LED Dynamic Message Sign Sample Procurement Specification

VF-2420 Series Full Matrix, Front-Access, Full-Color, 9-Inch (236 mm) Character, 30° Viewing Cones

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Section 1: Introduction

This document contains sample procurement specifications for a full matrix, front-access dynamic message sign (DMS) capable of displaying multiple lines of full-color text with multiple characters per line. These specifications describe major DMS system components, including:

- DMS
- DMS sign controller
- Sign controller enclosures
- DMS control software
- NTCIP communications protocol

The Specifications also address other key DMS project needs:

- DMS manufacturer qualifications
- Product testing
- Product documentation

1.1 How to Use This Document

This section describes how to use this procurement specification document. This document is intended to assist you in developing your own project specifications.

The document contains a number of locations that require the author to enter data specifically for the desired display model. The following check list details all locations that require attention.

1. **Section 2.7** requires that the author specify in which state, province, or country the structural PE must be certified.

2. **Section 3:** includes a number of fields, labeled "[A]" through "[H]" that must be replaced with physical specification of the DMS. These specifications, including dimensions, weight, power, and more, are located in the Daktronics model tables in **Section 1.2**. Be sure to use the correct table as the power requirements vary depending on which viewing cone option is selected.

3. **Section 5:** requires that the author select from several possible control equipment cabinet styles. The author need only delete the section(s) that do not apply.

If you have any questions regarding these specifications or how to use them, please contact Daktronics.

1.2 Model Definition and Specifications

The Daktronics Vanguard® DMS model numbers are read as:

VF-2420-RRxCCC-34-RGB

VF-2420	Vanguard DMS Full Matrix, 30-degree viewing cone, front-access signs
RR	Number of Pixel Rows High
CCC	Number of Pixels Columns Wide
34	34-mm Pixel Pitch with 9-inch Nominal Character Height
RGB	Full-Color (Red, Green, and Blue) LEDs

The DMS special provisions describe attributes common to all sizes of 9-inch full matrix front-access DMS. For features and data that are unique to different DMS sizes, please refer to the following tables. This information can be inserted into the specification using the reference letters provided (A, B, C, etc.).

Please refer to the following tables for the DMS dimension specifications:

- 30-degree viewing cone: *Table 1*

Note: The data in the following tables is approximate and subject to change. The cabinet depth in the following tables includes the Z-bar mounting bracket depth.

Daktronics Vanguard® DMS Model Number (30 Degree Viewing)	Pixel Rows [A]	Pixel Columns [B]	Cabinet Height (ft/m) [C]	Cabinet Width (ft/m) [D]	Cabinet Depth* (ft/m) [E]	Weight (lbs/kg) [F]	Max. Power (watts) [G]	Typ. Power (watts) [H]
VF-2420-18x60-34-RGB	18	60	3' 0"/0.9	7' 6"/2.29	1' 2"/0.34	320/145	722	307
VF-2420-18x75-34-RGB	18	75	3' 0"/0.9	9' 2"/2.78	1' 2"/0.34	390/177	862	342
VF-2420-18x90-34-RGB	18	90	3' 0"/0.9	10' 9"/3.28	1' 2"/0.34	460/209	1001	378
VF-2420-18x105-34-RGB	18	105	3' 0"/0.9	12' 5"/3.77	1' 2"/0.34	530/240	1140	414
VF-2420-18x120-34-RGB	18	120	3' 0"/0.9	14' 0"/4.27	1' 2"/0.34	590/268	1375	544
VF-2420-27x60-34-RGB	27	60	4' 0"/1.2	7' 6"/2.29	1' 2"/0.34	380/172	1001	378
VF-2420-27x75-34-RGB	27	75	4' 0"/1.2	9' 2"/2.78	1' 2"/0.34	470/213	1210	431
VF-2420-27x90-34-RGB	27	90	4' 0"/1.2	10' 9"/3.28	1' 2"/0.34	550/249	1514	579
VF-2420-27x105-34-RGB	27	105	4' 0"/1.2	12' 5"/3.77	1' 2"/0.34	630/286	1723	633
VF-2420-27x120-34-RGB	27	120	4' 0"/1.2	14' 0"/4.27	1' 2"/0.34	710/322	1932	686
VF-2420-36x60-34-RGB	36	60	4' 11"/1.49	7' 6"/2.29	1' 2"/0.34	450/204	1375	544
VF-2420-36x75-34-RGB	36	75	4' 11"/1.49	9' 2"/2.78	1' 2"/0.34	540/245	1653	615
VF-2420-36x90-34-RGB	36	90	4' 11"/1.49	10' 9"/3.28	1' 2"/0.34	640/290	1932	686
VF-2420-36x105-34-RGB	36	105	4' 11"/1.49	12' 5"/3.77	1' 2"/0.34	730/331	2211	757
VF-2420-36x120-34-RGB	36	120	4' 11"/1.49	14' 0"/4.27	1' 2"/0.34	830/376	2489	828
VF-2420-45x60-34-RGB	45	60	5' 11"/1.79	7' 6"/2.29	1' 2"/0.34	510/231	1653	615
VF-2420-45x75-34-RGB	45	75	5' 11"/1.79	9' 2"/2.78	1' 2"/0.34	620/281	2002	704

VF-2420-45x90-34-RGB	45	90	5' 11"/1.79	10' 9"/3.28	1' 2"/0.34	730/331	2350	793
VF-2420-45x105-34-RGB	45	105	5' 11"/1.79	12' 5"/3.77	1' 2"/0.34	840/381	2793	976
VF-2420-45x120-34-RGB	45	120	5' 11"/1.79	14' 0"/4.27	1' 2"/0.34	940/426	3141	1065
VF-2420-54x60-34-RGB	54	60	6' 11"/2.09	7' 6"/2.29	1' 2"/0.34	580/263	1932	686
VF-2420-54x75-34-RGB	54	75	6' 11"/2.09	9' 2"/2.78	1' 2"/0.34	700/318	2350	793
VF-2420-54x90-34-RGB	54	90	6' 11"/2.09	10' 9"/3.28	1' 2"/0.34	820/372	2863	994
VF-2420-54x105-34-RGB	54	105	6' 11"/2.09	12' 5"/3.77	1' 2"/0.34	940/426	3281	1101
VF-2420-54x120-34-RGB	54	120	6' 11"/2.09	14' 0"/4.27	1' 2"/0.34	1060/481	3699	1207

Table 1: *DMS Model Numbers for 30 Degree Viewing Cones*

Notes:
1. Maximum power includes a fully illuminated LED sign (with 100 percent of the pixels at full intensity), the sign controller, and ventilation fans or defogging system (if equipped). Maximum power excludes utility outlets, equipment cabinet, external communication equipment, lights, and other auxiliary equipment. These numbers should not be used to calculate site power requirements. Contact Daktronics for more information.

2. Typical Power includes a partially illuminated LED sign (with 15% pixels at 100% intensity), the sign controller and ventilation system.

3. Consistent with Daktronics continuous improvement program, all product features are subject to change without notice.

1.3 Glossary

The following abbreviations and definitions shall govern this specification:

- **AASHTO –** American Association of State Highway and Transportation Officials
- **AlInGaP –** Aluminum Indium Gallium Phosphide. Refers to the chemical composition of a red or amber LED dye.
- **ANSI –** American National Standards Institute
- **AWS –** American Welding Society
- **Bin –** Group of LEDs categorized and sorted by intensity or color. Each "bin" has upper and lower intensity or color specifications and contains only LEDs that are measured to be within that range. LED manufacturers sort LEDs into bins to ensure consistent intensity and color properties.
- **Control Computer –** A desktop or laptop computer used in conjunction with DMS control software to communicate with DMS sign controllers. The control computer can instruct a DMS sign controller to program and control the DMS, monitor DMS status, and run DMS diagnostic tests. A control computer can be used for remote control of one of more DMS, as well as for local control of a single DMS
- **DMS –** Dynamic message sign. An industry term that applies to various types of changeable sign technology. Also known as Changeable Message Signs (CMS) and Variable Message Signs (VMS).
- **Font –** The style and shape of alphanumeric characters that are displayed on the DMS matrix to create messages viewed by motorists and travelers
- **Frame –** see *page*
- **FSORS** – An NTCIP term meaning "Full, Standardized Object Range Support." See the NTCIP standards for additional information.
- **InGaN –** Indium Gallium Nitride. Refers to the chemical composition of green and blue LED dye.
- **GUI – G**raphical user interface
- **IPC** – Association Connecting Electronics Industries
- **ISO** – International Organization for Standardization
- **ITE** – Institute of Transportation Engineers
- **ITS –** Intelligent Transportation System
- **LED – L**ight Emitting Diode

- **Message –** Information displayed on the DMS for the purpose of visually communicating with motorists. A DMS message can consist of one or more pages of data that are displayed consecutively

- **MIB –** NTCIP management information base

- **Module** – Assembly consisting of a two-dimensional LED pixel array, pixel drive circuitry, and mounting hardware. Modules are installed in the display adjacent to each other to form the display matrix.

