

**INTELLIGENT TRANSPORTATION SYSTEMS
QUALIFIED PRODUCTS LIST
ITS/QPL**



**TENNESSEE TRAFFIC OPERATIONS
DIVISION**

**INTELLIGENT TRANSPORTATION
SYSTEMS
QUALIFIED PRODUCTS LIST**

ITS/QPL 10

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FOREWORD

The Intelligent Transportation Systems Qualified Product list (ITS/QPL) provides a list of products that have been known to perform satisfactorily to the Tennessee Department of Transportation. The list can be used by Construction, Maintenance and IT personnel to identify devices to be used on the ITS SmartWay infrastructure in the State of Tennessee. Testing, integration, approval and acceptance requirements are not waived for any of the devices listed. The products listed are considered acceptable for use on the ITS SmartWay infrastructure after testing, validation, and/or verification using state or outside resources. All devices shall be used in accordance with manufacturer recommendation. The list is non-inclusive of all types of products to be used on the SmartWay system. However, the list is applicable for the types of products listed. The list is a live document and will be updated and modified as needed.

The Department reserves the right to reject any product which does not demonstrate satisfactory performance in any of the tests outlined in the Evaluation Procedures. The Department also reserves the right to remove any product from the ITS/QPL that does not perform satisfactorily under real life conditions.

This publication shall be used in conjunction with the Standard Specifications for Road and Bridge Construction, Maintenance Specifications, Special Provisions, Technical Special Provisions, Plans and all supplementary documents effective at the time of usage. Any future corrections, additions or revisions made in the contents of this publication will be forwarded to the holders of this publication so that the publication is maintained up to date.

Any questions concerning this publication or its use should be directed to the following address:

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QPL 10 COLORED DYNAMIC MESSAGE SIGN

SPECIFICATIONS

10.1 Description

This Section describes furnishing, installing, and integrating a high resolution color electronic Dynamic Message Sign (DMS) assembly on a full span structure over the roadway and ground testing of signs. The Contractor shall supply a complete operating Light Emitting Diode (LED) sign including the sign case, sign controller unit (SCU), roadside DMS controller cabinet, all cabling, conduits, electrical service, surge suppression, and all hardware associated with a complete installation as required by these Special Provisions. Note that the DMS item used to include a Roadside DMS Controller Cabinet. Now a separate Type C cabinet item is included in the plans and utilized as the Roadside DMS Controller Cabinet.

The DMS assemblies will provide TMC personnel with a means to visually communicate with motorists regarding any incidents, accidents, special events, travel times, graphical representations of common road and construction signs, and the use of those graphics for lane management of the roadway during the roadway construction project. The DMS system shall also include manufacturer software that allows the creation, placement and display of graphics on the DMS. This software shall be installed in the Regional TMC with TMC operator access to the DMS field controller to allow display status and operational status.

10.2 Materials

10.2.1 General

1. Each DMS assembly shall consist of the following minimum components and general requirements:
 - a. Full matrix LED sign with walk-in sign case.
 - b. Mounting brackets.
 - c. Associated SCU and software.
 - d. Cabling between the various components.
 - e. All electrical components shall be of the solid-state design. Use of vacuum or gaseous tube devices is not acceptable.
2. Provide door locks for all sign case and DMS cabinet doors, keyed to TDOT standard Corbin #2 that will be provided and confirmed during the submittal process. Provide two keys with each DMS location.

3. Provide a voltage label on all sign cases and DMS cabinets or enclosures in accordance with the NEC labeling requirements. Voltage labels shall meet the following minimum requirements:
 - a. Labels shall be flat black lettering on a reflective yellow background. Lettering shall be a minimum of 1 inch in height.
 - b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.
 - c. Labels shall include the voltages entering the cabinet and shall be one continuous adhesive sheet. Examples are “120 VAC” or “120/240 VAC”.
 - d. Labels shall be installed on all sign case and DMS cabinet doors.

10.2.2 Sign Display

The sign display shall meet the following requirements:

1. Each sign display shall have a single plane surface constructed of a single array of pixels.
2. The multi-color DMS system shall include manufacturer’s central control software.
3. Each sign display shall be able to display full color, a minimum of 24 bit displayable color.
4. Each full matrix sign display shall be able to three (3) lines of twentyone (21) – 18” tall characters that adhere to the respective MUTCD required NEMA TS 4 font sizes for electronics changeable message signs.
5. Pixel columns and rows shall be perpendicular. The Pixel Matrix shall have a minimum of 96 rows x 400 cloumns.
6. Graphics shall be formed on the multi-color DMS.
7. Each sign shall be able to display graphic shapes including but not limited to arrows, roadway signs, and interstate shields, each of which can be designed and/or altered by the user through the supplied software.
8. Pixel spacing shall be such that three lines of text shall each have a nominal height of 18 inches with appropriate inter line spacing.
9. Vertical and horizontal spacing between pixel centers shall be equal.

10. Each line shall contain a continuous matrix of pixels allowing the display of at least three (3) lines of 21 characters per line using a standard 18-inch high font (23 X 15 pixel typical). Due to high-resolution aspect of the sign, pixel spacing between characters shall be determined as most compliant to latest version of MUTCD and NEMA TS 4 Hardware standard spacing.
11. A minimum 12" border shall surround the LED pixel array.
12. Provide an automated light intensity measurement through electronic light sensors that can be easily maintained. The sensors shall be mounted in a manner to measure front, rear and ambient light conditions to set brightness levels.

10.2.3 Character Set

The signs shall support the following character display requirements:

1. Characters and/or shapes shall be formed on a matrix comprised of rows and columns forming a continuous line.
2. Individual characters shall be formed by pixels within a character matrix defined by the character font.
3. All upper case characters shall be displayed over the entire height of each character matrix.
4. Character to character spacing shall be determined by the font selected by the user.
5. Lower case lettering - Lower case letters that extend below the bottom (g, j, p, q, y) must be proportioned in location and style per line.
6. Both fixed-space and proportional spaced fonts shall be supported.
7. Each sign shall be able to display a message composed of any combination of the following characters and shapes:
 - a. All upper case letters "A" through "Z".
 - b. All lower case letters "a" through "z".
 - c. All decimal digits "0" through "9".
 - d. A blank or space.
 - e. Punctuation marks shown in brackets [. , ! ? - ' " / ()]
 - f. Special characters shown in brackets [# \$ % & * + < >]

- g. 32 (or more) special graphic shapes, each of which can be designed and/or altered by the user.
- 8. Character height to stroke width ratio and character spacing shall be designed and constructed to achieve optimum legibility.
- 9. Character sets shall be submitted for review and approval.
- 10. Pixel size, pixel center-to-center distance, character height to stroke width ratio, and character spacing shall be designed and constructed to achieve legibility at 900 feet with a standard 18" font.

10.2.4 Physical Properties

The sign physical properties shall meet the following requirements:

- 1. Access for all maintenance shall be from within the sign case and from the rear (i.e., the side opposite of the display surface) of the sign display.
- 2. The sign design shall allow unobstructed and convenient access to all non-structural components. Structural components are defined as the metal sign case and Lexan display cover.
- 3. All serviceable components shall be modular, interchangeable, and removable from within the sign case.
- 4. The sign display shall be composed of identical and readily interchangeable display modules and drivers.
- 5. Each display module shall contain one or more display pixels.
- 6. The replacement of any display module shall not require the use of any special tools.
- 7. All wiring interconnecting individual display modules shall be modular harness assemblies with latching push-on/pull-off or twist on/off connectors.
- 8. The removal of any combination of one or more display modules shall not alter the structural integrity of the sign display assembly, nor of the sign case.
- 9. The removal of any combination of display modules shall not affect the operation of the remaining operational modules in any way.
- 10. The performance of the sign shall not be impaired due to vibration caused by wind, traffic, or any other source.
- 11. All serviceable components shall weigh 50 pounds or less.

