Complete parts list including names of vendors for parts not identified by universal part numbers such as JEDEC, RETMA, or EIA.

- Pictorial of component layout on circuit board.

- Complete maintenance and trouble-shooting procedures

- Complete stage-by-stage explanation of circuit theory and operation.

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

**Instructions and Guarantees Requirements**

- 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 CMS assembly unit.

- 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.

- The CMS 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.

**Testing Requirements**

The CMS 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 CMS 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 NYSDOT, 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 these specifications shall result in the rejection of the CMS. 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 digression, 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 CMS panel and CMS sign controller 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 CMS assembly is installed in its final location. The test shall be performed on all of the CMS 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 CMS assembly is installed in its final location and after the CMS assemblies have been connected to the communications infrastructure. The test shall be performed on all of the CMS 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 CMS 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 CMS. 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.

**CMS Central Control System Requirements**

The Contractor shall also provide a CMS Central Control System for management of the CMS utilizing manufacturer-supplied software. The CMS Central Control System shall:

- Permit the installation of a system computer that can communicate via a TCP/IP network or connect to the CMS via dial-up communications, or leased data service.
- The central control system software shall contain all the elements required to operate the CMS 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 CMS according to pre-determined schedules, or immediately in case of emergencies.
- The software shall also provide non-volatile storage for 500 pre-programmed message scenarios, each scenario being able to simultaneously broadcast a set of preprogrammed messages to up to 12 pre-selected CMS 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 direct able to a standard text file.

The sign control test software shall include a real-time graphic emulation of the current sign display. In addition, the graphic shall have the ability to display failed pixels.

The software shall include 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 offline via a user-friendly 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.

Training Requirements

After the successful completion of the first part of the System Acceptance Test (the actual test) of the first CMS assembly, training shall be provided for the MTAB&T’s engineering, maintenance and operations staff, at a facility provided by the MTAB&T. 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
ITEM 683.00360011 – CHANGEABLE MESSAGE SIGN ASSEMBLY

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 CMS 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.

CONSTRUCTION DETAILS

The Contractor shall furnish and assemble/integrate CMS panels on the proposed Static sign as specified on the plan and as directed by the Engineer. The Contractor shall install the CMS sign including field equipment and their cabinet at locations as shown on the plans. Sign mounting shall be in accordance with the details shown on the plans or as directed by the Engineer.

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 CMS Sign.

The Contractor shall furnish and install minimum three 2” Galvanized steel conduits between CMS sign controller cabinet and CMS sign. The contractor shall furnish and install all communication, control signal, grounding, and power cables between the CMS Sign and the CMS sign controller cabinet. The payment for these conduits and cables shall be included under Changeable Message Sign Assembly Item.

All material shall be transported and handled in a manner that will cause no permanent deformation, injury, or damage. Material to be stored shall be stored above the ground in a manner and at a location approved by the Engineer. Any part of the entire sign or structure damaged during transportation, handling or erection shall be repaired, or if determined by the Engineer as unfit for use in the finished work, shall be removed from the site and replaced by the Contractor at his own expense. Subsection 645-3.09 of the Standard Specification shall supply.

Once installed, the CMS message input signals shall be connected to the CMS sign Controller cabinet. Tests shall be conducted to verify that the sign is operational via the CMS sign Controller installed at the field cabinet. The Contractor shall be responsible for all local programming of the CMS sign Controller necessary to achieve remote operation of CMS via Verrazano Narrow Bridge Facility operation center.

All components to be supplied under this specification shall be warranted for a minimum of two-years from the conclusion of the final acceptance test of each assembly. This warranty shall include repair and/or replacement of all failed components via a factory authorized depot repair service. All items sent to the depot for repair shall be returned within two weeks of the date of receipt at the facility. The depot location shall be in the United States. Repairs shall not require more then two weeks from date of receipt and the provider of the warranty shall be responsible for all return shipping costs. The depot maintainer designated for each component shall be authorized by the original manufacturer to supply this service. A warranty certificate shall be supplied for each component from the designated depot repair site indicating the start and end dates of the
warranty. The certificate shall be supplied at the conclusion of the system acceptance test and shall be for a minimum of two years after that point. The certificate shall name MTAB&T as the recipient of the service. MTAB&T shall have the right to transfer this service to other private parties who may be contracted to perform overall maintenance of the facility.

**METHOD OF MEASUREMENT**

This work will be measured as the number of CMS Assembly furnished, installed and tested in accordance with the plans, specifications and as directed by the Engineer.

**BASIS OF PAYMENT**

The unit price bid for the CMS Assembly shall include the cost of furnishing all equipment, materials, labor, and tools required to complete the work as specified herein and as directed by the Engineer. Payment for all mounting hardware, local cabling, and conduit required at the sign location shall be included under this item.

Payment will be made at the contract unit price for each CMS Assembly which shall include all equipment, material, conduit and cables between CMS sign and field controller cabinet, testing, documentation, and labor detailed in the contract documents, and tools required to complete the work as specified herein and as directed by the Engineer for this bid item. Payment for all mounting hardware, local cabling, wiring and conduit required at the sign location shall be included under this item. Conduit and wire required connecting the CMS Cabinet to power service and communications system shall be paid for under other work items as identified on the plans. Progress payment will be made as follows:

1. Approval of Shop Drawings - 10%
2. Successful Factory Test, Field Inspection, and Installation 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

Payment will be made under:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>680.00360011</td>
<td>Changeable Message Sign Assembly</td>
<td>Each</td>
</tr>
</tbody>
</table>