- **NEMA –** National Electrical Manufacturers Association

- **NCHRP –** National Cooperative Highway Research Program

- **NTCIP –** National Transportation Communications for ITS Protocol

- **Object –** This is a NTCIP term referring to an element of data in an NTCIP-compatible device that can be manipulated to control or monitor the device.

- **Page –** This is a NTCIP term referring to the data that is displayed on the DMS display matrix at a given moment in time. Also referred to as a "frame."

- **Pixel –** Picture element. The smallest changeable (programmable) portion of a DMS display matrix

- **PMPP –** Point to multi-point protocol

- **PPP –** Point to point protocol

- **PWM –** Pulse width modulation

- **Schedule –** A set of data that determines the time and date when a DMS sign controller will cause a stored message to be displayed on the DMS

- **Sign Controller –** A stand-alone computer that is located at a DMS site, which controls a single DMS. A sign controller received commands and sends information to a control computer

- **Stroke –** Refers to the vertical and horizontal width of the lines and curves of a display font. "Single stroke" denotes character segments that are one pixel wide. "Double stroke" denotes character segments that are two pixels wide.

- **WYSIWYG –** What You See Is What You Get. More specifically, what you see on the DMS control computer monitor is a scaled representation of how a message will appear when it is being displayed on the DMS. Similarly, after a pixel diagnostic test routine has been run, what you see on the control computer monitor is a scaled representation of the functional status of each pixel in the DMS display matrix.

Section 2: Manufacturer Contract Requirements

This section describes the minimum qualifications required for a dynamic message sign manufacturer to be selected under this contract. A DMS manufacturer must meet these minimum qualifications prior to bidding. This section also details the product documentation that must be provided by the contractor.

2.1 DMS Manufacturer Qualifications

The dynamic message sign manufacturer for this contract shall:

- Have been in the business of manufacturing large outdoor permanently mounted LED DMS, which are used to manage vehicular roadway traffic, for minimum period of ten (10) years prior to the contract bid date. An "LED" DMS contains display pixels constructed solely of high-intensity discrete LEDs.

- Have in operation a minimum of one thousand (1000) large outdoor permanently mounted LED DMS in North America as defined above. Each of these DMS shall have successfully operated for a minimum period of one (1) year prior to the contract bid date.

- Have in operation as of the contract bid date a minimum of ten (10) independently owned and operated LED DMS systems. Each of the ten (10) systems shall contain a minimum of ten (10) permanently mounted DMS that use the National Transportation Communications ITS Protocol (NTCIP) as their primary communication protocol. Each of the DMS signs shall be communicating over dial-up telephone, cellular telephone, spread spectrum radio, or fiber optic networks.

- The DMS manufacturer must have an in house Quality Management System (QMS) in place certified by an approved registrar to the latest standard of ISO 9001

- Utilize a documented certified welding procedure in accordance with the latest version of AWS D1.2

Experiences with manufacturing other types of electronic sign products will not satisfy the requirements of this DMS specification such as:

- Indoor signs of any size or type

- Portable or mobile signs of any size or type

- Neon signs

- Back-lit signs

- Rotating drum or plank signs

- LED lens Displays
- Blank out signs
- Any type of sign that is not pixilated and cannot be programmed to display a nearly infinite quantity of messages
- DMS that have a pixel technology comprised of something other than high-intensity light emitting diodes (LED). Examples of unacceptable technologies are incandescent lamp, liquid crystal, fiber optic, flip disk, flip-fiber combination, and flip-LED combination
- DMS with a display matrix smaller than three lines of fifteen 7x5 characters per line and having a character height smaller than 9-inches (236mm)
- Outdoor electronic signs that are used for purposes other than roadway/motorway traffic management

2.2 Material, Manufacturing, and Design Standards

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.

2.3 Quality Management System (ISO 9001 Certified)

The DMS manufacturer must have an in house Quality Management System (QMS) in place that is certified by an approved registrar to ISO 9001:2008 or the latest released standard of ISO 9001. ISO 9001 certification is a means of ensuring the DMS organization conforms to specific requirements through quality planning in accordance to the latest standard of ISO 9001.

The manufacturer's pre-build technical submittal must provide a copy of the company's ISO 9001 certification.

2.4 Customer Service Department

The DMS manufacturer must have a customer service department that provides technical support and services for the manufacturer's DMS systems.

The manufacturer's customer service department must have technical support help desk that may be contacted via telephone, e-mail and fax. The help desk must be staffed from 8 am to 5 pm Central Time (CT) at a minimum. The manufacturer must also offer bench level repair services for failed components and stocking of most parts for replacement.

The manufacturer must include a description of its available customer support services in the pre-build technical submittal.

2.5 Manufacturing Automation Systems

The DMS manufacturer must utilize automated equipment in the manufacturing process. Automated systems shall be used for the following processes at a minimum: component insertion, soldering, circuit board washing, and conformal coating application.

2.6 Product Testing

The DMS manufacturer must provide documentation indicating that the DMS product has been tested to the following standards. It must be acceptable for the testing to be performed on scale-sized versions of the actual DMS provided that the test unit is functionally and structurally equivalent to the full size DMS.

Failure to conform to these testing requirements will be grounds for rejection. Rejected equipment may be offered for test or retest provided all non-compliant items have been corrected and tested or retested by the DMS manufacturer. Any corrections deemed necessary by the Engineer must be made by the DMS manufacturer, at no additional cost to the Department.

Product Testing

Product test reports shall be submitted for the following testing:

- *NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements* – Section 2, Environmental Requirements. Test report shall detail results of mechanical vibration and shock, electrical noise and immunity, temperature, and humidity.

- Underwriters Laboratories (UL), *UL 1433 Standard for Control Centers for Changing Message Type Electric Signs*. The UL report number(s) for all DMS and control equipment manufactured by the DMS manufacturer shall be submitted and the products shall bear the UL mark.

The supplier must provide a record of each test performed including the results of each test. The report must include a record of the product test report and the test lab's representative that witnessed the tests, including the signature of the lab's representative. The test reports must be provided to the Engineer for review as part of the technical submittal.

Self Certification

The DMS manufacturer must provide self-certification, including a statement of conformance and copies of test reports, indicating that the following tests have been performed and passed.

Product test reports must be submitted for testing of the following National Transportation Communication for ITS Protocol (NTCIP) standards:

- *NTCIP 1201 NTCIP Global Object Definitions*
- *NTCIP 1203 Object Definitions for Dynamic Message Signs* (including Amendment 1)
- *NTCIP 2101 Point to Multi-Point Protocol Using RS-232 Subnetwork Profile.*
- *NTCIP 2103: Point-to-Point Protocol Over RS-232 Subnetwork Profile.*

The NTCIP testing must 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. The NTCIP test report(s) must include testing of sub-network communications functionality, all mandatory objects in all mandatory conformance groups, and a subset of the remaining objects.

2.7 DMS Housing Structural Certification

A Professional Engineer registered in the [**State/Province/Country of _____**] must analyze the DMS structural design and shall certify that the DMS:

- Will withstand the temporary effects of being lifted by the lifting eyebolts provided
- Will comply with the applicable requirements of *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*
- Complies with the fatigue resistance requirements of *NCHRP Report 412, Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports.*

The Professional Engineer must analyze the complete DMS structural design. This includes the housing, mounting brackets, and lifting eyebolts, as well as the bracket-to-housing mounting hardware (nuts, bolts, washers, direct tension indicators, etc.) provided by the DMS manufacturer. Analysis must include, but shall not be limited to:

- The quantity and type of lifting eyebolts to be provided
- The quantity and type of mounting brackets to be provided
- The quantity and type of hardware (nuts, bolts, washers) used to attach the mounting brackets to the DMS
- Verification that no dissimilar metals problem will exist and/or affect the structural integrity of the DMS-to-bracket attachment points
- A recommendation of the number of attachment points, as well as the attachment locations, that the installing contractor should use when mounting the DMS to its support structure

The DMS manufacturer must include a signed and sealed copy of this P.E. certification, including all supporting calculations, with in thirty days of submittal approval. Failure to provide P.E. calculations will be cause for rejection.