12. Mating connectors shall be designated by the connector number and male/female relationship. Connectors shall be keyed or pinned to prevent improper insertion of the wrong connector or PCB.

10.2.5 Pixels

Each pixel shall meet the following requirements:

1. Each pixel shall contain the quantity of discrete LEDs needed to output white colored light at a minimum of 12,400 Candelas/m² (white).
2. The number of necessary LED's shall be determined by the Vendor and be provided to the Engineer for approval.
3. Pixel to pixel luminous intensity shall not vary by more than a 2:1 ratio.
4. The optical axis of all pixels shall be perpendicular to the face of the sign display.
5. Pixels shall be replaceable either individually or in groupings. Groupings with three or more pixels shall be permitted only if bench level repairs and replacements to individual pixels are possible.
6. The failure of an LED in one string within a pixel shall not affect the operation of any other string or pixel.
7. Pixel Pitch shall be 20 mm (0.81 in).
8. Pixel power shall not exceed 1.5 watts per pixel, including the driving circuitry.

10.2.6 LED Technology

LEDs used to form a display pixel shall meet the following minimum requirements:

1. The manufacturer shall be the same for all LED's in all signs.
2. The LED manufacturer shall perform color and intensity sorting to the bins. Each color and intensity of the LED's shall be obtained from no more than two (2) consecutive color 'bins' as defined by the LED manufacturer.
3. Each LED driver board shall be microprocessor controlled and shall communicate with the sign controller on a wire or fiber optic communications network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostics, and report pixel status.
4. Red LEDs shall utilize AlInGaP semiconductor technology and shall display a red color at a wavelength of 615 nm – 630 nm (± 5 nm).
5. Green LEDs shall utilize InGaN semiconductor technology and shall display a green

color at a wavelength of 520 nm – 530 nm (± 5 nm).

6. Blue LEDs shall utilize InGaN semiconductor technology and shall display a blue color at a wavelength of 465 nm – 470 nm (± 5 nm).
7. The LED shall have a nominal viewing cone of 30° with a half-power angle of 15° measured from the longitudinal axis of the LED. Viewing tolerances shall be specified in the LED manufacturer's product specifications and shall not exceed ± 5 °. Using optical enhancing lenses with 15° LED's will not conform to 30° half-power viewing cone specifications and will be cause for rejection.
8. The LED size shall be nominally 0.20 inches.
9. The luminous output shall be a minimum of 3,000 mcd luminous intensity at 20 mA forward current.
10. Current flow through any LED shall not exceed the following values under any light output level:
 - a. RMS current of 25 mA
 - b. Peak current of 30 mA
11. LED life shall be nominally rated for 100,000 hours of operation under field conditions, which shall include operating temperatures between -22° and +185°F (-30° and +85°C).
12. LED life shall be defined as time it takes for the LED light output to degrade to half of the LED's initial light output.
13. To maximize LED service life, LED drive currents will not be allowed to exceed the manufacturer's recommendations for the 100,000-hour life, but shall be sufficient to supply the required intensity.
14. 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.

10.2.7 Sign Case

The DMS Sign Case shall meet the following requirements:

1. Be a walk-in type, weatherproof enclosure that houses electrical, communication, and electronic control devices necessary for the operation of the sign. All steel components shall be stainless steel, unless otherwise noted in these specifications.

2. The sign case shall comply with AASHTO design standards for "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals" and with the fatigue requirements of the National Cooperative Highway Research Program (NCHRP). All sign case and structural drawings shall be stamped by a Professional Engineer certified in the State of Tennessee.
3. Be attached to and become an integral part of the support structure.
4. The dimensions of the sign case (including walk-in cabinet) shall be as specified in this SP. Sign case dimensions shall be approved by Engineer.
5. The sign case shall present a clean, unbroken, neat appearance.
6. The front of the sign case shall not have any visible text or logos on it.
7. The sign case shall be weatherproof and protect the interior from moisture, dust, dirt and corrosion.
8. Positive corrosion protection shall be provided between dissimilar metals.
9. The angular alignment of the sign case shall be adjusted in the vertical direction down by three (3) degrees and incorporated into the face of the display so as to leave the internal walkway as level as possible. If the sign can only be tilted using external brackets to the case, provisions shall be made to make the internal walkway level.
10. The sign case shall be constructed of aluminum sheeting to be 5052-H32 and structural members to be 6061-T6.
11. Aluminum sheeting shall be not less than 1/8 inch thick with all seams continuously welded by the inert gas process.
12. The front of the sign case shall have a flat black matte finish applied in accordance to American Architectural Manufacturers Association (AAMA 2605) with an expected outdoor service life of 10 to 15 years.
13. All other surfaces shall have a bare aluminum mill finish.
14. Weep holes shall be provided to allow moisture to escape.
15. The sign case shall have an interior, non-skid walkway where the walkway shall extend the entire length of the sign case.
16. The unobstructed walkway shall be at least 24 inches wide and at least 75 inches high.
17. The interior walkway shall be capable of supporting a concentrated load of 300 pounds per square foot at any location, and a total load of 1000 pounds within any

ten-foot section of the walkway.

18. Sign case shall have two lifting eyes for placement of sign on structure.
19. Complete sign, including casing, all peripherals and electronics shall weigh no more than 4200 lbs.
20. Total sign case dimensions shall not exceed:
 - a. Width: 31 feet (9.44 m)
 - b. Height: 9 feet (2.74 m)
 - c. Depth: 4.5 feet (1.4 m)

10.2.8 Access Door

The sign shall have an access door on the side of the sign case. The door shall meet the following requirements:

1. Access to the interior of the sign case shall be via a gasketed door that opens out. Door size should be no larger than 25 inches.
2. The door shall be located in the side of the sign case nearest the shoulder of the road and the catwalk when looking at the sign face.
3. The door, latches, and locks shall be engineered in such a way that the door can always be opened from inside of the sign to prevent a technician from being locked in the sign case.
4. The door latching mechanism shall be a three-point draw roller type.
5. The door latching pushrods shall be turned edgewise at the outward supports and have a cross section of 0.25 inch thick by 0.75 inch wide, minimum.
6. Gasketing shall be provided on all door openings and shall meet the following requirements:
 - a. Be dust-tight.
 - b. Meet NEMA 3R requirements.
 - c. Permanently bonded to the door metal.
 - d. Shall not stick to the mating metal surface.
7. A gasket top channel shall be provided to support the top gasket on the door (in order to

prevent gasket gravitational fatigue).

8. When the door is closed and latched, the door shall be locked. The lock shall meet the following requirements:
 - a. The lock and lock support shall be rigidly mounted on the door.
 - b. In the locked position, the bolt throw shall extend a nominal 0.25-inch into the latch cam area.
 - c. A lid or seal shall be provided to prevent dust or water entry through the lock opening.
 - d. The locks shall be Corbin #2 type and shall match the master number of the existing TDOT signs.
 - e. Two keys shall be supplied with each lock.
 - f. The keys shall be removable in the locked position only.
 - g. The locks shall have rectangular, spring loaded bolts.
9. The door shall have catch mechanism that is capable of holding the door open at 90° in 60 mph wind acting at an angle perpendicular to the plane of the door.

10.2.9 Sign Case Ventilation

The sign case shall include ventilation system that meets the following requirements:

1. Louvered vents or hoods shall be installed in the back or side walls of the sign case.
2. No vent(s) or hood(s) shall be installed in the door.
3. Ventilation openings shall be louvered or hooded.
4. Ventilation openings shall be covered with screens so as to prevent the entrance of birds or insects.
5. The number and size of louvered vents shall be determined by the DMS manufacturer to be of sufficient size to provide adequate ventilation.
6. Air filters shall be installed behind each vent and shall meet the following requirements:
 - a. Replaceable industrial grade pleated.
 - b. Shall completely cover the vent opening area.

