

**ITEM 683.93010005 – DYNAMIC MESSAGE SIGN (DMS) FULL MATRIX,
FULL COLOR, FRONT ACCESS LED**

DESCRIPTION:

This work item shall consist of furnishing and installing a complete operational, front access, full matrix, capable of displaying multiple lines of full-color text with multiple characters per line and graphic symbols Dynamic Message Sign (DMS) assembly at locations indicated in the contract documents. This item shall include all sign modules, sign housings, sign cabinets and controllers, fittings and cabling to make the sign compatible with the control software defined in this document.

GENERAL REQUIREMENTS:

The VMS shall be one of the three following pre-approved models:

Model Number TBD, manufactured by:

Ledstar, Inc.
131 Westcreek Drive
Woodbridge, Ontario, Canada L4L9N6
Phone (905) 265-7800
www.ledstar.com

or

Model Number VF-2420-36x150-34-RGB– manufactured by:

Daktronics, Inc.
P.O. Box 5128
331 32nd Avenue
Brookings, SD 57006
Phone: (800) 833-3157
www.daktronics.com

or

Model Number TBD, manufactured by:

Skyline Products
2903 Delta Avenue
Colorado Springs, CO 80910
Phone (800) 759-9046
www.skylineproducts.com

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The dynamic message sign housing dimensions shall not exceed 17'-3" wide by 4'-11" high. The front-to-back housing depth shall not exceed 1'-2" at its widest point, including the rear ventilation hoods.

MATERIALS:

DMS provided for this contract must comply with the following standards. If no revision date is specified, the most recent revision of the standard applies:

- General DMS Requirements – The DMS must be designed in accordance with NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements.
- Aluminum Welding – The DMS housing must be designed, fabricated, welded, and inspected in accordance with the latest revision of ANSI/AWS D1.2 Structural Welding Code-Aluminum.
- Electrical Components – High-voltage components and circuits (120 VAC and greater) must be designed, wired, and color-coded per the National Electric Code.
- Environmental Resistance – The DMS housing all be designed to comply with type 3R enclosure criteria as described in the latest revision of NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
- Product Electrical Safety – The DMS and associated equipment and enclosures must be listed by the Underwriters Laboratories (UL) and will bear the UL mark on the outside of the DMS enclosure. Control equipment and enclosures shall be listed as conformant to UL 1433 Standard for Control Centers for Changing Message Type Electric Signs. Failure to meet conformance will be cause for rejection.
- Radio Frequency Emissions – All equipment must be designed in accordance with Federal Communications Commission (FCC) Part 15, Subpart B as a “Class A” digital device.
- Structural Integrity – The DMS housing must be designed and constructed to comply with all applicable sections of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, as well as the fatigue resistance requirements of NCHRP Report 412, Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports.
- Communication Protocols – The sign controller hardware/firmware and DMS control software must conform to the applicable National Transportation Communication for ITS Protocol (NTCIP) standards. Refer to the NTCIP section of this specification for detailed NTCIP requirements for this contract.

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

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The DMS shall contain a full display matrix measuring a minimum of 36 rows high by 150 pixel columns wide. The matrix shall display messages that are continuous, uniform, and unbroken in appearance to motorists and travelers.

Each display pixel shall be composed of multiple red, green, and blue LEDs. Other pixel technologies, such as fiber optic, flip disk, combination flip disk-fiber optic, combination flip disk-LED, liquid crystal, LED lenses, and incandescent lamp, will not be accepted.

The pixel matrix shall be capable of displaying at minimum alphanumeric 6" high characters in accordance with the definition defined by NEMA TS 4 Hardware Standards for Dynamic Message Signs Standards

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

Legibility

DMS messages shall be legible within a distance range of 75 ft (22.9 m) to 450 ft (137 m) from the DMS display face under the following conditions:

- When the DMS is mounted so its bottom side is positioned between five feet (1,524 mm) and 20 feet (6,096 mm) above a level roadway surface
- Whenever the DMS is displaying alphanumeric text that is 9-inches (236 mm) high
- 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 DMS
- When viewed by motorists and travelers that have 20-20 corrected vision
- When the motorist eye level is 3 feet to 12 feet above the roadway surface.

DMS weight shall not exceed 1020 pounds.

The DMS housing shall be constructed to have a neat, professional appearance. The housing shall protect internal components from rain, ice, dust, and corrosion in accordance with NEMA enclosure Type 3R standards, as described in NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

The DMS housing bottom side shall contain small weep holes for draining any water that may accumulate due to condensation. Weep holes and ventilation/exhaust hoods shall be screened to prevent the entrance of insects and small animals.

DMS and sign controller components shall operate in a minimum temperature range of -30°F to +165°F (-34°C to +74°C) and a relative humidity range of 0 to 99%, non-condensing. DMS and sign controller components shall not be damaged by storage at or temporary operational exposure to a temperature range of -40°F to +185°F (-40°C to +85°C).

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Interior DMS Environmental Control

The DMS shall contain systems for cabinet ventilation and safe over-temperature shutdown.

Housing Ventilation System

The DMS shall contain a electronically controlled ventilation system and a failsafe thermostat designed to keep the internal DMS air temperature lower than +140°F (+60°C), when the outdoor ambient temperature is +115°F (+46°C) or less.

The ventilation system shall consist of two or more air intake ports. Intake ports shall be located near the bottom of the DMS rear wall. Each intake port shall be covered with a filter that removes airborne particles measuring 500 microns in diameter and larger. One or more ball bearing-type fans shall be mounted at each intake port. These fans shall positively pressure the DMS cabinet.

Fans and air filters shall be removable and replaceable from inside the DMS housing.

Each ventilation fan shall contain a sensor to monitor its rotational speed, measured in revolutions per minute. The fan speed shall be reported via a CAN (controller area network) communication network to the sign controller upon request.

The ventilation system shall move air across the rear of the LED modules in a manner such that heat is dissipated from the LED's. The airflow shall move from the bottom of the cabinet towards the top to work with natural convection to move heat away from the modules.

Each exhaust port shall be located near the top of the rear DMS wall. One exhaust port shall be provided for each air intake port. All exhaust port openings shall be screened to prevent the entrance of insects and small animals.

An aluminum hood attached to the rear wall of the DMS shall cover each air intake and exhaust port. All intakes and exhaust hoods shall be thoroughly sealed to prevent water from entering the DMS.