2.8 Pre-Build Technical Submittal

The DMS manufacturer must provide a complete pre-build technical submittal within 60 days of contract award and shall not proceed with DMS manufacture until the Engineer has approved the submittal. The DMS manufacturer shall provide five (5) copies of the submittal both in electronic format on CD and in paper format in three-ring binders.

The submittal must include:

- All DMS manufacturer qualification information, as specified herein
- DMS shop drawing, including an illustration of the recommended installation method
- DMS structural calculations and certification by a registered professional engineer from the state which the DMS is specified will be available within thirty days of submittal approval,
- DMS site riser diagram
- AC site power requirements, including the number of legs, current draw per leg, and typical site power consumption
- Major DMS schematics in block diagram form, including AC power distribution inside and outside the DMS, DC power distribution within the DMS, and control signal distribution inside and outside the DMS

- Drawings of major DMS components, including LED display modules, driver boards, control/logic components, environmental control assemblies, DMS sign controller, control equipment cabinet assembly, and control cabinet mounting footprint

- Catalog cut sheets for major DMS components, including front face paint material, polycarbonate face material, LEDs, regulated DC power supplies, circuit board conformal coating material, hookup wire, signal cable, surge suppression devices, panel board, circuit breakers, utility outlets, sign controller, ventilation/cooling fans, heaters, ventilation filter, thermostats, and any other major system components

- Test reports and certification for all items identified in the "Product Testing" specifications herein

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

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

- Equipment owner/operator agency name

- Contact person name, telephone number, fax number, and email address

- DMS system name and location of operations control center (project name/number, roadway name/number, state, county, and country)

- DMS commissioning date (first date of successful on-site operation)

- DMS quantity

- DMS display pixel technology (LED, fiber optic, flip disk, etc.)

- DMS display matrix size (pixel rows by pixel columns) and type (full matrix, line matrix, or discrete character)

- DMS housing access type (walk-in, front, rear, or other specific access type)

- Communications protocol used (NTCIP or proprietary; if proprietary, provide a name or description)

- Type of communications backbone used (telephone, fiber optic, direct, etc.)

- NTCIP compliance test reports prepared by independent testing companies, including contact information

The pre-build submittal shall also include the following background information about the

DMS manufacturer:

- Full corporate name
- Corporate address
- Contact person name, telephone number, fax number, and email address
- Names and qualifications of the primary project team members, including the following: sales person, project manager, product manager, application engineer, and manufacturing manager
- Number of years in business under the current corporate name
- Copy of the DMS manufacturer's in-house quality management system
- Copy of the DMS manufacturer's certified welding procedure
- Copy of welding certifications for all personnel who will perform welding of the DMS housing
- General corporate literature
- DMS product literature

Failure to provide complete and accurate submittal information, as specified herein, will be cause for rejecting the DMS manufacturer.

Section 3: DMS Construction and Operation

This section describes the minimum construction and operational functionality requirements for the dynamic message signs (DMS) to be supplied under this contract. The contractor shall provide all the materials, software, and services necessary to install DMS and associated equipment that fully comply with the functional requirements specified herein, including incidental items that may have been inadvertently omitted.

3.1 Intent Disclaimer

The Department acknowledges there may be alternative methods to meet the intent of the specification without meeting the exact wording of the specification. The Department encourages DMS Manufacturers to propose advances in technology and alternates to meet the Department's intent. Each deviation of the written specification must be clearly shown and the benefits explained. The Department reserves the right to reject any specification alternate without reason to the DMS Manufacturer.

3.2 General Specifications

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.

The DMS shall contain a full display matrix measuring a minimum of [**A**] rows high by [**B**] 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 alphanumeric 9”(236mm) 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 (914 mm) to 12 feet (3,658 mm) above the roadway surface.

Dimensions

DMS housing dimensions shall not exceed [**C**] ft/m high by [**D**] ft/m wide. The front-to-back housing depth shall not exceed [**E**] ft/m at its widest point, including the rear ventilation hoods.

DMS weight shall not exceed [**F**] pounds/kg

Power Requirements

Maximum AC power shall not exceed [**G**] watts, when the following circuits are operational and fully loaded:

- LED display pixel matrix, with 100% of the pixels operating at their maximum possible drive current
- DMS environmental control system
- Utility outlet circuit
- DMS sign controller

Typical DMS AC operating power shall not exceed [**H**] watts with the following circuit loadings:

- LED display pixel matrix, with 15% of the pixels operating at their maximum possible drive current
- DMS sign controller

DMS shall operate from a 120/240 VAC, 60Hz, single-phase power source, including neutral and earth ground (3 wire plus ground).

Sign Construction

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 –30ºF to +165ºF (-34ºC to +74ºC) 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 –40ºF to +185ºF (-40ºC to +85ºC).

External DMS component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from hot dipped or mechanically galvanized steel, stainless steel, aluminum, nylon, or other durable corrosion-resistant materials suitable for the roadway signage application.

DMS and sign controller components shall be 100% solid-state, except for the environmental control fans and thermostats. All high voltage electrical components (exceeding 24 VDC) used in the DMS and the sign controller shall be UL (Underwriter's Laboratory) listed and meet all local NEC codes applicable to DMS applications.

The presence of ambient radio signals and magnetic or electromagnetic interference, including those from power lines, transformers, and motors, shall not impair the performance of the DMS system. The DMS system shall not radiate electromagnetic signals that adversely affect any other electronic device, including those located in vehicles passing underneath or otherwise near the DMS and its sign controller.

3.3 DMS Sign Housing

The major structural frame members in the DMS housing shall consist of aluminum extrusions made from 6061-T6 aluminum alloy. Minor structural frame members shall consist of 0.125 inch (3.17 mm) thick formed sheet stock made from 5052-H32 aluminum alloy. The rear of the DMS housing exterior shall be covered with 0.125-inch (3.17 mm) thick aluminum sheets made from 5052-H32 aluminum alloy. This external aluminum skin shall be attached to the structural framework using a proven method of attachment.

DMS housing right, left, front, and rear walls shall be vertical. The top and bottom sides shall be horizontal.

DMS structural assembly hardware (nuts, bolts, washers, and direct tension indicators) shall be galvanized A325 high-strength steel and shall be appropriately sized for the application.

Chemical Bonding

An alternate method of attaching the aluminum sheet to the cabinet extrusion shall be the use of a two-part chemically bonding structural adhesive. The adhesive shall be applied in a continuous bead on all cabinet extrusion surfaces that contact the aluminum sheet. The adhesive shall provide the necessary structural bond between the aluminum sheet and the cabinet extrusion as required by the contract specifications and other pertinent standards and codes. The adhesive shall ensure a watertight seal is obtained around the entire perimeter of the cabinet and where any aluminum sheets are spliced.

To ensure that appropriate procedures are followed to bond the aluminum sheet and cabinet extrusion, the structural adhesive manufacturer shall certify the DMS manufacturer. The DMS manufacturer is responsible for performing all necessary testing of the adhesive to meet all requirements of the contract specifications.

3.4 Mounting Brackets

Multiple mounting brackets in the form of Z-bar extrusions shall be bolted to the DMS housing exterior rear wall to facilitate attachment of the DMS to the support structure. Mounting brackets shall be:

- Extruded from aluminum alloy number 6061-T6
- Attached to the DMS structural frame members, not just the exterior sheet metal
- Installed at the DMS manufacturer's factory
- Attached to the DMS using mechanically galvanized A325 high-strength steel bolts
- Attached to the DMS using direct tension indicators to verify that mounting hardware is tightened with the proper amount of force
- Installed such that all bracket-to-DMS attachment points are sealed and water-tight
- Designed and fabricated such that the installing contractor can drill into them without penetrating the DMS housing and compromising the housing's ability to shed water

3.5 Lifting Hardware

For moving and installation purposes, multiple galvanized steel lifting eyebolts shall be attached to the top of the DMS housing. Eyebolt hardware shall attach directly to the DMS housing structural frame and be installed at the DMS factory. All mounting points for eyebolts shall be sealed to prevent water from entering the DMS housing. Lifting hardware, as well as the housing frame, shall be designed such that the DMS can be shipped and handled without damage or excessive stress being applied to the housing prior to or during DMS installation on its support structure.

The lifting eyebolts shall be easily removed by one individual without opening or entering the display and without any risk of compromising water-tightness. Special tools shall not be required. Removal of the eyebolts shall not create holes and no replacement bolts or other hardware shall be necessary to seal the cabinet.

3.6 Front Face Construction

The DMS front face shall be constructed with multiple vertically hinged rigid door panels, each of which contains a full-height section of the LED display matrix. The door panels shall be fabricated using aluminum sheeting on the exterior and polycarbonate sheeting on the interior of the panel.