- c. Shall be manufactured per ASHRAE Standard 52.2P or later version.
 - d. Shall be of fire retardant and water resistant construction, able to withstand temperatures up to 300°F.
 - e. Filter replacement is to be accomplished without tools with easy access.
7. The sign case shall be equipped with one or more fans that meet the following requirements:
- a. Positive pressure ventilation system.
 - b. The continuous duty electric fans shall include ball or roller bearings.
 - c. Sign case venting fan(s) shall have a minimum combined capacity to keep the signs housing internal temperature to a maximum of thirty (30) degrees Fahrenheit above external ambient temperature.
 - d. LED cooling fans shall be provided to vent the air between the display module and the sign face cover.
 - e. Sufficient LED cooling fans shall be provided to keep the air surrounding the LEDs to a maximum temperature not exceeding the rated temperature for the LEDs.
 - f. The sign shall be equipped with a minimum of one (1) ambient temperature sensor, one (1) internal temperature sensor, and one (1) sensor that measures relative humidity of the air inside the housing. Mount the sensors such that they will never be in direct sunlight, and easy to maintain/replace. All sensors shall report data to the SCU.
 - g. Provide sign case ventilation calculations and LED cooling calculations to show sufficient air circulation is provided to meet this SP requirements under worse case air humidity, solar loading, internal heat generation with 50% of all sign pixel turned on at maximum light out level. All sign case temperatures shall be measured at ceiling level.
 - h. The fan(s) shall be mounted within the housing.
 - i. The fan(s) shall be downstream from the air filters.
 - j. The sign case venting fan(s) shall blow the air into the sign case.
 - k. The DMS manufacturer shall determine the number, placement, and size of the

electric fans.

- l. The fans shall be thermostatically controlled. The thermostat shall meet the following requirements:
 - i. Shall be manually adjustable to turn off and on between 91 and 149 degrees Fahrenheit.
 - ii. On and off hysteresis shall not exceed 3 degrees Fahrenheit.
 - iii. The manual adjustment shall be graded in 5 degrees Fahrenheit increment scale.
 - iv. Measure sign case temperature at ceiling level.
- m. The fan circuit shall be protected at 125% of the fan motor capacity.

10.2.10 Sign Face Cover

The sign face display cover shall meet the following requirements:

1. The sign face cover shall be attached to the front of the sign case.
2. The sign face cover shall be a weatherproof, multi-window assembly, which allows an unobstructed view of the sign display.
3. The window material shall meet the following requirements;
 - a. Be scratch resistant and ultraviolet stabilized polycarbonate plastic panels (Lexan with stabilizer or equivalent).
 - b. Be not less than 1/8 inch.
 - c. Shall not exhibit any flaws as a result of normal cleaning, installation or removal, ventilation, vibration and/or positive or negative pressure caused by wind or the passing of large vehicles.
4. Documentation shall be provided the Engineer showing the materials used in the manufacture of the window material.
5. The window attachment mechanism shall provide for the replacement of individual windows without disturbing adjacent windows.
6. The removal of any combination of windows shall not adversely affect the integrity of the sign display cover.

7. The attachment mechanism shall allow the windows to expand and contract with changes in the temperature.
8. A weatherproof seal shall be maintained when the window expands and contracts.
9. The windows shall be installed with a reusable gasket or caulking. The gasket or caulking shall meet the following requirements:
 - a. Designed for outside plant use.
 - b. Design life of at least ten (10) years.
 - c. Remain flexible for at least ten (10) years.
10. Internal strip heaters shall be provided inside the sign case at the bottom of the sign face to prevent fogging of the sign face cover.
11. The internal axial or strip heaters shall be thermostatically controlled. The thermostat shall meet the following requirements:
 - a. Shall be manually adjustable to turn on and off between -20 degrees Fahrenheit to 50 degrees Fahrenheit
 - b. On and off hysteresis shall not exceed 3 degrees Fahrenheit.
 - c. The manual adjustment shall be graded in 5 degrees Fahrenheit increment scale.

10.2.11 Redundant Power Supply

The DMS display power supply and driver electronics shall meet the following requirements:

1. Shall be auto-ranging regulated DC power source.
2. Operate from 90 VAC, 60 Hz (or 240 VAC, 60 Hz). Require NEMA TS 2 voltage input requirements.
3. Have an output of less than 24 VDC.
4. Shall be wired in a redundant parallel configuration that uses multiple supplies to power a single load.
5. Shall be rated such that if one power supply fails, the remaining supplies will be able to operate up to 75% of the pixels in their display section at full brightness.
6. Shall incorporate short circuit protection.

7. Shall incorporate power failed alarm under the following conditions:
 - a. Output voltage below 15% of normal.
 - b. Internal temperature outside the design operational range.
8. Power supply failure alarm and power supply location or number shall be reported to the Sign Controller Unit.

10.2.12 Sign Electrical Requirements

1. The 120/240 Volt electrical service panel shall be rated for 100 amperes maximum.
2. The panel shall have an interrupt rating of not less than 10KA.
3. Internal sign case illumination shall meet the following minimum requirement:
 - a. Mounted near the DMS ceiling.
 - b. Provide uniform light distribution in the sign case.
 - c. The lighting shall be via compact fluorescent lamps with a life of at least 10,000 hours of operation and a minimum 30 watt rating.
 - d. A minimum of one (1) compact fluorescent light fixture shall be installed every eight (8') feet of DMS width. The lamps shall provide uniform light distribution throughout the inside of the assembly.
 - e. The lamps shall be self-ballasted and be rated for cold weather.
 - f. The lamps shall be shielded with a protective wire cage.
 - g. The lights are to be controllable with a manual timer having an adjustable maximum on-time of four (4) hours.
 - h. Two of the light fixtures shall be located approximately two feet from each end of the sign case, and one fixture shall be located in the center of the sign case.
4. The sign case shall be constructed to prohibit any interior light from being visible from the outside when the door is shut.
5. The sign case shall be equipped with three, 15 amp, 120 VAC duplex GFCI (NEMA 15-R) AC receptacles.
6. Two AC receptacles shall be located approximately four feet from each end, and one receptacle shall be located in the center of the sign case.

7. The AC receptacle shall be mounted on the back wall of the sign case.
8. The interior lighting circuits shall be protected by ground-fault circuit-interrupters.
9. The ground-fault circuit interruption shall occur on 6 mA of ground-fault current and shall not occur on less than 4 mA of ground-fault current.
10. All lighting and receptacle circuits shall use #12 AWG wiring enclosed in thin wall $\frac{3}{4}$ or $\frac{1}{2}$ -inch conduit or other measures.

10.2.13 *Sign Controller Unit (SCU)*

The Sign Controller Unit (SCU) shall control the operation of all equipment housed at the Dynamic Message Sign site. The SCU shall meet the following requirements:

1. Shall include a front panel interface with graphical LCD and keypad for direct (local) operation and diagnostics.
2. Shall respond to the direct commands from the system computer and the portable, field-testing computer.
3. Shall be mounted in the roadside DMS cabinet and not in the sign enclosure.
4. Shall receive and interpret commands sent by the system computer and cause the immediate message to be displayed on the sign, and shall provide a return message to the computer that provides information concerning the status of the sign.
5. Shall continuously monitor command messages from the system computer.
6. Shall either blank the display, or continue to display a given message, depending on the option selected by the operator, when a computer system poll is not received within a user-definable threshold period.
7. Shall maintain a library of not less than 60 different display messages and related parameters. The SCU shall support uploading and downloading the message library.
8. Shall monitor and report internal sign case temperatures.
9. Shall be capable of detecting power failures. Power failure is defined when the power is out of limits for 3 or more cycles.
10. Shall include a battery backup that allows the controller to operate for a minimum of 30 minutes while the incoming AC power source has failed.
11. The battery backup circuit shall supply enough power capacity to operate the following equipment:
 - a. SCU
 - b. All communication equipment within the DMS roadside cabinet