Over Temperature Safety Shutdown

The DMS shall automatically shut down the LED modules to prevent damaging the LEDs if the measured internal cabinet air temperature exceeds a maximum threshold temperature

All electronic setup and adjustments for the display shall be enabled from the ground mounted equipment cabinet.

All materials to be furnished, assembled, fabricated or installed shall be new, corrosion resistant and in accordance with the details as shown on the Plans or as specified in the Contract documents.

Face Panels

Front face panels shall provide a high-contrast background for the DMS display matrix. The aluminum mask of each door panel shall be painted black and shall contain an opening for each pixel. Openings shall be large enough to not block any portion of the viewing cones of the LEDs.

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Each door panel shall have a single 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 DMS. 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 use of a plastic lens system will not meet the requirements and will be cause for rejection.

- LED display modules shall mount to the inside of the DMS front face door panels. No tools shall be needed for removal and replacement of LED display modules.
- DMS front face borders (top, bottom, left side, and right side), which surround the front face panels and LED display matrix, shall be painted black to maximize display contrast and legibility.
- In the presence of wind, the DMS front face shall not distort in a manner that adversely affects LED message legibility.

DMS front face panels and front face border pieces shall be coated with semi-gloss black polyvinylidene fluoride (PVDF) applied in accordance to American Architectural Manufacturers Association (AAMA 2605) which has an expected outdoor service life of 10 to 15 years.

All other DMS housing surfaces, including the DMS mounting brackets, shall be natural mill-finish aluminum.

The DMS shall be installable either over the road as shown in the contract plans.

The sign assembly and mounting hardware shall be designed to meet the loading and fatigue requirements specified in the following documents:

“NYSDOT Design Specification for Overhead Sign Structures Carrying Variable Message Signs” dated October, 1998; and the revisions to this document contained in: Engineering Bulletin EB 01-049, “Overhead Sign Structure Interim Design Criteria”, dated 10/01/01; Engineering Instruction EI 99-038 “Design Loads for Permanent Variable Message Signs”, dated 12/31/99; and any other subsequent revisions.

LED Display Modules

The DMS shall contain LED display modules that include an LED pixel array, and LED driver circuitry. These modules shall be mounted adjacently in a two-dimensional array to form a continuous LED pixel matrix. Each LED display module shall be constructed as follows:

- All LED modules shall be manufactured and designed to IPC standards.
- Each LED display module shall be mounted to the rear of the display’s front face panels using durable non-corrosive hardware. No tools shall be required for module removal and replacement. The modules shall be mounted such that the LEDs emit light through the face panel’s pixel holes and such that the face panel does not block any part of the

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viewing cone of any of the LEDs in any pixels. The use of light enhancing lenses to achieve defined viewing cone shall be cause for rejection.

- LED display module power and signal connections shall be a quick-disconnect locking connector type. Removal of a display module from the DMS shall not require a soldering operation.
- All exposed metal on both sides of each printed circuit board, except connector contacts, shall be protected from water and humidity exposure by a thorough application of conformal coating. Bench level repair of individual components, including discrete LED replacement and conformal coating repair, shall be possible.
- Individual addressing of the each LED display module shall be configured via the communication wiring harness and connector. No on-board addressing jumpers or switches shall be allowed.
- Removal or failure of a single LED module shall not affect the operation of any other LED module or sign component. Removal of one or more LED modules shall not affect the structural integrity of any part of the sign.
- It shall not be possible to mount an LED display module upside-down or in an otherwise incorrect position within the DMS display matrix.
- All LED display modules, as well as the LED pixel boards shall be identical and interchangeable throughout the DMS.

LED Pixels

Each LED module shall contain a printed circuit board to which LED pixels are soldered. The LED pixel matrix shall conform to the following specifications:

- Each LED module shall contain a minimum of 135 LED pixels configured in a two dimensional array. The pixel array shall be a minimum of sixteen (9) pixels high by sixteen (15) pixels wide.
- The distance from the center of one pixel to the center of all adjacent pixels, both horizontally and vertically, shall be 1.30-inches (~33 mm).
- All pixels shall contain an equal quantity of discrete LEDs and LED strings. If a pixel contains four (4) or more discrete LEDs, then each pixel shall contain a minimum of two (2) independent and parallel strings of LEDs.
- The failure of an LED string or pixel shall not cause the failure of any other LED string or pixel in the DMS.
- Each pixel shall contain the quantity of discrete LEDs needed to output white colored light at a minimum luminous intensity of 12,400 candelas per square meter when measured using a photometric meter through the DMS front face panel assembly. Failure to conform to the requirements will be cause for rejection.

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- Each pixel shall also be capable of displaying amber colored light with a minimum luminous intensity of 7,440 candelas per square meter when measured using a photometric meter through the DMS front face panel assembly. Failure to conform to the requirements will be cause for rejection.
- The LEDs shall be soldered so that they are parallel to the surface of the printed circuit board. The longitudinal axis of the LEDs shall be perpendicular to the circuit board.

Discrete LEDs

DMS pixels shall be constructed with discrete LEDs manufactured by a reputable manufacturer such as Avago Technologies (formerly Agilent Technologies), Nichia Corporation, OSRAM, CREE, or EOI. Discrete LEDs shall conform to the following specifications:

- All LEDs shall have a nominal viewing cone of 30 degrees with a half-power angle of 15 degrees measured from the longitudinal axis of the LED. Viewing cone tolerances shall be as specified in the LED manufacturer's product specifications and shall not exceed +/- 5 degrees. Using optical enhancing lenses with 15 degree LED's will not conform to 30 degree half-power viewing cone specifications and will be cause for rejection.
- Red LEDs shall utilize AlInGaP semiconductor technology and shall emit red light that has a peak wavelength of 618-630nm.
- Green LEDs shall utilize InGaN semiconductor technology and shall emit green light that has a peak wavelength of 519-539nm.
- Blue LEDs shall utilize InGaN semiconductor technology and shall emit blue light that has a peak wavelength of 440-480nm.
- The LED packages shall be fabricated from UV light resistant epoxy.
- The LED manufacturer shall perform intensity sorting of the bins. LEDs shall be obtained from no more than two (2) consecutive luminous intensity "bins" as defined by the LED manufacturer.
- The various LED color shall be distributed evenly throughout the sign and shall be consistent from pixel to pixel.
- The LED manufacturer shall assure color uniformity and consistency on the LED display face within the 30 degree cone of vision. Inconsistent color shifts or intensity will be cause for rejection.
- All LEDs used in all DMS provided for this contract shall be from the same manufacturer and of the same part number, except for the variations in the part number due to the intensity and color.