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

Doors

One (1) access door shall be provided for each 20 to 30 pixel wide section of the sign housing. These doors shall be vertically hinged and shall contain a section of the sign's front face. The doors shall swing out from the face to provide access to the cabinet interior. Each door shall extend the full height of the display matrix.

To prevent open doors from blowing in wind, they shall each have a retaining latch mechanism to hold the door open at a 90-degree angle.

Each door shall form the face panel for a section of the sign. The LED modules shall be mounted to the door and be removable from the door when in the open position. Other sign components, such as power supplies, wiring, etc. shall be located inside the sign cabinet and

be accessible through the door opening. Each door shall cover an opening that is a minimum of 23-inches (584 mm) wide and the same height as the display pixel matrix.

Each door shall contain a minimum of two (2) captive-type latches to lock them in the closed position. These latches shall be captive to prevent them from falling off. They shall pull the door tight and compress a gasket located around the perimeter of each door. They shall also be capable of providing leverage to easily release the gasket seal when opening the doors. The gasket shall prevent water from entering the cabinet around the doors.

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.

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. Polycarbonate sheets shall have the following characteristics:

- Tensile Strength, Ultimate: 10,000 PSI
- Tensile Strength, Yield: 9,300 PSI
- Tensile Strain at Break: 125%
- Tensile Modulus: 330,000 PSI
- Flexural Modulus: 330,000 PSI
- Impact Strength, Izod (1/8", notched): 17 ft-lbs/inch of notch
- Rockwell Hardness: M75, R118
- Heat Deflection Temperature Under Load: 264 PSI at 270F and 66 PSI at 288F
- Coefficient of Thermal Expansion: 3.9X10-5 in/in/F
- Specific Heat: 0.30 BTU/lb/F
- Initial Light Transmittance: 85% minimum
- Change in Light Transmittance, 3 years exposure in a Southern latitude: 3%
- Change in Yellowness Index, 3 years exposure in a Southern latitude: less than 5%

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. The surrounding borders shall be a minimum of 2/3 of the character height on the display according to NEMA TS4's standard font set (7) pixels high by (5) pixels wide font).

In the presence of wind, the DMS front face shall not distort in a manner that adversely affects LED message legibility.

3.7 Exterior Finish

DMS front face panels and front face border pieces shall be coated with semi-gloss black polyvinylidene fluoride (PDVF) 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.

3.8 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:

- Each LED display module may consist of one or two circuit boards. If two boards are used, they shall be mounted physically to each other using durable non-corrosive hardware. They shall be electrically connected via one or more header-type connectors. The header connectors shall be keyed such that the boards cannot be connected incorrectly.

- 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 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 any 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 and driver circuit boards, shall be identical and interchangeable throughout the DMS.

3.9 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 nine (9) pixels high by fifteen (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.

- 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 circular base of the discrete LEDs shall be soldered so that they are flush and parallel to the surface of the printed circuit board. The longitudinal axis of the LEDs shall be perpendicular to the circuit board.

3.10 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 615-635nm.

- Green LEDs shall utilize InGaN semiconductor technology and shall emit green light that has a peak wavelength of 520-535nm.

- Blue LEDs shall utilize InGaN semiconductor technology and shall emit blue light that has a peak wavelength of 464-470nm.

- 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 LED manufacturer shall perform color sorting of the bins. LEDs shall be obtained from no more than two (2) consecutive color "bins" as defined by the LED manufacturer.

- The various LED color and intensity bins shall be distributed evenly throughout the sign and shall be consistent from pixel to pixel. Random distribution of the LED bins shall not be accepted.

- 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.

- LED package style shall be through-hole flush-mount. Through-hole LEDs with standoffs or surface-mount LEDs will not be accepted.

- 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.

- 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 70% of the original brightness.

3.11 Pixel Drive Circuitry

One (1) electronic driver circuitry shall be provided for each LED pixel module and shall individually control all pixels on that module. The driver circuit boards 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 if the power source is present or not.

- 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.

3.12 Regulated DC Power Supplies

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

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 +140ºF (60ºC) 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. This circuit shall monitor the voltage of each power supply. The power supply voltages shall be reported via a CAN (controller area network) communication network to the sign controller upon request.

The power supplies used to power the LED pixel modules 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.

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 –30ºF to +165ºF (-34ºC to +74ºC)
- Maximum output power rating shall be maintained over a minimum temperature range of –30ºF to +140ºF (-34ºC to +60ºC)
- Power supply efficiency shall be a minimum of 80%
- Power factor rating shall be a minimum of 0.95
- Power supply input circuit shall be fused
- Automatic output shut down and restart if the power supply overheats or one of the following output faults occurs: over-voltage, short circuit, or over-current
- Power supplies shall be UL listed
- Printed circuit boards shall be protected by an acrylic conformal coating

3.13 Control Systems

The DMS shall include a DMS controller and auxiliary control panel as specified in the Requirements for DMS Controllers section herein.

3.14 Environmental Monitoring Systems

The DMS shall include sensors that monitor and report ambient (external) light level and temperature, as well as the internal temperature and humidity.

Ambient Light Measurement

Sensors that measure the outdoor ambient light level and the outdoor ambient temperature at the DMS site shall be mounted in-line with the DMS housing walls. This ambient light and temperature measurement system shall consist of three (3) electronic light sensors.

Two of the light sensors shall be placed such that they measure the ambient light levels striking the front and rear of the DMS. The third light sensor shall be mounted to the floor of the DMS housing and shall face the ground. The DMS sign controller shall continuously

monitor the light sensors and adjust the LED display matrix intensity to a level that creates a legible message on the DMS face.

Ambient Temperature Measurement

A minimum of one (1) ambient temperature sensor shall be mounted to the rear wall or bottom of the DMS housing. The sensor shall be placed such that it is never in direct contact with sunlight. The external temperature sensor reading shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

Internal Temperature Measurement

The DMS shall contain a minimum of one (1) temperature sensor. The sensor(s) shall measure the temperature of the air in the cabinet over a minimum range of -40°F to +176ºF (-40°C to +80°C). The internal temperature sensor output shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

Internal Humidity Measurement

The DMS shall contain one (1) sensor that measures the relative humidity of the air inside the DMS cabinet. The sensor shall monitor the humidity from 0 to 100%. The humidity sensor output shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

3.15 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. The threshold temperature shall be configurable and shall have a default factory setting of 140°F (+60°C). The factory default setting shall be overridden if the selected message priority is set above 200 or is selected as an emergency message.

3.16 Sign Controller Signal Interface

In situations where the sign controller is located in a ground-mounted or pole-mounted traffic cabinet, the communication signals from the external sign controller to the DMS shall use fiber optic cable with the following specifications:

- 62.5/125 µm diameter
- ST-style connectors
- Rated for indoor/outdoor use
- UL-rated
- PVC outer jacket
- Tight buffer inner jacket
- Operating temperature range: –40ºF to +185ºF (-40ºC to +85ºC)

A minimum of six (6) fibers shall be provided with one (1) for controller to sign commands, one (1) for sign to controller responses, and four (4) spares.

For systems with controllers mounted inside the DMS cabinet, the controller to sign interface shall use shielded Category 5 copper cable.

3.17 Wiring and Power Distribution

Power and Signal Entrances

Two threaded conduit hubs shall be located on the rear or side wall of the DMS housing. One hub shall be for incoming AC power and the other shall be for incoming DMS signal cabling or a communications line.

Panel Board

The DMS shall contain a power panel board and circuit breakers that meet the following minimum requirements:

- Service entrance-rated
- Minimum of 8 circuit breaker mounting positions
- Short circuit ratings of 10,000 amps and 10,000 amps for the main and branch circuits, respectively
- UL listed panel board and circuit breakers

Internal Wiring

Wiring for LED display module control, environmental control circuits, and other internal DMS components shall be installed in the DMS housing in a neat and professional manner.

Wiring shall not impede the removal of display modules, power supplies, environmental control equipment, and other sign components. Wires shall not make contact with or bend around sharp metal edges. All wiring shall conform to the National Electrical Code.

Earth Grounding

The DMS manufacturer shall provide one earth ground lug that is electrically bonded to the DMS housing. The lug shall be installed near the power entrance location on the DMS housing's rear wall. The DMS installation contractor shall provide the balance of materials and services needed to properly earth ground the DMS. All earth grounding shall conform to the National Electrical Code.

3.18 Convenience Outlets

The DMS housing shall contain a utility outlet circuit consisting of a minimum of one (1) 15-A NEMA 15-R, 120 VAC duplex outlet, with ground-fault circuit interrupters. This outlet shall be located near the panel board.