12. Shall perform the following function when power is restored after a power failure is detected:
 - a. Display the same message prior to power failure if the outage is less than the user specified period.
 - b. The sign display shall be blank if the power is restored after the user specified period.
13. Shall provide contact closure inputs alarms for the following functions:
 - a. Sign case door switch.
 - b. Roadside DMS cabinet door switch for each door.
14. Shall perform the following actions upon receiving a contact closure input alarm:
 - a. For sign case and roadside door open alarm, the SCU shall report a door open alarm.
 - b. For over-height vehicle detection alarm, the SCU shall perform the following actions:
 - i. Display a user programmable non-volatile message.
 - ii. The message shall overwrite any current message.
 - iii. The message shall be displayed for a user programmable time interval.
 - iv. The operator at the TMC must be able to override the message if needed.
15. Shall incorporate memory with the following requirements:
 - a. Permanent memory.
 - b. Non-volatile memory capable of retaining the data in memory for a minimum of 30 days without power.
16. Schedule and all configurable controller data shall be stored in non-volatile memory.
17. Shall have a user configurable IP address.
18. Shall have a user interface that allows resetting of the sign control unit.
19. Shall have a user interface that initiates a manual test of each pixel in the sign.
20. Shall have circuitry to perform the following functions:

- a. Drive the sign display,
 - b. Determine ambient lighting levels,
 - c. Control pixel luminance levels and
 - d. Monitor the internal sign case temperature by mounting temperature sensors on the sign case.
21. Shall have a hardware watchdog timer that shall check its own operation. While the SCU program is running, the hardware watchdog timer shall be periodically reset. If the watchdog timer is not reset, the watchdog timer shall reset the SCU.
22. A slide-out notebook shelf, power, and connections to the Sign Controller Unit shall be provided at the roadside DMS cabinet to allow for control of the sign from the roadside cabinet with a laptop computer.
23. The presence of ambient radio signals, magnetic or electromagnetic interferences, including those from power lines, transformers, or motors within the proximity of any components of the system, shall not impair the performance of the system.
24. The system shall not radiate any electrical or electromagnetic signals that could adversely affect any other electrical or electronic device.
25. The sign controller as a function of the ambient light conditions shall automatically set the luminous intensity of the sign display pixels. Shall support brightness table with a minimum of 255 levels for automatic settings. Manually adjustable and may be set from 1% to 99% in 1% increments.
26. The controller shall monitor ambient light levels through a photo sensor assembly that senses the ambient illumination level using three (3) photodiodes oriented as follows:
- a. Cell 1 –Monitors the change from “day” to “night”.
 - b. Cell 2 – Facing towards oncoming traffic; monitors prevailing ambient light levels in the upstream traffic.
 - c. Cell 3 – Facing passed traffic; monitors prevailing ambient light levels in the downstream traffic.
27. In the event of communications failure, the sign shall blank and/or display a programmable stored message as determined by the Engineer at delivery time.
28. In the event of a controller lock-up due to any circumstance, the sign shall blank.
29. Shall be capable of auto line centering, left, and right justified in the specific line.

10.2.14 Communications

The DMS controller shall provide interfaces for local and remote communications meeting the following minimum requirements:

1. Communication interface shall be 10/100 Base TX Ethernet for all DMS devices. No serial to Ethernet converters (i.e., terminal servers) are permitted either internal or external to the controller.
2. Communication interface shall comply with NTCIP 1203 v03 or later version.
3. All DMS components shall be in compliance with FCC Part 15. All DMS components may not cause harmful wireless interference and must accept any interference received, including interference that may cause undesired operations. Manufacturer certification of compliance or declaration of conformity with FCC rules shall be provided to TDOT to ensure compliance.

10.2.15 NTCIP Requirements

This SP references several standards through their NTCIP designated names and numbers. Each NTCIP Component covered by these project specifications shall implement the most recent version of the standard that is available as of August 1, 2018, including any and all prepared Amendments to these standards as of the same date.

Profile Implementation conformance Specifications (PICS) for each NTCIP standard required shall be submitted for review and approval to the Department.

1. Ethernet Interface

Communication interfaces using Ethernet shall conform at a minimum with all mandatory objects of all mandatory Conformance Groups of the following standards:

- a. 1101 – NTCIP Simple Transportation Management Framework (STMF)
- b. 1203 – NTCIP Object Definition for Dynamic Message Signs
- c. 2301 – NTCIP AP-STMF
- d. 2202 – NTCIP TP-Internet
- e. 2104 – NTCIP SP-Ethernet

2. RS-232 Interface

Communication interfaces using RS-232 shall conform at a minimum with all standards:

- a. 1101 – NTCIP Simple Transportation Management Framework (STMF)
- b. 1203 – NTCIP Object Definition for Dynamic Message Signs
- c. 2301 – NTCIP AP-STMF
- d. 2201 – NTCIP TP-Transportation Transport Profile
- e. 2104 – NTCIP SP-PMPP/RS232

3. Subnet Level

For each communication interface, the Subnet Level shall meet the following minimum requirements:

- a. NTCIP Components may support additional Subnet Profiles at the manufacturer's option.
- b. At any one time, only one Subnet Profile shall be active on a given communication interface.
- c. The NTCIP Component shall be configurable to allow the field technician to activate the desired Subnet Profile.

4. Transport Level

For each communication interface, the Transport Level shall meet the following minimum requirements:

- a. Communication interfaces may support additional Transport Profiles at the manufacturer's option.
- b. Response data-grams shall use the same Transport Profile used in the request.
- c. Each communication interface shall support the receipt of diagrams conforming to any of the identified Transport Profiles at any time.

5. Application Level

For each communication interface, the Application Level shall meet the following minimum requirements:

- a. All communication interfaces shall comply with NTCIP 1101 and shall meet the requirements for Conformance Level 1 (NOTE - See Amendment to standard).
- b. Optionally, the NTCIP Component may support SNMP traps.
- c. A communication interface may support additional Application Profiles at the manufacturer's option.
- d. Responses shall use the same Application Profile used by the request.
- e. Each communication interface shall support the receipt of application data packets at any time allowed by the subject standards.

6. Information Level

All communication interfaces Information Level protocol shall meet the following minimum requirements:

- a. All communication interfaces shall provide Full, Standardized Object Range Support of all objects required by these procurement specifications unless otherwise indicated below.
- b. The maximum Response Time for any object or group of objects shall be 200 milliseconds.
- c. All communication interfaces shall implement all mandatory objects of all mandatory Conformance Groups as defined in NTCIP 1203 and their respective Amendments.
- d. The sign shall blank if a command to display a message contains an invalid Message CRC value for the desired message and shall provide a return message.
- e. Shall also implement all mandatory objects of the following optional conformance groups of NTCIP 1201.
 - i. Time Management Conformal Group
 - ii. Report Conformal Group. Table 4 indicates the modified object requirements.
- f. Implement all objects of the Font Configuration Conformance Group, as defined in NTCIP 1203.
- g. Implement all objects of the DMS Configuration Conformance Group, as defined in NTCIP 1203.
- h. Implement all objects of the Multi Configuration Conformance Group, as defined in

NTCIP 1203.

- i. Implement all objects of the Multi Error Configuration, as defined in NTCIP 1203.
- j. Implement all objects of the Illumination/Brightness.
- k. Sign Status, as defined in NTCIP 1203.
- l. Status Error, as defined in NTCIP 1203.
- m. Pixel Error Status, as defined in NTCIP 1203.
- n. Since the display of graphics is currently not defined within the NTCIP Standards or their amendments, the vendor shall propose, and provide detailed documentation (i.e., interface protocol description level), how the specified graphical shapes can be displayed.

10.2.16 NTCIP Compliance Documentation

Software shall be supplied with full documentation of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:

- 1. The relevant version of each official standard MIB Module referenced by the device functionality.
- 2. 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.
- 3. 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.
- 4. A MIB containing any other objects supported by the device.

Additionally, the manufacturer shall provide a test procedure that demonstrates how the NTCIP compliance of both, the data dictionaries (NTCIP 1201, 1203, and their amendments) and the communications protocols have been tested.