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- The LEDs shall be rated by the LED manufacturer to have a minimum lifetime of 100,000 hours of continuous operation while maintaining a minimum of 50% of the original brightness.

Pixel Drive Circuitry

Driver circuitry shall be provided for each LED pixel module and shall individually control all pixels on that module. The modules shall conform to the following specifications:

- Each LED driver board shall be microprocessor-controlled and shall communicate with the sign controller on a wire or fiber optic communication network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostic tests, and report pixel and diagnostic status.
- Constant current LED driver ICs shall be used to prevent LED forward current from exceeding the LED manufacturer's recommended forward current whenever a forward voltage is applied. To maximize LED service life, LED drive currents will not be allowed that exceed the manufacturer's recommendations for the 100,000-hour lifetime requirement.
- The LED pixels shall be directly driven using pulse width modulation (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.
- Each LED driver circuit shall be powered by 24 VDC from external regulated DC power supplies.
- The voltage of each power input shall be measured to the nearest tenth of a volt and reported to the sign controller upon request. Each driver circuit shall also contain a status LED for the power supplies that indicates which power input is in use.
- The LED driver circuitry shall be able to detect that individual LED strings or pixels are stuck off and shall report the pixel status to the sign controller upon request.
- The LED driver board shall contain a seven segment numeric LED display that indicates the functional status of the LED pixel display module. At a minimum, it shall indicate error states of the LED pixels and communication network.

POWER REQUIREMENTS:

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 configuration that uses multiple supplies for the DMS display matrix.

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

Each power supply shall receive 120VAC power from separate circuits on separate circuit breakers, such that a single tripped breaker will not disconnect power from more than one supply.

The power supplies shall be sufficient to maintain the appropriate LED display intensity throughout the entire operating input voltage range.

Each power supply shall be monitored by a microprocessor-controlled circuit.

The power supplies used to power the LED pixel modules must be identical and interchangeable throughout the DMS.

The power supplies used to power the LED pixel modules shall have an application of acrylic conformal coating to protect from the environmental elements and must be UL listed or recognized.

The 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 264 VAC
- Operating temperature range shall be a minimum of -30°F to +165°F (-34°C to +74°C)
- Maximum output power rating shall be maintained over a minimum temperature range of -30°F to +140°F (-34°C to +60°C)
- 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

The cabinet shall contain a power panel and an AC load center with a minimum of 6 circuit breaker mounting positions.

The power panel shall contain a two (2) 15-A NEMA 15-R, 120 VAC duplex outlets, with ground-fault circuit interrupters.

The power panel shall include one (1) earth ground lug that is electrically bonded to the cabinet. All earth grounding shall conform to the National Electrical Code.

Solar/DC Option:

No solar option allowed.

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Surge Suppression:

The DMS distribution box shall contain surge suppression for both the DC power and sign communications. The sign power surge suppression shall consist of thermal resettable fuses conforming to SAE specification J53 Type 1. The sign communication shall consist of a surge suppression device capable of withstanding a 10kA peak surge in < 1 nanosecond.

Electrical Protection, Documentation, Warranty:

In order to protect all different parts of the dynamic message sign assembly from electric and electromagnetic surges, all necessary equipment shall be supplied as part of the dynamic message sign assembly. AC input transient and surge protection must meet or exceed the UL 1449 standard.

Electrical protection shall include but not be limited to:

- Surge suppressor for the LED display and the digital control unit;
- Lightning arrester for the LED display and the digital control unit;
- Data line protector
- Telephone line noise and surge protection where communication is by land line.

The sign assembly, cabinet and structure shall be electrically bonded to assure proper grounding of all components.

The Contractor shall provide four (4) sets of the maintenance manual for the LED dynamic message sign, digital control unit and auxiliary equipment supplied for each LED dynamic message sign assembly furnished. Also four (4) complete sets of schematics of the electronics for the LED display and all boards shall be furnished.

Four (4) complete sets of manuals for all software shall be provided.

WARRANTY:

All of the mechanical and electronic equipment specified to make the system operational and functional shall be warranted for a period of two (2) years. The warranties shall be issued to the New York State Thruway Authority by the respective manufacturer and/or system fabricator. The warranties shall cover the repair or replacement of the component or device. Replacements shall be new units. The Authority will be responsible for removing and re-installing the component or device after the Contractors initial warranty period. The warranties shall be effective from the date of final acceptance of this item.

The Contractor shall comply with Subsection 105-18 of the Standard Specifications for the initial warranty period.

Nothing contained in these Special Specifications shall relieve the Contractor of the implied warranty that the equipment, system, and service provided are both first quality, fit, and merchantable for the uses intended as indicated herein.

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DMS CONTROLLER:

Each sign shall be individually addressable from a PC type computer. In addition, all signs shall have the capability of being addressed from a single communications link.

The controller shall be capable of providing all the necessary functions to control and monitor the DMS locally and from the Traffic Management Center (TMC). Local control shall be made possible in the field by either an alphanumeric keypad or optional QWERTY keyboard connected to the controller with an LCD display.

The software shall be compatible with Windows 7, 32-bit and 64-bit, Windows 8, 32-bit and 64-bit, and Windows Server 2008 R2. It shall be able to run fully under a standard user level security account without any special changes or configurations.

Four sets of Software shall be provided for installation in remote PC type computers. The software shall be supplied to allow the remote operator to create, edit, and/or delete messages, and to fully control all capabilities of the system. The software sets are to be turned over to the New York State Thruway Authority unless installations at specific remote sites are required by special note.

Additionally, the software shall be designed so as to allow an exact animated simulation of the LED display in order to permit the dynamic visualization of the message prior to actual display. Furthermore, the software shall have the capability to automatically broadcast specific messages to at least 100 remote variable message signs, according to predetermined schedules, or immediately in case of emergencies.

The controller shall be mounted in the cabinet as shown in the contract plans or as provided by the manufacturer. The communication signals from sign controller to the DMS shall be RS-232 for distances up to 50 feet and RS-485 for distances up to 4,000 feet. Optional TCP/IP communications will also be an acceptable communications technology.

MESSAGING

The DMS controller shall have the ability to display messages on the DMS display face as required herein.