3.19 Transient Protection

The DMS and sign controller signal and power inputs shall be protected from electrical spikes and transients as follows:

Sign AC Power

The AC power feed for all equipment in the sign cabinet shall be protected at the panel board by a parallel-connection surge suppresser rated for a minimum surge of 50 kA. This device shall conform to the following requirements:

- Withstand a peak 100,000-ampere surge current, 50kA L-N, 50kA L-G
- Designed, manufactured, & tested consistent with: ANSI/IEEE C62.41.1-2002, C62.42.2-2002C62.45-2002, NEMA LS-1, NEC 285, and IEC 61643, CE
- Less than 1 nanosecond response time
- Temperature range of -15ºF to +140°F (-25ºC to +60ºC)
- Approximate dimensions of 3-inches (76 mm) wide by 8-inches (203 mm) long by 3-inches (76 mm) high
- High Energy Parallel Deign for Category C3 & C-High Application
- UL listed to: UL 1449 Third Edition 200kA & 100kA SCCR

Section 4: Requirements for DMS Controllers

This section describes the minimum specifications for the dynamic message sign (DMS) controllers and auxiliary control panels to be provided with this contract. Each DMS shall include a sign controller, auxiliary control panel, and associated equipment. The contractor shall provide all the materials, software, and services necessary to install DMS controllers, auxiliary control panels, and associated equipment that fully comply with the functional requirements specified herein, including incidental items that may have been inadvertently omitted.

4.1 General Requirements

Each DMS shall be controlled and monitored by its own sign controller. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with DMS control software in order to perform most DMS control functions.

The sign controller shall meet the following operational requirements:

- Communicate using embedded NTCIP protocol
- Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation
- Include a front panel user interface graphical LCD and keypad for direct operation and diagnostics as described herein
- Contain a minimum of three (3) NTCIP-compliant RS232 communication ports
- Contain a minimum of one (1) NTCIP-compliant RS422 communication pot with RJ45 Connector.
- Contain a minimum of one (1) NTCIP-compliant Ethernet port with RJ45 connector
- Have the ability to play volatile messages
- Contain DMS-specific control firmware (embedded software) that shall monitor all external and internal sensors and communication inputs and control the display modules as directed by external control software and the front panel interface

NTCIP shall be natively supported in the DMS controller. External protocol converter or translator devices shall not be allowed.

4.2 Controller Location

The sign controller and associated communication equipment shall be installed in one of the following locations:

- Inside a ground-mounted control equipment cabinet located near the sign
- Inside the DMS housing
- Inside a pole-mounted control equipment cabinet attached to the DMS support structure

4.3 Environmental

The sign controller shall meet the following environmental requirements defined in *NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements.*

4.4 Mechanical and Electrical

The sign controller shall meet the following electrical and mechanical requirements:

- Mount in a standard EIA 19-inch (480 mm) equipment rack with a maximum 4U space requirement
- Weigh no more than 10 pounds, including its enclosure
- Consume no more than 30 watts of power
- Powered by an internal regulated DC power supply capable of operating on 120VAC or 240VAC at both 50Hz and 60Hz
- All printed circuit boards shall be sealed with an acrylic conformal coating

4.5 Operational Requirements

Front Panel User Interface

The sign controller's front panel shall include a menu driven architecture, 16-button keypad and a 64x240 graphical LCD screen. These devices shall be used to perform the following functions with the sign controller and DMS:

- 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 including the use of graphical messages.
- Perform all diagnostics testing of various system components, including pixels, power systems, sensors, and more
- Activate, create, preview, and delete messages stored in memory
- Blank the sign
- Start and stop the schedule
- Configure display parameters, including display size and color technology
- Configure date and time
- Configure communications port settings and NTCIP options
- Configurable level of password protection per user
- Select automatic or manual brightness mode of operation

The front panel interface shall also include:

- 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

Memory

The sign controller shall have non-volatile electronically changeable memory. This memory shall be formed by flash or battery-backed static RAM integrated circuits that retain the data in memory for a minimum of 30 days following a power loss. This changeable memory shall be used to store messages and schedules. The controller memory shall be capable of storing a minimum of 500 changeable messages in non-volatile RAM.

Internal Clock

The DMS sign controller shall contain a computer-readable clock that has a battery backup circuit. The battery shall keep the clock operating properly for at least 3 years without external power, and the clock shall automatically adjust for daylight savings time and leap year using hardware, software, or a combination of both. The clock shall be set electronically by the sign controller microprocessor and shall be accurate to within one (1) minute per month.

4.6 Communications

All remote communication ports shall be NTCIP-compatible as defined in the "Requirements for NTCIP Compatibility" section of these specifications.

Communication Modes

The DMS sign controller shall be able to receive instructions from and provide information to a computer containing DMS control software using the following communication modes:

- Remotely via direct or dial-up communications with a remotely located computer. The system communications backbone, as well as all field modems or signal converters, shall provide the DMS sign controller with an RS232 signal.

- Locally via direct connection with a laptop computer that is connected directly to the sign controller using an RS232 null modem connection.

Serial Communication Ports

The DMS sign controller shall contain a minimum of three (3) NTCIP-compatible RS232 communication ports. These ports shall support multiple communication interfaces, including, but not limited to, direct null-modem (for local laptop control), dial-up and leased-line modems, radio systems, cellular modems, and fiber optic modems. The RS232 ports shall all have standard DB9M connectors.

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

Ethernet Port

The DMS sign controller shall contain a minimum of one (1) 10/100Base-T Ethernet communication port. This port shall be available for optional use for communicating from the

central control system to the DMS sign controller when an Ethernet network is available. The Ethernet port shall have a standard RJ45 connector.

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

Controller Addressing

The DMS sign controller shall use whatever addressing scheme is appropriate for the NTCIP network types used for communications. The controller addressing shall be configurable through the front panel user interface.

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

Transient Protection

The RS422 and Ethernet communication ports in the DMS sign controller shall be protected with surge protection between each signal line and ground. This surge protection shall be integrated internally within the controller.

A series/parallel two-stage suppression device shall protect the modem communication port from over-voltage and over-current conditions. This surge protection shall be integrated internally within the controller.

4.7 DMS Control Outputs

The DMS sign controller shall transmit and receive data packets to and from the DMS via dedicated fiber optic cables. Copper cables may be used if the controller is located within the sign housing. This network will communicate with all sensors, drivers, and other devices utilizing a CAN (controller area network) bus network running throughout the DMS.

Data transferred shall include pixel states, sensor values, and I/O readings from various devices, such as door sensors and power supply monitors. Pixel data shall include the states to be displayed on the sign face as well as diagnostic data retrieved from the LED drivers.

4.8 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
- 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

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)
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 2: *Font Table*

Display of Graphic Images

The DMS control software shall support the inclusion of graphics in messages. If the NTCIP 1203 v2 standard has not reached a “recommended” or “approved” state by the time of contract award, the vendor shall support graphics using manufacturer-specific objects and MULTI tags.

If a manufacturer-specific means of supporting graphics is used, the vendor shall commit to provide NTCIP 1203 v2 firmware updates at no cost to the customer. These updates will include all current requirements of these specifications and also standard graphics support. The vendor shall install the updates no later than six months after the NTCIP 1203 v2 standard reaches the “approved” state.

4.9 DMS Intensity Control

The DMS controller shall provide means to change the brightness of the display matrix manually or automatically. The manual control will allow the user to select one of at least 100 intensity levels, which will be communicated to the LED drivers in the DMS. The brightness shall remain at that level until the user changes the level or sets the controller to automatic mode.

The automatic intensity control mode will monitor the ambient light sensors of the DMS and will use a mathematical algorithm to automatically select one of the 100 or more intensity levels. The intensity level will then be transmitted to the LED drivers in the DMS. The algorithm used to calculate the intensity level shall be determined by the manufacturer and tested under real-world lighting conditions.

The intensity control mode, manual or automatic, shall be settable via NTCIP using the control software or via the front panel interface. The manual brightness level shall be settable via the software or front panel. The mode and brightness level shall be monitored from both the software or front panel interfaces.

4.10 System Status Monitoring and Diagnostic Testing

The DMS controller shall be capable of monitoring the status of many of the DMS components and subsystems in real-time and/or manual modes, depending on the component or system. The following sections detail the status and diagnostic information that shall be provided by the controller. All of this status and diagnostic data shall be available via the front panel LCD screen and shall be transmitted via NTCIP to control software upon request.

Message Display Status

The DMS controller shall be capable of monitoring and displaying the currently active message (if any) including graphical messages on the controller's front panel LCD display. This display shall be in a WYSIWYG format.