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

10.2.17 Dynamic Message Sign Operation

The Dynamic Message Sign shall support three distinct modes.

1. System Control: System control is the normal mode of operation. The SCU responds to commands from the system computer.
2. Local Control: This is the mode of operation that is used to test the sign operation. In this mode, the SCU responds to commands from a portable computer that is interfaced to the SCU.
3. Failed Condition: This is the mode of operation that is used when the hardware watchdog timer or the communications watchdog timer is not reset, or a communications error is detected, or an error is detected by the SCU. In this mode, the sign face is blank (all LED pixels are off).

10.2.18 Sign Control Test Software

The Contractor shall provide Test Software that meets the following requirements:

1. The software shall operate on a laptop computer.
2. The software shall interface with the SCU using the SCU Ethernet port and crossover cable.
3. The software shall provide interface using Active Directory Service Interfaces (ADSI).
4. The software shall initiate a test pattern that energizes and verifies each individual pixel in the sign.
5. The test pattern shall be supported by a test report that documents the results of the test.
6. The software shall include a communication monitoring function that meet the following requirements:
 - a. Display on the screen of the portable computer the commands received by the SCU from the system computer.
 - b. Display the response transmitted by the SCU to the system computer.
 - c. Display function shall be real-time and be functional when the SCU is operating in the system control mode.

10.2.19 Central Control Sign Software

The Contractor shall provide Test Software that meets the following requirements:

1. The software shall operate on TMC operator's workstation PCs. It shall be a client-server type architecture, and be able to be installed on an existing server running Windows Server 2016. The relationship shall support multiple operator-client workstations that interface with the Server. One server license shall be required for multiple PC use.
2. The Display Control, the software shall be able to view, group and monitor multiple DMS's in real time.
3. Shall be able to communicate to any NTCIP-compliant sign communicating with the TMC, including portable NTCIP-compliant signs.
4. Shall be able to support list view and map view of signs. The map shall be configured to show all applicable signs in the Region, as required by the Engineer.
5. Shall support full-color text, shape and graphic message creation.
6. Shall be able to change messaging based on various input data, including time, temperature, date and speed
7. Shall be able to generate graphics, such as roadway signs and interstate shields, as well as clip art, shapes and free form creations. Standard MUTCD symbols shall be included in the graphics generator. The editing tool shall be able to move text and images on the editing area with graphical editing tools.
8. Shall be able to display multiple graphics, including shields and arrows for lane designation, or lane management.
9. Shall be able to schedule by date and time, up to one minute increments via a calendar view, with options for schedule recurrence.
10. Shall be able to configure message flash rates, scrolling, beacons, templates and fonts to provide optimal DMS legibility.
11. Shall provide spell check and be able to create a list of prohibited words that can only be accessed for edit by an administrator.
12. Shall be able to log events and subsystem failures.
13. Shall be able to run diagnostics and alert for all system failures, including pixel tests and failures, power failures, environmental status, and other failure notifications.
14. Shall have built in security levels of access, including login/password access.

15. The software shall be provided with the ability to install the client on Operator Workstations.
16. The Central Software shall include full software maintenance support for a duration of three years.
17. The software shall also include the following functionality:
 - a. Full diagnostic test of peripherals
 - b. Remote SCU reset and password override
 - c. Set/view brightness levels
 - d. View NTCIP conformance group values
 - e. Separate windows for multi-monitor display
 - f. Support the latest NTCIP 1203 font table changes and graphics objects
 - g. Display real time date/time/speed/temperature fields
 - h. Variable spacing between characters
 - i. View and Run Schedule Day Plans by week, month, year

10.2.20 Roadside DMS Cabinet (Type C Cabinet)

The Contractor shall provide a ground-mounted cabinet for each DMS. The DMS cabinet is labeled as a Type C cabinet in the Plans (See section 10.2.13 for additional Roadside DMS Cabinet requirements). The cabinet shall meet the following requirements:

1. Shall meet the same lighting, 19" rack, and ventilation requirements as Caltrans Type 170 model 332 cabinet.
2. Shall meet the applicable requirements of a Type C equipment cabinet in Section 6. Shall be ground mounted.
3. A slideout notebook shelf, power, and connections to the Sign Controller Unit (SCU) shall be provided at the roadside DMS cabinet to allow for control of the sign from the roadside cabinet with a laptop computer.
4. Shall be ground mounted.
5. Shall be constructed of 5052 sheet aluminum alloy with a minimum thickness of 1/8

inch.

6. All inside and outside edges shall be free of burrs.
7. The outside surface of the cabinet shall have a smooth, uniform, and natural aluminum finish.
8. All welds shall be neatly formed and free of cracks, blow holes, and other irregularities.
9. All welds shall be made by using the Heliarc welding method.
10. The cabinet should be of sufficient size to hold all of the DMS support equipment (i.e. controller, power distribution panel, etc.), cabinet accessories (slide-out notebook shelf, etc.), and communication equipment as shown in the Plans.
11. Cabinet hinges shall be 14 Gauge diameter stainless steel or 1/8 inch diameter aluminum.
12. The hinge pins shall be constructed of stainless steel.
13. Shall be furnished with a three point latching system (top, bottom, center locations).
14. Shall be furnished with a doorstop, which retains the door at a 90 degree and 120 degree positions.
15. Shall have thermostatically controlled fan located at the top of the cabinet.
16. Minimum fan rating of 100 cubic feet per minute.
17. Fan thermostat shall have a user adjustable range from 80 to 125°F.
18. Minimum of 2-½ inch galvanized anchor bolts shall be used to secure the cabinet to the foundation.
19. Shall be provided with a minimum 20-Watt or equivalent light source.
20. The lamp shall automatically turn ON when either cabinet door is open.
21. Shall include a three wire GFCI 115 VAC duplex convenience receptacle.
22. The receptacle shall be protected by a 15 Amp circuit breaker.
23. Shall include a main circuit breaker, which shall turn off all power to the cabinet and the DMS sign case.
24. Shall include separate circuit breaker to power the sign case.

25. Shall include transient suppression meeting the following requirements:
- a. Shall be UL Listed and labeled to UL 1449.
 - b. Shall have an I-nominal rating of 20kA.
 - c. SPD surge current rating shall equal or exceed 50 kA per mode. Per phase rating shall equal or exceed 100kA per phase.
 - d. Leads shall be as short and straight as possible
 - e. All metal oxide varistors used for surge protection shall be rated in the appropriate voltages and it's operational status shall be monitored via visual indicator.
 - f. SPD operating temperature shall be between -40°F to 185°F
26. Shall include both serial and Ethernet communication cable surge protection devices with the following characteristics:
- a. Hybrid Multi-stage Suppression components, including gas tube and silicon avalanche diode
 - b. Response time to greater than 1 nanosecond
 - c. UL listed (UL 1449, UL 497, 497A, 497B, etc as appropriate) and bonded to the same single-point ground point. Any DIN rail mounted SPD's shall be grounded via conductor and shall not rely solely upon the DIN rail's mechanical connection as a grounding point.
 - d. Sides shall be clearly marked 'protected' and 'unprotected'
27. Provide sunshields and mounting fasteners on all roadside DMS cabinets. Sunshields and fasteners shall meet the following minimum requirements:
- a. Sunshields shall be 0.125 inch aluminum with smoothed, deburred edges and rounded corners. Provide cutouts for door handles and/or locks as required.
 - b. Cabinets shall be equipped with press-in threaded inserts on the cabinet interior. Sunshields shall be mounted by fasteners and aluminum or stainless steel standoffs tightened into the threaded inserts. Provide a minimum of four inserts/fasteners for top face sunshields.
 - c. Provide a minimum of six inserts/fasteners for any door or side sunshield.
 - d. For doors or sides greater than 54 inches tall, provide inserts and fasteners sufficient for a maximum vertical or horizontal distance of 27 inches between any

fasteners.