Message Presentation on the DMS Display Matrix

The sign controller shall control the LED drivers in a manner that causes the desired message to display on the DMS sign. At a minimum, the sign controller shall support the following features as described in the DMS specification:

- Display of alpha numeric characters, including letters, numbers, and punctuation
- Selection of particular character fonts style
- Horizontal alignment of text on the display, including left, center, and right justification
- Vertical alignment of text on the display, including top, middle, and bottom justification

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- Adjusting the spacing horizontally between characters or vertically between lines of text
- Alternating between pages of a multiple-page message
- Display of graphic bitmaps of various sizes ranging to very small to the size of the entire DMS matrix

Message Effects

The DMS shall be able to display messages using the following types of effects:

- **Static Message** – The selected message is displayed continuously on the sign face until the sign controller blanks the sign or causes the display of another message
- **Flashing Message** – All or part of a message is displayed and blanked alternately at rates between 0.1 seconds and 9.9 seconds. The flash rate is user programmable in increments of 0.1 seconds
- **Scrolling Message** – The message moves across the display face from one side to the other. The direction of travel is user selectable as either left-to-right or right-to-left
- **Multiple-Page Message** – A message contains up to six different pages of information, with each page filling the entire pixel matrix. Each page's display time is user programmable from 0.1 seconds to 25.5 seconds, and adjustable in increments of 0.1 seconds.

Message Activation

Messages shall be activated on a DMS in three ways:

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

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

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

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It shall be possible to confer a “priority” status onto any message, and a command to display a priority message shall cause any non-priority message to be overridden.

Schedule Activation

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

Display of Alphanumeric Text

The DMS sign controller shall support the storage and use of a minimum of twelve (12) font sets with which messages can be formatted and displayed. Each font shall support up to 255 characters. All text font files shall include the following characters:

- The letters “A” through “Z”, in both upper and lower case
- Decimal digits “0” through “9”
- A blank space
- Eight (8) directional arrows
- Punctuation marks, such as: . , ! ? - ‘ ’ “ ” ; :
- Special characters, such as: # & * + / () [] < > @

The DMS supplier shall provide the DMS controller with the following fonts preinstalled. The controller shall support changing or replacing these fonts from the central software using NTCIP.

Font Name	Character Height	Character Width (avg.)	Variable or Fixed Width	Stroke Width
7x4	7	4	Variable	Single (1)
7x5	7	5	Fixed	Single (1)
7x6	7	6	Variable	Double (2)
7x8	7	8	Variable	Triple (3)
Graphic 7	7	N/A	Variable	N/A
8x4	8	4	Variable	Single (1)
8x6	8	6	Variable	Double (2)
8x8	8	8	Variable	Triple (3)
9x5	9	5	Variable	Single (1)
9x6	9	6	Variable	Double (2)

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9x8	9	8	Variable	Triple (3)
11x7	11	7	Fixed	Double (2)
11x7	11	7	Variable	Double (2)
11x9	11	9	Variable	Triple (3)
14x8	14	8	Fixed	Double (2)
14x10	14	10	Variable	Triple (3)
16x8	16	8	Variable	Double (2)
16x10	16	10	Variable	Triple (3)
24x15	24	15	Variable	Triple (3)

Table 1: Sample Font Table

Display of Graphic Images

The DMS control software shall support the inclusion of graphics in messages. The display of graphics shall conform to NTCIP 1203 v2 standard.

Laptop Interface Enclosure

A pole-mounted control interface cabinet shall be provided. It shall be provided with two (2) mounting brackets suitable for use with pole-mount straps. The cabinet shall enclose an auxiliary control panel, 120 VAC electrical outlets, and a laptop shelf.

General Specifications

The pole-mounted cabinet shall be 20” (508 mm) +/- 1” (25.4 mm) high by 24” (610 mm) +/- 0.5” (12.7 mm) wide by 10” (254 mm) +/- 0.5” (12.7 mm) deep. The front-to-back cabinet dimensions shall not exceed 12” (305 mm) at its widest point, including the door handle and roof overhang.

The cabinet weight shall not exceed 50 pounds (22.7 kg) when the cabinet is empty.

Cabinet Construction

The controller cabinet shall be constructed to have a neat, professional appearance. The cabinet shall protect all internal components from rain, ice, dust and corrosion in accordance with NEMA

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enclosure Type 3R standards, as described in *NEMA Standards Publication 250 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 cabinet shall be constructed using 0.125-inch thick aluminum alloy 5052-H32. The exterior of the controller cabinet shall be natural mill-finish aluminum.

Serviceability

The controller 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.

One (1) vertically hinged door shall be mounted on the cabinet for interior access. The door shall be located on the front face of the cabinet. The door opening shall not be less than 17” (432 mm) high by 21” (533 mm) wide. The opening shall be sealed with a 0.5” x 2” closed cell foam gasket.

The door shall be attached to the cabinet by a full-length stainless steel hinge and mounting hardware. The doors shall open outward. In the closed position, the door shall latch to a double-flanged door opening. The door handle shall be stainless steel. The door shall be equipped with a Corbin #2 lock.

Equipment Mounting

The auxiliary control panel shall be mounted to the interior rear wall of the cabinet.

The cabinet shall contain a fold-down shelf suitable for supporting a laptop computer during maintenance operations. The shelf shall be a minimum of 15” (381 mm) wide by 12” (305 mm) deep.

Electrical Systems

The cabinet 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 one (1) ground-fault circuit interrupters.

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.

Cost for laptop interface controller enclosure shall be included under this specification.

NATIONAL TRANSPORTATION COMMUNICATIONS FOR ITS PROTOCOL (NTCIP):

This section describes the minimum specifications for the NTCIP communication capabilities of the DMS controller and DMS control software. The contractor shall provide all the software, firmware, and services necessary to operate a dynamic message sign (DMS) system that fully complies with the NTCIP functional requirements specified herein, including incidental items that may have been inadvertently omitted.

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References

These specifications reference standards through their NTCIP designated names. The following list provides the current versions of each of these standards.

Each NTCIP device covered by these project specifications shall implement the version of the standard that is specified in the following table. Refer to the NTCIP library at www.ntcip.org for information on the current status of NTCIP standards.