LED Pixel Testing

Upon command from either the front panel control interface or via NTCIP from remote control software, the sign controller shall direct all of the LED modules to perform diagnostic tests of all their pixels. The controller shall then collect and report the results of the pixel testing.

The controller shall also be capable of automatically detecting in real-time the status of each of the display's pixels and reporting their on/off status. This monitoring shall take place without interfering with the display of data on the DMS face.

Power Supply Operation

The sign controller shall monitor and report the functional status of regulated DC power supplies located in the DMS by monitoring diagnostic outputs located on the supplies. The controller shall monitor the output voltage of each power supply and the status of each output fuse. The power supply voltages shall be measured to the nearest tenth of a volt and the fuse status shall be indicated as pass or fail.

Door States

If the DMS or control equipment cabinet is equipped with access doors and sensors to monitor their open status, the controller shall monitor the status of those doors.

Fan Operation

If the DMS is equipped with fan diagnostic systems, the controller shall monitor and report the status of the fans.

Environmental Conditions

The DMS controller shall monitor the readings of all light, temperature, and humidity sensors installed in the DMS housing.

4.11 Error Notification

The DMS sign controller shall be capable of automatically informing a maintenance operator (via the local LCD panel) and a central control system (via NTCIP communication) of the occurrence of important events and subsystem failures.

All major component and subsystem errors shall be indicated on the controller's LCD front panel.

The controller shall be capable of sending event notifications to the central control system via SNMP "traps" as allowed by NTCIP. When one of these events occurs, the sign controller shall create a data packet for transmission to the central controller that shall contain details about the event. The transmission of traps shall be governed by the NTCIP standards. The controller shall be configurable to enable or disable the transmission of traps for each event or error type. This configuration will include the automatic initiation of these traps, including establishing telephone modem connections if appropriate, when the NTCIP network permits transmission initiation by the sign controller.

The following sections list errors and events that the controller shall report as defined above.

Over Temperature Shutdown

The DMS controller shall continuously monitor the DMS housing's temperature sensors and shall automatically shut down the DMS if the internal cabinet temperature exceeds a safety threshold. This threshold shall have a default value of +140ºF (60ºC) and shall be configurable at the controller.

If the temperature approaches the threshold the controller shall reduce the brightness of the sign face. If the temperature continues to increase and exceeds that threshold, the controller shall trigger a warning notification event and blank the face of the sign. The sign face will remain blank until the temperature begins to drop. As the temperature drops, the controller will gradually increase the brightness of the display face, eventually returning to full brightness.

The sign controller shall employ an algorithm to control the above brightness reductions and increases utilizing hysteresis to ensure that the display face does not visibly flicker as the temperature changes.

The event notifications sent for over temperature situations will include visual indication on the controller's front panel LCD, as well as a trap notification sent to the central control system.

Controller Restart

When the DMS controller detects that it has been restarted due to a manual reset or error condition, it shall send a trap notification to the central system. It shall also automatically activate the NTCIP reset message if it is configured to do so.

Power Loss

When the DMS controller detects that it has lost power, it shall automatically indicate that on the front panel LCD. It shall also send a trap notification to the central system and activate the NTCIP power loss message if configured to do so.

Power System Failure
The DMS controller shall automatically monitor the major power systems in the sign and detect when one of them has failed. These failures will be reported on the front panel LCD and transmitted to the central system in the form of a trap.

Door Opened
When the sign controller detects that one of the sign cabinet or control cabinet doors has been opened, it will transmit a trap to the central system indicating which door has opened.

Communication Loss
The DMS controller shall monitor the frequency of communication packets from the central system. If the controller detects that communication has not occurred between the controller and central system for longer than a configurable timeout, then the controller will automatically activate a communication loss message as defined by NTCIP. This communication loss message shall be configurable and may be disabled as allowed by NTCIP.

4.12 Auxiliary Control Panel

The DMS shall include an auxiliary control panel that will provide a secondary user interface panel for DMS control, configuration, and maintenance. The auxiliary control panel shall meet the same electrical, mechanical, and environmental specifications as the DMS controller. It shall be powered independently from a 120 VAC outlet.

Interface Panel
The auxiliary control panel shall have graphical LCD panel and keypad identical to those found on the DMS controller. It shall also contain a local/remote switch, a reset switch, status LEDs, and one NTCIP compatible RS232 communication port that meet the same specifications as the DMS controller.

DMS Control Interface
The auxiliary control panel shall include an identical menu system to the DMS controller with all of its features and functionality.

Location
The auxiliary control panel shall be located in one of the following locations:

- If the DMS controller is located in a ground-mounted or pole-mounted cabinet, the auxiliary control panel will be located inside the DMS cabinet to facilitate operation by maintenance workers while working inside the DMS.
- If the DMS controller is located in the DMS cabinet, the auxiliary control panel shall be mounted inside a ground-mounted or pole-mounted cabinet for maintenance access from the ground.

Controller Signal Interface
The auxiliary control panel shall interface to the DMS controller using Category 5 copper cable. It shall be capable of operating up to 2000 feet from the DMS controller.

Section 5: Requirements for Control Equipment Cabinets

This section describes the requirements of the metal cabinet(s) used to house the sign controller and associated equipment separately from the sign cabinet.

Specification Writer:
Please select from the following control equipment cabinet options. Note that if the controller is to be mounted in the DMS cabinet, then the "Laptop Interface Enclosure" section should be included to provide a ground-accessible controller interface.

5.1 Ground-Mounted Controller Cabinet

The ground-mounted control equipment cabinet shall be a 334-type cabinet. It shall be designed to mount on a concrete pad near the DMS. The cabinet shall enclose the sign controller, panel board, 120 VAC electrical outlets, and remote communication devices, such as a modem.

General Specifications

The ground-mounted controller cabinet shall be 66" (1,676 mm) +/- 1" (25.4 mm) high by 24" (610 mm) +/- 0.5" (12.7 mm) wide by 30" (762 mm) +/- 0.5" (12.7 mm) deep. The front-to-back cabinet dimensions shall not exceed 36" (914 mm) at its widest point, including the door handles, louvers and roof overhang.

The controller cabinet weight shall not exceed 200 pounds (45.5 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 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 DMS controller 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.

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 be less than 54" (1,372 mm) high by 21" (533 mm) wide. Each opening shall be sealed with a 0.5" x 2" 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 three-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 controller cabinet to illuminate the cabinet interior. A switch mounted near the front and rear doors shall automatically turn on the light when the door is opened.

Equipment Rack

The cabinet shall contain a full-height standard EIA 19-inch rack. The rack shall be secured within the cabinet by mounts at the top and bottom.

The rack shall contain a minimum of one (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 cabinet shall contain a power panel board and circuit breakers that meet the following minimum requirements:

- Service entrance-rated
- Minimum of 12 circuit breaker mounting positions
- 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 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 outlets shall be mounted inside the cabinet and located near the panel board.

The cabinet shall include one (1) earth ground lug that is electrically bonded to the cabinet. 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 control 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.

5.2 Pole-Mounted Controller Cabinet

The pole-mounted control equipment cabinet shall be a 336S-type cabinet. It shall be provided with two (2) mounting brackets suitable for use with pole-mount straps. The cabinet shall enclose the sign controller, panel board, 120 VAC electrical outlets, and remote communication devices, such as a modem.

General Specifications

The pole-mounted controller cabinet shall be 46" (1,168 mm) +/- 1" (25.4 mm) high by 24" (610 mm) +/- 0.5" (12.7 mm) wide by 20.25" (514 mm) +/- 0.5" (12.7 mm) deep. The front-to-back cabinet dimensions shall not exceed 26" (660 mm) at its widest point, including the door handles, louvers and roof overhang.

The controller cabinet weight shall not exceed 200 pounds (45.5 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 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 DMS controller 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.

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 be less than 36" (914 mm) high by 21" (533 mm) wide. Each opening shall be sealed with a 0.5" x 2" 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 three-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 controller cabinet to illuminate the cabinet interior. A switch mounted near the front and rear doors shall automatically turn on the light when the door is opened.

Equipment Rack

The cabinet shall contain a full-height standard EIA 19-inch rack. The rack shall be secured within the cabinet by mounts at the top and bottom.

The rack shall contain a minimum of one (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 cabinet shall contain a power panel board and circuit breakers that meet the following minimum requirements:

- Service entrance-rated
- Minimum of 12 circuit breaker mounting positions
- 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 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 outlets shall be mounted inside the cabinet and located near the panel board.

The cabinet shall include one (1) earth ground lug that is electrically bonded to the cabinet. 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 control 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.