- e. Furnish and install a top face sunshield on all cabinets.
 - f. Furnish and install door or side sunshields on any cabinet face that is within 60 degrees in either direction of due south. A minimum of two door or side faces shall have sunshields on any cabinet. A cabinet with a face exactly perpendicular to the south shall have three shields.
28. Provide agency name, device name and ID labels on all roadside DMS cabinets.

Labels shall meet the following minimum requirements:

- a. Labels shall be flat black lettering on a reflective white background. Lettering shall be a minimum of 1 inch in height.
- b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.
- c. The agency name labels shall be “TDOT ITS” in one continuous adhesive sheet.
- d. The device ID labels shall include the acronym and hyphen “DMS-” and shall be one continuous adhesive sheet.
- e. The device ID shall be numerals corresponding to the location and shall be installed adjacent to the acronym sheet. Examples are “DMS-02401” and “DMS- 07503”.
- f. Labels shall be installed along the top of the cabinet door (front cabinet door on DMS cabinets), with TDOT ITS label at the top and the device ID labels immediately underneath.

10.2.21 Warranty

The complete Dynamic Message Sign assembly shall carry a one-year manufacturer's warranty from the date of final acceptance against any imperfections in workmanship or materials. The warranty shall include but not be limited to sign face panels (LED), Sign Controller Unit, sign communications hardware, and sign ventilation system.

10.3 Testing Requirements

The Vendor shall complete and submit the attached Colored Dynamic Message Sign Specification Compliance Form to the TDOT Traffic Operations Division. Following the Traffic Operations Division's written approval confirming the Colored Dynamic Message Sign meets the minimum requirements outlined in QPL 10, a sample DMS panel and controller will be tested by TDOT Traffic Operations staff or TDOT TMC staff. The

vendor shall be responsible for coordinating with the appropriate staff for delivery of equipment.

1. Any system failure during the testing period may require an additional amount of time to fully evaluate the Colored Dynamic Message Sign.
2. Determination of a system failure shall be at the discretion of the TMC, TMC IT, or Traffic Operations Division.
3. The overall testing period will be considered complete upon the successful completion of the testing period, as determined by TDOT TMC or Traffic Operations staff.

ADDITIONAL DOCUMENTS

SPECIFICATIONS COMPLIANCE FORM

ACCEPTANCE TEST FORM/APPROVAL

CONTACT LIST

QUALIFIED PRODUCTS LIST

INTELLIGENT TRANSPORTATION SYSTEMS
QUALIFIED PRODUCTS LIST
ITS/QPL

QPL 10 Colored DMS Specifications Compliance Form

Updated 4/29/2019

THIS COLUMN FOR TDOT USE ONLY

TDOT Pay Item Number(s): 725-21.02

Manufacturer/Model: _____

Colored Dynamic Message Sign

Vendor

Authorization: _____

Date: _____

Received date: _____

Forward date: _____

Compliant: Yes No

Signed: _____

Date: _____

Submittal / Resubmittal

(Underline one)

Contract Compliant	Cross-Reference to Attached Documentation
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No

Yes

Status / Comments

Section	Requirements			Status / Comments
		No	Yes	
10.1 Description	<p>This Section describes furnishing, installing, and integrating a high resolution color electronic Dynamic Message Sign (DMS) assembly on a full span structure over the roadway and ground testing of signs. The Contractor shall supply a complete operating Light Emitting Diode (LED) sign including the sign case, sign controller unit (SCU), roadside DMS controller cabinet, all cabling, conduits, electrical service, surge suppression, and all hardware associated with a complete installation as required by these Special Provisions. Note that the DMS item used to include a Roadside DMS Controller Cabinet. Now a separate Type C cabinet item is included in the plans and utilized as the Roadside DMS Controller Cabinet.</p> <p>The DMS assemblies will provide TMC personnel with a means to visually communicate with motorists regarding any incidents, accidents, special events, travel times, graphical representations of common road and construction signs, and the use of those graphics for lane management of the roadway during the roadway construction project. The DMS system shall also include manufacturer software that allows the creation, placement and display of graphics on the DMS. This software shall be installed in the Regional TMC with TMC operator access to the DMS field controller to allow display status and operational status.</p>			
10.2 Materials				
10.2.1	General			
10.2.1.1	Each DMS assembly shall consist of the following minimum components and general requirements:			
10.2.1.1.a	Full matrix LED sign with walk-in sign case.			
10.2.1.1.b	Mounting brackets.			
10.2.1.1.c	Associated SCU and software.			
10.2.1.1.d	Cabling between the various components.			
10.2.1.1.e	All electrical components shall be of the solid-state design. Use of vacuum or gaseous tube devices is not acceptable.			
10.2.1.2	Provide door locks for all sign case and DMS cabinet doors, keyed to TDOT standard Corbin #2 that will be provided and confirmed during the submittal process. Provide two keys with each DMS location.			
10.2.1.3	Provide a voltage label on all sign cases and DMS cabinets or enclosures in accordance with the NEC labeling requirements. Voltage labels shall meet the following minimum requirements:			
10.2.1.3.a	Labels shall be flat black lettering on a reflective yellow background. Lettering shall be a minimum of 1 inch in height.			
10.2.1.3.b	Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.			
10.2.1.3.c	Labels shall include the voltages entering the cabinet and shall be one continuous adhesive sheet. Examples are "120 VAC" or "120/240 VAC".			
10.2.1.3.d	Labels shall be installed on all sign case and DMS cabinet doors.			
10.2.2	Sign Display The sign display shall meet the following requirements:			
10.2.2.1	Each sign display shall have a single plane surface constructed of a single array of pixels.			
10.2.2.2	The multi-color DMS system shall include manufacturer's central control software.			
10.2.2.3	Each sign display shall be able to display full color, a minimum of 24 bit displayable color.			
10.2.2.4	Each full matrix sign display shall be able to three (3) lines of twentyone (21) _ 18" tall characters that adhere to the respective MUTCD required NEMA TS 4 font sizes for electronics changeable message signs.			
10.2.2.5	Pixel columns and rows shall be perpendicular. The Pixel Matrix shall have a minimum of 96 rows x 400 columns.			
10.2.2.6	Graphics shall be formed on the multi-color DMS.			
10.2.2.7	Each sign shall be able to display graphic shapes including but not limited to arrows, roadway signs, and interstate shields, each of which can be designed and/or altered by the user through the supplied software.			
10.2.2.8	Pixel spacing shall be such that three lines of text shall each have a nominal height of 18 inches with appropriate inter line spacing.			
10.2.2.9	Vertical and horizontal spacing between pixel centers shall be equal.			