Document Number and Version	Document Title	Document Status
NTCIP 1101:1996 and Amendment 1	<i>Simple Transportation Management Framework (STMF)</i>	Approved Standard with Amendment
NTCIP 1102:2004 v01.15	<i>Octet Encoding Rules (OER) Base Protocol</i>	Approved Standard
NTCIP 1103:2010 v02.17	<i>Transportation Management Protocols</i>	Recommended Standard
NTCIP 1201:2010 v03.13	<i>Global Object (GO) Definitions</i>	Approved Standard with Amendment
NTCIP 1203:2010 v02.39b	<i>Object Definitions for Dynamic Message Signs</i>	Approved Standard with Amendment
NTCIP 2101:2001 v01.17	<i>Point to Multi Point Protocol (PMPP) Using RS-232 Subnetwork Profile</i>	Approved Standard
NTCIP 2102:2003 v01.09	<i>Point to Multi Point Protocol (PMPP) Using FSK Subnetwork Profile</i>	Approved Standard
NTCIP 2103:2008 v02.07	<i>Point-to-Point Protocol Over RS-232 Subnetwork Profile</i>	Approved Standard

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Document Number and Version	Document Title	Document Status
NTCIP 2104:2003 v01.11	<i>Ethernet Subnetwork Profile</i>	Approved Standard
NTCIP 2201:2003 v01.15	<i>Transportation Transport Profile</i>	Approved Standard
NTCIP 2202:2001 v01.05	<i>Internet (TCP/IP and UDP/IP) Transport Profile</i>	Approved Standard
NTCIP 2301:2010 v02.19	<i>Simple Transportation Management Framework (STMF) Application Profile</i>	Approved Standard

Table 2: NTCIP Document References

Subnetwork Profiles

Each serial or modem port on each NTCIP device shall be configurable to support both NTCIP 2101 and NTCIP 2103. Only one of these profiles shall be active at any given time. Serial ports shall support external dial-up modems.

Each Ethernet port on the NTCIP device shall comply with NTCIP 2104.

The NTCIP device(s) may support additional Subnet Profiles at the manufacturer’s option. At any one time, only one subnet profile shall be active on a given port of the NTCIP device. All response datagram packets shall use the same transport profile used in the request. The NTCIP device shall be configurable to allow a field technician to activate the desired subnet profile and shall provide a visual indication of the currently selected subnet profile.

Transport Profiles

Each serial or modem port on each NTCIP device shall be configurable to support both NTCIP 2201 and NTCIP 2202.

Each Ethernet port on the NTCIP device shall comply with NTCIP 2202.

The NTCIP device(s) may support additional transport profiles at the manufacturer’s option. Response datagrams shall use the same transport profile used in the request. Each NTCIP device shall support the receipt of datagrams conforming to any of the supported transport profiles at any time.

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Application Profiles

Each NTCIP device shall comply with NTCIP 2301 and shall meet the requirements for Conformance Level 1.

An NTCIP device may support additional application profiles at the manufacturer’s option. Responses shall use the same application profile used by the request. Each NTCIP device shall support the receipt of application data packets at any time allowed by the subject standards.

Object Support

Each NTCIP device shall support all mandatory objects of all mandatory conformance groups as defined in NTCIP 1201 and NTCIP 1203.

Each NTCIP device shall support all mandatory objects in all optional conformance groups required herein. All optional objects listed in these specifications shall be supported. The NTCIP device(s) shall are required to support the following optional conformance groups.

Conformance Group	Reference
Time Management	NTCIP 1201
Timebase Event Schedule	NTCIP 1201
Report	NTCIP 1201
PMPP	NTCIP 1201
Font Configuration	NTCIP 1203
DMS Configuration	NTCIP 1203
MULTI Configuration	NTCIP 1203
MULTI Error Configuration	NTCIP 1203
Illumination/Brightness Control	NTCIP 1203
Scheduling	NTCIP 1203
Sign Status	NTCIP 1203
Status Error	NTCIP 1203
Pixel Error Status	NTCIP 1203

Table 3: Required Optional Conformance Groups

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The following table indicates objects that are considered optional in the NTCIP standards, but are required by this specification. It also indicates modified object value ranges for certain objects. Each NTCIP device shall provide the full, standardized object range support (FSORS) of all objects required by these specifications unless otherwise indicated below.

Object	Reference	Project Requirement
moduleTable	NTCIP 1201 Clause 2.2.3	Shall contain at least one row with <i>moduleType</i> equal to 3 (software).
maxTimeBaseScheduleEntries	NTCIP 1201 Clause 2.4.3.1	Shall be at least 28
maxDayPlans	NTCIP 1201 Clause 2.4.4.1	Shall be at least 20
maxDayPlanEvents	NTCIP 1201 Clause 2.4.4.2	Shall be at least 12
maxEventLogConfig	NTCIP 1201 Clause 2.5.1	Shall be at least 50
eventConfigMode	NTCIP 1201 Clause 2.4.3.1	The NTCIP Component shall Support the following Event Configuration: onChange, greaterThanValue, smallerThanValue, Hysteresis is Bound, Periodic.
eventConfigLogOID	NTCIP 1201 Clause 2.5.2.7	FSORS
eventConfigAction	NTCIP 1201 Clause 2.5.2.8	FSORS
maxEventLogSize	NTCIP 1201 Clause 2.5.3	Shall be at least 200
maxEventClasses	NTCIP 1201 Clause 2.5.5	Shall be at least 16

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Object	Reference	Project Requirement
eventClassDescription	NTCIP 1201 Clause 2.5.6.4	FSORS
maxGroupAddresses	NTCIP 1201 Clause 2.7.1	Shall be at least 1
communityNamesMax	NTCIP 1201 Clause 2.8.2	Shall be at least 3
numFonts	NTCIP 1203 Clause 2.4.1.1.1.1	Shall be at least 12
maxFontCharacters	NTCIP 1203 Clause 2.4.1.1.3	Shall be at least 255
defaultFlashOn	NTCIP 1203 Clause 2.5.1.1.1.3	The DMS shall support flash “on” times ranging from 0.1 to 9.9 seconds in 0.1 second increments
defaultFlashOff	NTCIP 1203 Clause 2.5.1.1.1.4	The DMS shall support flash “off” times ranging from 0.1 to 9.9 seconds in 0.1 second increments
defaultBackgroundColor	NTCIP 1203 Clause 2.5.1.1.1.1	The DMS shall support the black background color
defaultForegroundColor	NTCIP 1203 Clause 2.5.1.1.2	The DMS shall support the amber foreground color
defaultJustificationLine	NTCIP 1203 Clause 2.5.1.1.1.6	The DMS shall support the following forms of line justification: left, center, and right
defaultJustificationPage	NTCIP 1203 Clause 2.5.1.1.1.7	The DMS shall support the following forms of page justification: top, middle, and bottom
defaultPageOnTime	NTCIP 1203 Clause 2.5.1.1.1.8	The DMS shall support page “on” times ranging from 0.1 to 25.5 seconds