5.3 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 enclosure Type 3R standards, as described in *NEMA Standards Publication 250Enclosures 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.

Section 6: Requirements for DMS Control Software

This section describes the minimum specifications for the DMS sign control software. The contractor shall provide all software, software media, licenses, and documentation necessary to install and operate a dynamic message sign (DMS) control system that fully complies with the functional requirements herein, including incidental items that may have been inadvertently omitted.

6.1 General Specifications

DMS control software shall:

- Operate on desktop and laptop computers with the following minimum hardware requirements: 1.5GHz processor, 1 GB RAM, and 2GB of free hard drive space.
- Support the following operating systems: XP Professional, Vista, Windows 7, Windows Server 2003, Windows Server 2008 with all critical updates installed.
- Support 32 bit or 64 bit processors and operating systems
- Provide a user-friendly multi-color graphical user interface
- Be written using Microsoft-certified software development tools (compilers, etc.)
- Be able to support at least 250 dynamic message signs
- Utilize a client-server architecture with the server handling sign communications and the clients connecting to the server via local and wide area networks
- Support DMS communications via any combination of dedicated hardwired serial network, fiber-optic network, dial-up telephone lines, leased phone lines, dialup cellular modem, Cellular IP modem,, spread spectrum radio, Ethernet, or other as specified herein
- Support DMS control, monitoring, and diagnostic functions as specified herein
- Control DMS both remotely from a central location, and locally at the DMS site using a laptop computer
- Be accompanied by an easy-to-use software installation utility
- Contain an on-line help system that includes documentation for each feature or present in the software. It shall also be context sensitive such that pressing the help button or [**F1**] key on any screen will launch the help page for that particular function.

- Be fully compliant with the communications protocol requirements of the NTCIP Special Provision specified herein

6.2 Software Security

DMS control software shall support the creation of user IDs and passwords for up to 100 system users. Only a "System Administrator" shall assign user creation.

The DMS control software shall support different level of rights and authorizations to control DMS, to create and modify messages within software, configuration of control software, and ability to modify DMS settings or running content on DMS.

DMS control software shall require the use of passwords and ability to modify requirements for user passwords to ensure user passwords are secure. These include requiring setting minimum password lengths and include support for minimum alpha-numeric combinations.

Before a system operator can use the DMS control software, the software shall request a "user name" and user "password." If the correct user name and password are not provided, access to the software shall be declined.

6.3 Client-Server Architecture

The software shall be of a modular design including a server and multiple client modules. The server shall handle all DMS communication and shall store all configuration data, messages, schedules, communications settings, DMS status, and other data. The client software modules shall send requests to and receive responses from the server over any TCP/IP-based network, including LANs and WANs. Client applications shall include the following functionality:

- Login application to provide user access to system with username and password
- Central software to manage display communications, monitoring system status, and various DMS diagnostics.
- Message creation application for creating DMS messages
- Message scheduler client for creating time and date schedules for activating messages
- Administration client for DMS system configuration and administration

6.4 DMS Control

The DMS control software shall provide a user interface that presents the system's DMS in both list and graphical (map) formats. The software will allow the DMS to be organized into groups as defined by the end user to allow for separating displays by region, roadway, and or any user specified category as needed by the administrator. The DMS list and map interfaces will include only the signs for the group currently selected.

List, Map, and Display Monitor Interfaces

The DMS list shall clearly display the following information about each DMS:

- DMS ID number, as the numerical ID of the display
- DMS name, in a descriptive text format
- Message name or description of the message being displayed on the DMS
- Date and time of last communication between the control software and the DMS sign controller
- Error and warning status, including pixel errors, power failures, communication error, etc.
- Graphical representation (WYSIWYG) of current message displayed

The graphical map interface shall include the following:

- Configurable bitmaps that may be used to show all or parts of the system geographically
- Message name or description of message being displayed on DMS
- Icons for each sign located anywhere on the map
- Icon color changes to indicate the status of the DMS (i.e., yellow for warnings or red for errors)
- Date and time of last communication between the control software and the DMS sign controller
- Sign name is visible if mouse is placed over a DMS icon
- Graphical representation (WYSIWYG) of current message displayed when hovering over the sign icon.

The display monitor interface shall display the following information:

- DMS name, in a descriptive text format
- Message name or description of message being displayed on DMS
- Date and time of last communication between the control software and the DMS sign controller
- Graphical representation of messages running on DMS
- Ability to select the DMS visible by sign name, running messages

Direct Control Operations

The user interface shall provide a means for users to directly perform the following tasks for each sign:

- Send and activate stored messages from the libraries
- Blank the display
- Activate an ad-hoc quick message that is created immediately, not loaded from a library
- Send and activate schedules
- Retrieve messages from the sign
- Perform diagnostics of DMS subsystems, such as power supplies, sensors, climate

control devices, etc.
- Perform pixel testing and report coordinates of any failed pixels with failure detection

Polling

The software shall have a feature to poll all or a set of DMS at predefined intervals or at a specific time-of-day. During this poll, the software shall retrieve the most recent status information from the sign and present it to the user as appropriate in the list and map interfaces.

Scenarios

The administrator shall have the ability to create scenarios that act like macros or scripts to automate a series of often repeated tasks. These scenarios shall have the ability to perform the following actions:

- Send and activate stored messages from the libraries
- Blank the display
- Send and activate schedules
- Perform diagnostics of DMS subsystems, such as power supplies, sensors, climate control devices, etc.
- Perform tests of pixels

The scenarios shall be saved to libraries where system operators may activate them through the graphical user interface. The scenarios shall also be scheduled to automatically run at predetermined times and dates.

System Monitoring

The software shall be capable of monitoring and displaying to the operator the contents of any communications in progress with DMS. The status of all outgoing and incoming data packets will be visible.

Multi-Vendor Sign Control

The software shall be capable of controlling any NTCIP-compatible DMS regardless of the manufacturer. Functionality supported shall be limited to NTCIP standard MIB objects only. Other manufacturer support many require proof of NTCIP compliance of controller to verify compatibility. The software shall be configurable to enable or disable support for any standard optional NTCIP objects.

6.5 Message Creation and Editing

A DMS system operator shall be able to use the DMS control software to create, edit, name, and store message files.

The message editor GUI shall present a scaled image of the DMS display matrix, including a complete and accurate representation of the display matrix type (character, line or full matrix) and the number of display pixels. The DMS editor image shall actively show message content in a WYSIWYG format, while a new message is being created or an existing message is being edited.

The message editor shall provide the operator with the following capabilities:

Text Editing Capabilities:

- Be able to type in message text as if typing in any word processor
- Text entry shall be directly in message editing area, external input windows to enter text then displayed on a graphic representation is not a true WYSIWYG editor
- Text entry includes but is not limited to text input, modification, removal, or insertion
- Ability to select font per character
- Ability to set flashing text and variable flashing rates per character
- Character map functionality to insert special characters such as arrows
-
- Support for many different fonts ranging in size and boldness for improved legibility of message (line and full matrix only)
-
- Adjustable interline spacing in number of pixels for improved legibility of message (full matrix only)
- Horizontal message justification on the DMS display matrix including left, center, and right
- Vertical message justification on the DMS display matrix including top, middle, and bottom (full matrix only)
- Ability to make text scrollable per line, including direction and scroll rate
- Ability to change inter-character spacing between individual characters (line and full matrix only)
- Ability to change text foreground and background color per character based on color depth capabilities of display
- Support for inserting NTCIP standard real time fields

Graphics Editing Capabilities (full matrix only)

- Be able to insert text and locate anywhere on matrix display
- Be able to insert graphic images files into message editing area
- Be able to move the graphic text and images around within message editing area
- Support for inserting true type font text
- Support for enabling anti-aliasing of font text
- Be able to resize images when inserted
- Be able to layer images and text and change the z-order (top to bottom)
- Be able to move shapes to the front or back within the z-order
- Be able to insert shapes include lines, rectangles, ellipse, triangles, spheres, and diamonds
- Be able to support drawing tools include shape fill, line color, fill color, and brush width
- Support at least color depth of 32k for full RGB color displays
- Time with AM/PM or am/pm (NTCIP 1203 v2

Message Properties

- The number of pages that the message is to contain (shall be a maximum of six)
- Ability to turn on and off beacon per message
- Page on and off times for each page
- Ability to adjust message priority status per message stored in library