Section	Requirements	Contract Compliant		Cross-Reference to Attached Documentation	Status / Comments
		No	Yes		
10.2.2.10	Each line shall contain a continuous matrix of pixels allowing the display of at least three (3) lines of 21 characters per line using a standard 18-inch high font (23 X 15 pixel typical). Due to high-resolution aspect of the sign, pixel spacing between characters shall be determined as most compliant to latest version of MUTCD and NEMA TS 4 Hardware standard spacing.				
10.2.2.11	A minimum 12" border shall surround the LED pixel array.				
10.2.2.12	Provide an automated light intensity measurement through electronic light sensors that can be easily maintained. The sensors shall be mounted in a manner to measure front, rear and ambient light conditions to set brightness levels.				
10.2.3	Character Set The signs shall support the following character display requirements:				
10.2.3.1	Characters and/or shapes shall be formed on a matrix comprised of rows and columns forming a continuous line.				
10.2.3.2	Individual characters shall be formed by pixels within a character matrix defined by the character font.				
10.2.3.3	All upper case characters shall be displayed over the entire height of each character matrix.				
10.2.3.4	Character to character spacing shall be determined by the font selected by the user.				
10.2.3.5	Lower case lettering - Lower case letters that extend below the bottom (g, j, p, q, y) must be proportioned in location and style per line.				
10.2.3.6	Both fixed-space and proportional spaced fonts shall be supported.				
10.2.3.7	Each sign shall be able to display a message composed of any combination of the following characters and shapes:				
10.2.3.7.a	All upper case letters "A" through "Z".				
10.2.3.7.b	All lower case letters "a" through "z".				
10.2.3.7.c	All decimal digits "0" through "9".				
10.2.3.7.d	A blank or space.				
10.2.3.7.e	Punctuation marks shown in brackets [., ! ? - ' " / ()]				
10.2.3.7.f	Special characters shown in brackets [# \$ % & * + < >]				
10.2.3.7.g	32 (or more) special graphic shapes, each of which can be designed and/or altered by the user.				
10.2.3.8	Character height to stroke width ratio and character spacing shall be designed and constructed to achieve optimum legibility.				
10.2.3.9	Character sets shall be submitted for review and approval.				
10.2.3.10	Pixel size, pixel center-to-center distance, character height to stroke width ratio, and character spacing shall be designed and constructed to achieve legibility at 900 feet with a standard 18" font.				
10.2.4	Physical Properties The sign physical properties shall meet the following requirements:				
10.2.4.1	Access for all maintenance shall be from within the sign case and from the rear (i.e., the side opposite of the display surface) of the sign display.				
10.2.4.2	The sign design shall allow unobstructed and convenient access to all non-structural components. Structural components are defined as the metal sign case and Lexan display cover.				
10.2.4.3	All serviceable components shall be modular, interchangeable, and removable from within the sign case.				
10.2.4.4	The sign display shall be composed of identical and readily interchangeable display modules and drivers.				
10.2.4.5	Each display module shall contain one or more display pixels.				
10.2.4.6	The replacement of any display module shall not require the use of any special tools.				
10.2.4.7	All wiring interconnecting individual display modules shall be modular harness assemblies with latching push-on/pull-off or twist on/off connectors.				
10.2.4.8	The removal of any combination of one or more display modules shall not alter the structural integrity of the sign display assembly, nor of the sign case.				
10.2.4.9	The removal of any combination of display modules shall not affect the operation of the remaining operational modules in any way.				
10.2.4.10	The performance of the sign shall not be impaired due to vibration caused by wind, traffic, or any other source.				
10.2.4.11	All serviceable components shall weigh 50 pounds or less.				
10.2.4.12	Mating connectors shall be designated by the connector number and male/female relationship. Connectors shall be keyed or pinned to prevent improper insertion of the wrong connector or PCB.				
10.2.5	Pixels Each pixel shall meet the following requirements:				
10.2.5.1	Each pixel shall contain the quantity of discrete LEDs needed to output white colored light at a minimum of 12,400 Candelas/m ² (white).				
10.2.5.2	The number of necessary LED's shall be determined by the Vendor and be provided to the Engineer for approval.				
10.2.5.3	Pixel to pixel luminous intensity shall not vary by more than a 2:1 ratio.				
10.2.5.4	The optical axis of all pixels shall be perpendicular to the face of the sign display.				
10.2.5.5	Pixels shall be replaceable either individually or in groupings. Groupings with three or more pixels shall be permitted only if bench level repairs and replacements to individual pixels are possible.				
10.2.5.6	The failure of an LED in one string within a pixel shall not affect the operation of any other string or pixel.				
10.2.5.7	Pixel Pitch shall be 20 mm (0.81 in).				
10.2.5.8	Pixel power shall not exceed 1.5 watts per pixel, including the driving circuitry.				
10.2.6	LED Technology LEDs used to form a display pixel shall meet the following minimum requirements:				
10.2.6.1	The manufacturer shall be the same for all LED's in all signs.				
10.2.6.2	The LED manufacturer shall perform color and intensity sorting to the bins. Each color and intensity of the LED's shall be obtained from no more than two (2) consecutive color 'bins' as defined by the LED manufacturer.				

Section	Requirements	Contract Compliant		Cross-Reference to Attached Documentation	Status / Comments
		No	Yes		
10.2.6.3	Each LED driver board shall be microprocessor controlled and shall communicate with the sign controller on a wire or fiber optic communications network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostics, and report pixel status.				
10.2.6.4	Red LEDs shall utilize AlInGaP semiconductor technology and shall display a red color at a wavelength of 615 nm – 630 nm (± 5 nm).				
10.2.6.5	Green LEDs shall utilize InGaN semiconductor technology and shall display a green color at a wavelength of 520 nm – 530 nm (± 5 nm).				
10.2.6.6	Blue LEDs shall utilize InGaN semiconductor technology and shall display a blue color at a wavelength of 465 nm – 470 nm (± 5 nm).				
10.2.6.7	The LED shall have a nominal viewing cone of 30° with a half-power angle of 15° measured from the longitudinal axis of the LED. Viewing tolerances shall be as specified in the LED manufacturer's product specifications and shall not exceed ± 5 °. Using optical enhancing lenses with 15° LED's will not conform to 30° half-power viewing cone specifications and will be cause for rejection.				
10.2.6.8	The LED size shall be nominally 0.20 inches.				
10.2.6.9	The luminous output shall be a minimum of 3,000 mcd luminous intensity at 20 mA forward current.				
10.2.6.10	Current flow through any LED shall not exceed the following values under any light output level:				
10.2.6.10.a	RMS current of 25 mA				
10.2.6.10.b	Peak current of 30 mA				
10.2.6.11	LED life shall be nominally rated for 100,000 hours of operation under field conditions, which shall include operating temperatures between -22° and +185°F (-30° and +85°C).				
10.2.6.12	LED life shall be defined as time it takes for the LED light output to degrade to half of the LED's initial light output.				
10.2.6.13	To maximize LED service life, LED drive currents will not be allowed to exceed the manufacturer's recommendations for the 100,000-hour life, but shall be sufficient to supply the required intensity.				
10.2.6.14	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.				
10.2.7	Sign Case The DMS Sign Case shall meet the following requirements:				
10.2.7.1	Be a walk-in type, weatherproof enclosure that houses electrical, communication, and electronic control devices necessary for the operation of the sign. All steel components shall be stainless steel, unless otherwise noted in these specifications.				
10.2.7.2	The sign case shall comply with AASHTO design standards for "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals" and with the fatigue requirements of the National Cooperative Highway Research Program (NCHRP). All sign case and structural drawings shall be stamped by a Professional Engineer certified in the State of Tennessee.				
10.2.7.3	Be attached to and become an integral part of the support structure.				
10.2.7.4	The dimensions of the sign case (including walk-in cabinet) shall be as specified in this SP. Sign case dimensions shall be approved by Engineer.				
10.2.7.5	The sign case shall present a clean, unbroken, neat appearance.				
10.2.7.6	The front of the sign case shall not have any visible text or logos on it.				
10.2.7.7	The sign case shall be weatherproof and protect the interior from moisture, dust, dirt and corrosion.				
10.2.7.8	Positive corrosion protection shall be provided between dissimilar metals.				
10.2.7.9	The angular alignment of the sign case shall be adjusted in the vertical direction down by three (3) degrees and incorporated into the face of the display so as to leave the internal walkway as level as possible. If the sign can only be tilted using external brackets to the case, provisions shall be made to make the internal walkway level.				
10.2.7.10	The sign case shall be constructed of aluminum sheeting to be 5052-H32 and structural members to be 6061-T6.				
10.2.7.11	Aluminum sheeting shall be not less than 1/8 inch thick with all seams continuously welded by the inert gas process.				
10.2.7.12	The front of the sign case shall have a flat black matte finish applied in accordance with American Architectural Manufacturers Association (AAMA 2605) with an expected outdoor service life of 10 to 15 years.				
10.2.7.13	All other surfaces shall have a bare aluminum mill finish.				
10.2.7.14	Weep holes shall be provided to allow moisture to escape.				
10.2.7.15	The sign case shall have an interior, non-skid walkway where the walkway shall extend the entire length of the sign case.				
10.2.7.16	The unobstructed walkway shall be at least 24 inches wide and at least 75 inches high.				
10.2.7.17	The interior walkway shall be capable of supporting a concentrated load of 300 pounds per square foot at any location, and a total load of 1000 pounds within any ten-foot section of the walkway.				
10.2.7.18	Sign case shall have two lifting eyes for placement of sign on structure.				
10.2.7.19	Complete sign, including casing, all peripherals and electronics shall weigh no more than 4200 lbs.				
10.2.7.20	Total sign case dimensions shall not exceed:				
10.2.7.20.a	Width: 31 feet (9.44 m)				
10.2.7.20.b	Height: 9 feet (2.74 m)				
10.2.7.20.c	Depth: 4.5 feet (1.4 m)				
10.2.8	Access Door The sign shall have an access door on the side of the sign case. The door shall meet the following requirements:				
10.2.8.1	Access to the interior of the sign case shall be via a gasketed door that opens out. Door size should be no larger than 25 inches.				
10.2.8.2	The door shall be located in the side of the sign case nearest the shoulder of the road and the catwalk when looking at the sign face.				