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Object	Reference	Project Requirement
		in 0.1 second increments
defaultPageOffTime	NTCIP 1203 Clause 2.5.1.1.1.9	The DMS shall support page “off” times ranging from 0.0 to 25.5 seconds in 0.1 second increments
defaultCharacterSet	NTCIP 1203 Clause 2.5.1.1.1.10	The DMS shall support the eight bit character set
dmsMaxChangeableMsg	NTCIP 1203 Clause 2.6.1.1.1.4	Shall be at least 100.
dmsMessageMultiString	NTCIP 1203 Clause 2.6.1.1.1.8.3	The DMS shall support any valid MULTI string containing any subset of those MULTI tags listed in Table 3 (below)
dmsControlMode	NTCIP 1203 Clause 2.7.1.1.1.1	Shall support at least the following modes: local, central, and centralOverride
dmsSWReset	NTCIP 1203 Clause 2.7.1.1.1.2	FSORS
dmsMessageTimeRemaining	NTCIP 1203 Clause 2.7.1.1.1.4	FSORS
dmsShortPowerRecoveryMessage	NTCIP 1203 Clause 2.7.1.1.1.8	FSORS
dmsLongPowerRecoveryMessage	NTCIP 1203 Clause 2.7.1.1.1.19	FSORS
dmsShortPowerLossTime	NTCIP 1203 Clause 2.7.1.1.1.10	FSORS
dmsResetMessage	NTCIP 1203 Clause 2.7.1.1.1.12	FSORS

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Object	Reference	Project Requirement
dmsCommunicationsLossMessage	NTCIP 1203 Clause 2.7.1.1.1.12	FSORS
dmsTimeCommLoss	NTCIP 1203 Clause 2.7.1.1.1.12	FSORS
dmsEndDurationMessage	NTCIP 1203 Clause 2.7.1.1.1.15	FSORS
dmsMemoryMgmt	NTCIP 1203 Clause 2.7.1.1.1.16	The DMS shall support the following Memory management Modes: normal clearChangeableMessages clearVolatileMessages
dmsMultiOtherErrorDescription	NTCIP 1203 Clause 2.4.1.1.1.20	If the vendor implements any vendor-specific MULTI tags, the DMS shall provide meaningful error messages within this object whenever one of these tags generates an error
dmsIllumControl	NTCIP 1203 Clause 2.8.1.1.1.1	The DMS shall support the following illumination control modes: Photocell, and Manual
dmsIllumNumBrightLevels	NTCIP 1203 Clause 2.8.1.1.1.4	Shall be at least 100
dmsIllumLightOutputStatus	NTCIP 1203 Clause 2.8.1.1.1.9	FSORS
numActionTableEntries	NTCIP 1203 Clause 2.9.1.1.1	Shall be at least 200
watcdogFailureCount	NTCIP 1203 Clause	FSORS

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Object	Reference	Project Requirement
	2.11.1.1.1.5	
dmsStatDoorOpen	NTCIP 1203 Clause 2.11.1.1.1.6	FSORS
fanFailures	NTCIP 1203 Clause 2.11.2.1.1.8	FSORS
fanTestActivation	NTCIP 1203 Clause 2.11.2.1.1.9	FSORS
tempMinCtrlCabinet	NTCIP 1203 Clause 2.11.4.1.1.1	FSORS
tempMaxCtrlCabinet	NTCIP 1203 Clause 2.11.4.1.1.2	FSORS
tempMinSignHousing	NTCIP 1203 Clause 2.11.4.1.1.5	FSORS
tempMaxSignHousing	NTCIP 1203 Clause 2.11.4.1.1.6	FSORS

Table 4: Modified Object Ranges and Required Optional Objects

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MULTI Tags

Each NTCIP device shall support the following message formatting MULTI tags. The manufacturer may choose to support additional standard or manufacturer-specific MULTI tags.

MULTI Tag	Description
f1	Field 1-time (12 hr)
f2	Field 1-time (24 hr)
f8	Field 8- day of month
f9	Field 9-month
f10	Field 10-2 digit year
f11	Field 11-4 digit year
fl (and /fl)	Flashing text on a line-by-line basis with flash rates controllable in 0.1-second increments.
Fo	Font
jl2	Justification- line-left
jl3	Justification- line-center
jl4	Justification- line- right
jp2	Justification- page- top
jp3	Justification- page- middle
jp4	Justification- page- bottom
mv	Moving text
nl	New line
np	New page up to 5 instances in a message (i.e. up to 6 pages/frame in a message counting first page)
pt	Page times controllable in 0.1-second increments

Table 5: Required MULTI Tags

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Documentation

NTCIP documentation shall be provided on a CD-ROM and will contain 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 modules 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. The filename of this file shall be identical to the standard MIB Module except that it will have the extension “man”.
- A MIB module in ASN.1 format containing any and all manufacturer 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

Acceptance Testing

The vendor will provide certification of NTCIP-compliance as part of the vendor’s pre-build submittal documentation. This certification shall be in the form of a comprehensive test plan and completed test report as performed by either the vendor or a third-party testing agency. The testing shall have been completed using industry accepted test tools such as the NTCIP Exerciser, Trevilon’s NTester, Intelligent Devices’ Device Tester, and/or Frontline’s FTS for NTCIP. Data capture files from the FTS software during the performance of the above testing shall be furnished upon request of the Engineer.

The Engineer can elect to perform additional NTCIP testing if desired. This testing shall be conducted on a production DMS in the vendor’s facility during the factory acceptance test. The vendor shall provide a written NTCIP test procedure to the Engineer a minimum of 30 days prior to the NTCIP testing.

Interpretation Resolution

If the Engineer or DMS manufacturer discovers an ambiguous statement in the standards referenced by this procurement specification, the issue shall be submitted to the NTCIP DMS Working Group for resolution. If the Working Group fails to respond within 90 days, the engineer shall provide an interpretation of the specification for use on the project.

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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.