Editor Capabilities

- Include a spell checker to verify against misspelled words
- Ability to adjust message priority status per message stored in library
- Include a list of prohibited words and prevent from being used in message text
- Include a library of common MUTCD symbols for easy insertion of graphic images
- Support clip board operations of cut, copy, and paste
- Support undo/redo actions
- Ability to rearrange page order for multiple page messages
    - Ability to duplicate pages
    - Be able to preview message as would run on display
    - Be able to zoom in/out editing area
    - Messages shall be able to be sent to any NTCIP DMS using standard NTCIP 1203 MULTI tags
    - Include a most recent list of last messages edited for quick access.
    - Support default options when creating new messages including page time on and off, line and page justification, and default font

Message Library Capabilities

- Top level folders shall be organize by DMS type and size
- Be able to create folders to store messages
- Be able to rename files and folders
- Be able to delete files and folders
- Be able to create multiple levels of folders
- Be able to save the message for future use
- Be able to edit a saved message for future changes
- Be able to open a existing message and save as a new message

Available Fonts

- Should include the following fonts (height x width, line width, fixed width)
    - 7 x 4, 1, variable
    - 7 x 6, 1, variable
    - 7 x 6, 2, variable
    - 7 x 8, 3, variable
    - 8 x 4, 1, variable
    - 8 x 6, 2, variable
    - 8 x 8, 3, variable
    - 9 x 5, 1, variable
    - 9 x 6, 2, variable
    - 9 x 8, 3, variable
    - 11 x 7, 2, variable
    - 11 x 9, 3, variable
    - 14 x 8, 2, variable

- 14 x 10, 3, variable
- 16 x 8, 2, variable
- 16 x 10, 3, variable
- 7 x 5, 1, fixed , as defined by NEMA 4 standards
- 8 x 5, 1, fixed
- 11 x 7, 2 fixed
- 14 x 8, 2, fixed

6.6 Schedule Creation and Editing

DMS control software shall support the creation of message schedules, which instruct the DMS sign controller to run specific messages at pre-determined times and dates.

Software shall contain an editor, which allows messages to be scheduled via:

- Month of the year (January, February, etc.)
- Day of the week (Monday, Tuesday, etc)
- Day of the month (1,2, ….31)
- Time of the day

The schedule editor shall provide a convenient means for the operator to:

- Create a new schedule
- Rename an existing schedule
- Delete a schedule
- Save all new changes

The schedule editor shall contain a calendar view to see the scheduled day plans. The view shall be able to view by week, month, or year.

When adding a message to a schedule, the software shall provide a visual representation of the messages. The verification ensures the user is adding the correct message to the displays schedule.

It shall be possible to store schedule files in both the DMS control computer memory and the DMS sign controller memory.

6.7 Display Fonts

The software shall support a minimum of twelve (12) fonts for each model of DMS. These fonts shall be configurable by the system administrator. The fonts used shall be selectable from a library containing a minimum of 24 fonts provided by the software vendor. Each sign model shall be capable of using a different set of fonts. The software shall automatically adjust the available fonts in the message editor based on the DMS model configuration.

The software shall include a font editor to allow the operator to create custom fonts. The font editor shall allow the DMS system operator to create new fonts or modify existing fonts. The operator shall have the capabilities to graphically edit each character within a font in a pixel-by-pixel manner.

Any of the fonts provided by the software vendor or created/modified by the administrator shall be

downloadable to the DMS.

6.8 Event Logging

The software shall include an event logging system that logs all significant system events. Each logged events shall include the following fields at a minimum:

- Event ID number
- Operator that initiated the event
- Time and date that the event occurred
- Description of the event (i.e., “Diagnostic Test Performed”)
- Source of the event (i.e., DMS sign name)
- Additional data relevant to the event (i.e., “Failed pixel: (4, 73)”)

The events logged shall include, but not be limited to, the following:

- User login/logout
- Communication failures
- Configuration changes
- Message and schedule activation or display blanking
- Diagnostics test results
- Warning events sent from the sign
- Other system errors

The system operators will have the ability to view, sort by category, and print the log file at any time.

6.9 System Configuration

The DMS control software shall allow system administrators, and other users with correct security access right, to configure many system parameters and functions. The basic sets of configurable settings include the following:

- Sign models and individual signs
- Communication networks
- NTCIP profiles to enable/disable MIB objects
- System error/warning alarms
- User security rights
- System maps and sign icon placement
- Default system option settings
- Default message parameters
- Message priority settings
- Prohibited word list

Sign Configuration

Each sign in the DMS control software shall be configured with the following parameters:

- Sign viewing area height and width (for full-matrix signs)
- Number of lines and each line’s height and width (for line-matrix signs)
- Number of lines and characters size for character matrix signs
- Color capabilities (amber, tricolor, full-color)
- Site name

- DMS ID number
- Network address
- Communication parameters
- Time zone and daylight savings time settings

Communication Settings

Communication network configuration shall include the ability to configure and modify sign communication networks with the following parameters:

- Network type (direct serial, dial-up, Ethernet)
- Communication port (i.e., COM4)
- Baud rate (ranging from 1200 to 115,200)
- Hardware handshaking
- NTCIP subnetwork and transport protocols
- Communication retries and timeouts
- IP address and port

User Administration

The access rights shall be capable of four (4) levels of security

- *Limited*- access to only view information
- *Standard*- simple control of running messages and content
- *Power*-modify display settings and configuration
- *Administrator*- full rights to all software commands including adding, removing, modifying user access rights.

System Maps

It shall be possible to configure each sign group to appear on a map within the software. The administrator shall be able to use the software to select the map, identified as a bitmap file, which can then be imported into the software. Each sign shall have an icon that may be placed anywhere on the map.

Message Editor Defaults

The message editor shall automatically utilize the following default settings during the creation of new message files:

- Pixel spacing between adjacent lines of text
- Pixel spacing between adjacent text characters
- Display duration of a given message page
- Beacon activation status (for DMS that contain flashing beacons)
- Effect to be applied to text (i.e., static, scrolling, etc.)
- Message priority classification
- Horizontal text justification supporting left, center, or right
- Vertical text justification supporting top, middle, and bottom
- Default font
- Spell check on message save
- Force text to uppercase
- Disable scrolling

Message Priorities

User-definable defaults shall allow messages to be assigned a priority classification of:

- Emergency
- High
- Normal
- Low
- Minimal

A numeric priority range shall be assigned to each of these five priority classifications. The priority shall allow two different message files to be assigned the same classification, but within that classification, one message can be identified as having higher priority.

6.10 Software Use and Reproduction Rights

Software shall support a licensing key to prevent unauthorized or unlicensed copies of the software to be installed on non agency computers or personal machines. The license shall apply to the server machine, and authorize client use from server machine. The DMS manufacturer shall provide a DMS control software license for this contract. A copy of the DMS control software shall be provided to the engineer on CD-ROM within thirty (30) days of contract award.

Section 7: Requirements for NTCIP Conformance

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.

7.1 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	*Simple Transportation Management Framework (STMF)*	Approved Standard with Amendment
NTCIP 1102:2004	*Octet Encoding Rules (OER) Base Protocol*	Approved Standard
NTCIP 1103 v1.26a	*Transportation Management Protocols*	Recommended Standard
NTCIP 1201:1996 and Amendment 1	*Global Object (GO) Definitions*	Approved Standard with Amendment
NTCIP 1203:1997 and Amendment 1	*Object Definitions for Dynamic Message Signs*	Approved Standard with Amendment
NTCIP 2101:2001	*Point to Multi Point Protocol (PMPP) Using RS-232 Subnetwork Profile*	Approved Standard
NTCIP 2102:2003	*Point to Multi Point Protocol (PMPP) Using FSK Subnetwork Profile*	Approved Standard
NTCIP 2103:2003	*Point-to-Point Protocol Over RS-232 Subnetwork Profile*	Approved Standard
NTCIP 2104:2003	*Ethernet Subnetwork Profile*	Approved Standard
NTCIP 2201:2003	*Transportation Transport Profile*	Approved Standard
NTCIP 2202:2001	*Internet (TCP/IP and UDP/IP) Transport Profile*	Approved Standard
NTCIP 2301:2001	*Simple Transportation Management Framework (STMF) Application Profile*	Approved Standard

Table 3: *NTCIP Document References*

7.2 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.

7.3 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.

7.4 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.

7.5 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 4: *Required Optional Conformance Groups*

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 *moduleType* 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
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	Shall be at least 255

	2.4.1.1.3	
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 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	FSORS

	2.7.1.1.1.10	
dmsResetMessage	NTCIP 1203 Clause 2.7.1.1.1.12	FSORS
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 2.11.1.1.1.5	FSORS
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 5: *Modified Object Ranges and Required Optional Objects*

7.6 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 6: *Required MULTI Tags*

7.7 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

7.8 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.

7.9 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.