CENTRAL SOFTWARE:

Unless otherwise specified in the contract plans, the Contractor shall supply DMS central control software necessary to interface sign functions remotely from the TMC. All control software shall be delivered on CD-ROM and installed on the DMS computer and workstations as directed by the TMC manager. The TMC should be contacted for specifics of the communications protocols and software in place.

DMS software shall comply with the National Transportation Communications for ITS Protocol (NTCIP) documents and all related amendments, effective September 2008, and as referenced herein. The software shall be of a client-server design, in which users can connect to, configure, monitor, and control signs from workstations in the TMC and also from workstations connected to the DMS computer by a TCP/IP 100-BaseT network. Some workstations may use dial-up telephone lines or other low-speed connections to reach the network via the LAN server. The DMS computer shall communicate with the signs via either multipoint EIA-232 communication channels or over TCP/IP Ethernet protocol. The DMS central software shall support at least 30 users and workstations, and 100 signs.

The software shall provide the following capabilities to users at the workstations and DMS computer:

- See a list of messages stored in the sign or on the sign controller with an indication of which is currently being displayed on the monitor screen exactly as it appears to motorist.
- Cause a different message to be displayed.
- Upload and download new message files between the sign controllers and the DMS computer.
- Automatically detect malfunctions, including loss of communication or power, and errors.
- Create and edit fonts and messages and storing them on the DMS computer's disk drive for subsequent downloading to one or more signs.
- Create an activity log for all signs.
- Allow existing, or future, NTCIP based signs to be incorporated, configured, controlled, and monitored.

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- On screen notification/alarm of cabinet door open, malfunctions, errors, and out of range environmental conditions.

CONSTRUCTION DETAILS:

The DMS will be installed on new overhead sign structures as shown in the contract documents. Posts, post foundations, and other supporting structures shall be paid for under other contract items as shown in the plans.

The Contractor shall develop and deliver shop drawings which illustrate, in detail, how to mount and connect the variable message sign enclosure to the appropriate truss shown on the plans. All shop drawings shall be approved by a licensed N.Y.S. Professional Engineer. The sign enclosure shall be attached so that the sign face will be tilted down at an angle of 5 degrees to diminish sun glare. The dynamic message sign enclosure shall include any support mechanism necessary for the installation of the dynamic message sign enclosures which would not have been included in the support structure.

The sign shall not be mounted over the road unless all power and communication lines have been brought to the site and are ready for connection to the sign.

Installation Certification

All controller(s), LED display modules, and mounting hardware shall be installed in accordance with manufacturer's instructions and recommendations. To ensure the sign was installed properly the Contractor shall submit to the Engineer documentation which that states either a.) the manufacturer, or the manufacturer's authorized supplier, verifies that the Contractor has been trained on the installation, operation, testing and maintenance of the equipment or b) provides documentation from the manufacturer that the installation has been inspected and approved by the manufacturer or authorized representative.

Testing Requirements

Test Plan:

The manufacturer shall provide a test plan, 30-days prior to each test, for review and approval by the Engineer, for each of the three types of acceptance testing required: Design Acceptance Testing, Stand-alone Acceptance Testing, and System Acceptance Testing.

The test plans 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 required functions and capabilities under this item.

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

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- 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 flashing a part 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 environmental warnings.
- 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.

Test Equipment:

The test plan shall identify all equipment required to perform the tests. This equipment shall be provided by the Contractor for the duration of the testing program. As a minimum, functional testing equipment shall include the latest version of the Device Tester for NTCIP, software by Intelligent Devices Inc, or approved equal.

Test Performance:

The test shall be coordinated with NYSDOT at least three (3) weeks prior to the actual date. The Contractor shall conduct all tests, in the presence of the Engineer and/or up to two (2) other representatives. The Engineer may waive the right to witness certain tests. The utilized software shall be in recording/capturing mode while performing the test procedures.

Test Reports:

The Contractor 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 documentation shall be completed and provided to the Engineer for review. This documentation shall be the basis for acceptance or rejection by the Engineer. All test reports shall be signed by the Contractor's authorized testing representative.

Test Failure:

The unit shall be corrected or another unit substituted in its place and the test successfully repeated. The substitute unit shall have passed all other tests successfully. If any DMS equipment or software/firmware modifications are necessary as a result of any test or demonstration failure, full retesting for compliance with these specifications may be required and a test report shall be prepared and delivered to the Engineer prior to retesting of the equipment. The report shall describe the nature of the failure and corrective action taken. If a failure pattern, as defined by the Engineer, develops, the Engineer may direct that design and construction modifications be made to all units without additional cost to the State, other involved agencies, or extension of the contract period.

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Test Specifics:

Design Approval Test

Design approval tests shall be conducted by the Contractor on one or more sample equipment of each type, as approved by the Engineer, to determine if the design of the equipment meets the requirements of this specification. The tests shall be conducted in accordance with the approved test procedures. Tests shall be conducted between -35 degrees F and +165 degrees F.

In the case of standard product line equipment, the Engineer may waive the design approval tests if the manufacturer's written specifications (functional and environmental) are equal to or better than those specified herein and he so states in writing or if the Contractor provides certification by an independent testing laboratory that these design approval tests have been previously satisfactorily completed. The design approval test shall cover the following at a minimum:

Temperature:

All functional operations of the equipment shall be successfully performed under the following conditions and in the order specified below:

The equipment shall be stabilized at 32°F. After stabilization at this temperature, the equipment shall be operated without degradation for 2 hours.

The equipment shall be stabilized at 122°F. After stabilization, the equipment shall be operated without degradation for 2 hours.

Relative Humidity:

All equipment shall meet its performance requirements when subjected to temperature and relative humidity of 122°F and 70 % respectively. The equipment shall be maintained at the above condition for 48 hours. At the conclusion of the soak, within 30 minutes the equipment shall meet all of its operation requirements.

Power Variation:

The equipment shall meet all of the specified performance requirements when the input voltage is plus or minus 10 volts from the nominal value of 115 volts. The equipment shall be operated at the extreme limits for at least 15 minutes during which it shall meet all of its operation requirements.

Vibration:

The equipment shall show no degradation of mechanical structure, soldered components, plug-in components or satisfactory operation in accordance with the manufacturer's specification after being subjected to the following vibration test:

The equipment shall be secured to the (shaker) head of suitable electro-mechanical shaker in the

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vertical, lateral and longitudinal planes respectively. The object of the test is to vibrate the equipment in each of the three mutually perpendicular axes, in accordance with the following parameters:

- Amplitude - 0.06 “Double Amplitude” (peak-to-peak).
- Linear Acceleration (g’s) - 5 maximum.
- Linear Velocity - approximately 7 inches per second.
- Frequency - 40 Hz.
- Duration - 5 minute dwell in each axis.

If the equipment fails the design approval test, the design fault shall be corrected and the entire design approval test shall be repeated. All deliverable equipment shall be modified, without additional cost to the Authority, to include design changes required to pass the design approval tests.

On-Site Stand-Alone and System Performance Test:

The Contractor shall conduct approved stand-alone tests of the equipment installed in the field and at the TMC. The tests shall, as a minimum, exercise all stand-alone (non-network) functional operations of the field equipment, including NTCIP compliance, and TMC equipment and software with all the equipment installed per the plans as directed by the Engineer. Approved data forms shall be completed and turned over to the Engineer as the basis for review and rejection or acceptance.

Each unit of equipment shall be operated long enough to permit equipment temperature stabilization, and to check and record an adequate number of performance characteristics to ensure compliance with the requirements of this specification. The test shall, as a minimum, exercise all the input and output functions of the unit and demonstrate all operational features.

Following successful completion of the On-Site Stand-Alone tests the entire complement of subsystems and equipment shall be integrated into one system. Interface tests shall then be performed to verify the transfer of information between field equipment elements and the TMC.

System performance testing shall exercise all functional operations of each unit of field equipment from the TMC, and demonstrate compliance with all contract requirements.

The tests shall include multiple combinations of functions including infrequent combinations, input validation, and stress testing. Compliance with all performance requirements shall be demonstrated. Where there are multiple units of the same item of equipment used, compliance with performance parameter requirements may be demonstrated on sample units with approval of the Engineer.

If the equipment fails the stand-alone test, it shall be corrected or another substituted in its place and the test successfully repeated.

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In addition to the Stand Alone Test defined in A. above, once installed the sign controller must pass a test of the NTCIP Compliance as specified herein. The test will be performed by Thruway personnel or their designee using Intelligent Devices NTCIP testing software or another testing package. Prior to testing, the test scripts will be viewable by the Contractor and the manufacturer. During the test it is expected that the Contractor, manufacturer, and Authority's Construction inspection firm will be present. The date, location, and time of the test will be designated by the Authority.

NOTE: The sign controller must pass this test in order to be accepted. If the manufacturer can prove that the Authority has tested the exact VMS Controller, Software, Firmware, and system software using the above method, then this item may be waived at the sole discretion of the Authority.

90-Day Operational Test (Final Acceptance Test:

Following successful completion of the system performance tests, a 90-calendar day test shall be performed. The test shall start at the same time for all system elements unless a waiver is received from the Engineer.

The 90-day test will be run from the Thruway Statewide Operation Center, TSOC. Each sign must successfully connect 95% of the time during the test period. During this time the following tests, at a minimum, must occur:

- A daily test of communicating to each sign
- A daily test message, using 2-panels, will be correctly displayed on each sign and this will be verified by visual inspection (observation).
- Once a week a detailed pixel test will occur. This test will include, but is not limited to, All ON, 10% brightness, etc.

The purpose of the Operational Tests is to demonstrate the reliability of system equipment for a 90 day period. In the event of a failure of any contractor supplied components, or of any existing system elements that may be affected, that portion of the system shall be subjected to an additional 30 day test period. Failure shall be defined as any interruption of operation that can be contributed to the DMS components. If a failure occurs, the test shall be stopped until the failure has been resolved. If the same failure occurs three (3) times, the failure shall be resolved and the 90-day test shall begin anew.

In the event that greater than 20% of similar equipment items malfunction during the test period, the Engineer may declare a system defect and require replacement of all items of that equipment.

When a system defect is declared, the 90 day test period shall be restarted for the affected equipment after replacement.

During the Operational Test period the Contractor shall provide support for all installed equipment including problem troubleshooting and replacement of items not operating as

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specified. The Contractor shall maintain detailed daily records in the form of a maintenance and activity log. The log shall include the identity of equipment on which work is performed, the cost of equipment malfunction, if any, a description of the work performed, materials or special equipment used and the time required to complete the activity. The log shall contain the current test status of all equipment items. The maintenance and activity log shall be available to the Engineer upon request.

The final acceptance shall be based on the satisfactory completion of all 90-Day tests.

Training Requirements:

Contractor Training:

Prior to the installation of any specified equipment, the Contractor's personnel shall have received training from the supplier on installation, operations, testing and maintenance of all equipment. No equipment will be accepted without detailed documentation from the equipment supplier certifying that the training has taken place.

NYSTA Training:

Unless otherwise specified on the contract plans, the contractor and/or DMS manufacture shall be responsible for providing a one (1) day training seminar in the operations and maintenance of the DMS for NYSTA management, engineering, operations, and maintenance personnel. The contractor shall contact the Engineer to verify the requirements and number of personnel scheduled for training. Training sessions shall be conducted at the TMC and in the field, consisting of both classroom and "hands-on" training using installed system equipment.

Training shall not exceed 8 hours with a maximum of twelve students. The Contractor shall submit two copies of the course outline, training materials, and instructors' qualifications to the Engineer for approval 30 calendar days prior to the anticipated start of training. Following approval of the material the Contractor shall submit enough copies of the course material for use by the NYSTA during the training program.

The costs for instructors, course materials, handouts, etc. shall be included in the costs of this item. No separate payment for training will be made to the Contractor.

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METHOD OF MEASUREMENT:

The DMS will be measured for payment as each unit installed, tested, and made fully operational.

BASIS OF PAYMENT:

The unit price bid for each DMS shall include the cost of furnishing all labor, materials, tools, software, equipment and incidentals as necessary to complete the work. This includes hardware necessary for mounting the DMS to the support structure.

Communications devices and associated patch cords will be paid under separate bid items.

Primary sign support structures such as heavy posts, concrete foundations, bridge mount frames, and other structures supporting the sign shall be paid for under other contract items as shown on the contract plans.

Progress payment will be made as follows:

Fifty percent (50%) of the bid price of each item will be paid when it is installed.

Forty percent (40%) of the bid price will be paid upon satisfactory completion of the On-Site Stand-Alone and System Performance Test.

Ten percent (10%) of the bid price will be paid upon satisfactory completion of the 90 Day Operational Test.