Section	Requirements	Contract Compliant		Cross-Reference to Attached Documentation	Status / Comments
		No	Yes		
10.2.8.3	The door, latches, and locks shall be engineered in such a way that the door can always be opened from inside of the sign to prevent a technician from being locked in the sign case.				
10.2.8.4	The door latching mechanism shall be a three-point draw roller type.				
10.2.8.5	The door latching pushrods shall be turned edgewise at the outward supports and have a cross section of 0.25 inch thick by 0.75 inch wide, minimum.				
10.2.8.6	Gasketing shall be provided on all door openings and shall meet the following requirements:				
10.2.8.6.a	Be dust-tight.				
10.2.8.6.a	Meet NEMA 3R requirements.				
10.2.8.6.a	Permanently bonded to the door metal.				
10.2.8.6.a	Shall not stick to the mating metal surface.				
10.2.8.7	A gasket top channel shall be provided to support the top gasket on the door (in order to prevent gasket gravitational fatigue).				
10.2.8.8	When the door is closed and latched, the door shall be locked. The lock shall meet the following requirements:				
10.2.8.8.a	The lock and lock support shall be rigidly mounted on the door.				
10.2.8.8.b	In the locked position, the bolt throw shall extend a nominal 0.25-inch into the latch cam area.				
10.2.8.8.c	A lid or seal shall be provided to prevent dust or water entry through the lock opening.				
10.2.8.8.d	The locks shall be Corbin #2 type and shall match the master number of the existing TDOT signs.				
10.2.8.8.e	Two keys shall be supplied with each lock.				
10.2.8.8.f	The keys shall be removable in the locked position only.				
10.2.8.8.g	The locks shall have rectangular, spring loaded bolts.				
10.2.8.9	The door shall have catch mechanism that is capable of holding the door open at 90° in 60 mph wind acting at an angle perpendicular to the plane of the door.				
10.2.9	Sign Case Ventilation The sign case shall include ventilation system that meets the following requirements:				
10.2.9.1	Louvered vents or hoods shall be installed in the back or side walls of the sign case.				
10.2.9.2	No vent(s) or hood(s) shall be installed in the door.				
10.2.9.3	Ventilation openings shall be louvered or hooded.				
10.2.9.4	Ventilation openings shall be covered with screens so as to prevent the entrance of birds or insects.				
10.2.9.5	The number and size of louvered vents shall be determined by the DMS manufacturer to be of sufficient size to provide adequate ventilation.				
10.2.9.6	Air filters shall be installed behind each vent and shall meet the following requirements:				
10.2.9.6.a	Replaceable industrial grade pleated.				
10.2.9.6.b	Shall completely cover the vent opening area.				
10.2.9.6.c	Shall be manufactured per ASHRAE Standard 52.2P or later version.				
10.2.9.6.d	Shall be of fire retardant and water resistant construction, able to withstand temperatures up to 300°F.				
10.2.9.6.e	Filter replacement is to be accomplished without tools with easy access.				
10.2.9.7	The sign case shall be equipped with one or more fans that meet the following requirements:				
10.2.9.7.a	Positive pressure ventilation system.				
10.2.9.7.b	The continuous duty electric fans shall include ball or roller bearings.				
10.2.9.7.c	Sign case venting fan(s) shall have a minimum combined capacity to keep the signs housing internal temperature to a maximum of thirty (30) degrees Fahrenheit above external ambient temperature.				
10.2.9.7.d	LED cooling fans shall be provided to vent the air between the display module and the sign face cover.				
10.2.9.7.e	Sufficient LED cooling fans shall be provided to keep the air surrounding the LEDs to a maximum temperature not exceeding the rated temperature for the LEDs.				
10.2.9.7.f	The sign shall be equipped with a minimum of one (1) ambient temperature sensor, one (1) internal temperature sensor, and one (1) sensor that measures relative humidity of the air inside the housing. Mount the sensors such that they will never be in direct sunlight, and easy to maintain/replace. All sensors shall report data to the SCU.				
10.2.9.7.g	Provide sign case ventilation calculations and LED cooling calculations to show sufficient air circulation is provided to meet this SP requirements under worse case air humidity, solar loading, internal heat generation with 50% of all sign pixel turned on at maximum light out level. All sign case temperatures shall be measured at ceiling level.				
10.2.9.7.h	The fan(s) shall be mounted within the housing.				
10.2.9.7.i	The fan(s) shall be downstream from the air filters.				
10.2.9.7.j	The sign case venting fan(s) shall blow the air into the sign case.				
10.2.9.7.k	The DMS manufacturer shall determine the number, placement, and size of the electric fans.				
10.2.9.7.l	The fans shall be thermostatically controlled. The thermostat shall meet the following requirements:				
10.2.9.7.l.i	Shall be manually adjustable to turn off and on between 91 and 149 degrees Fahrenheit.				
10.2.9.7.l.ii	On and off hysteresis shall not exceed 3 degrees Fahrenheit.				
10.2.9.7.l.iii	The manual adjustment shall be graded in 5 degrees Fahrenheit increment scale.				
10.2.9.7.l.iv	Measure sign case temperature at ceiling level.				
10.2.9.7.m	The fan circuit shall be protected at 125% of the fan motor capacity.				
10.2.10	Sign Face Cover The sign face display cover shall meet the following requirements:				

Section	Requirements	Contract Compliant		Cross-Reference to Attached Documentation	Status / Comments
		No	Yes		
10.2.10.1	The sign face cover shall be attached to the front of the sign case.				
10.2.10.2	The sign face cover shall be a weatherproof, multi-window assembly, which allows an unobstructed view of the sign display.				
10.2.10.3	The window material shall meet the following requirements;				
10.2.10.3.a	Be scratch resistant and ultraviolet stabilized polycarbonate plastic panels (Lexan with stabilizer or equivalent).				
10.2.10.3.b	Be not less than 1/8 inch.				
10.2.10.3.c	Shall not exhibit any flaws as a result of normal cleaning, installation or removal, ventilation, vibration and/or positive or negative pressure caused by wind or the passing of large vehicles.				
10.2.10.4	Documentation shall be provided the Engineer showing the materials used in the manufacture of the window material.				
10.2.10.5	The window attachment mechanism shall provide for the replacement of individual windows without disturbing adjacent windows.				
10.2.10.6	The removal of any combination of windows shall not adversely affect the integrity of the sign display cover.				
10.2.10.7	The attachment mechanism shall allow the windows to expand and contract with changes in the temperature.				
10.2.10.8	A weatherproof seal shall be maintained when the window expands and contracts.				
10.2.10.9	The windows shall be installed with a reusable gasket or caulking. The gasket or caulking shall meet the following requirements:				
10.2.10.9.a	Designed for outside plant use.				
10.2.10.9.b	Design life of at least ten (10) years.				
10.2.10.9.c	Remain flexible for at least ten (10) years.				
10.2.10.10	Internal strip heaters shall be provided inside the sign case at the bottom of the sign face to prevent fogging of the sign face cover.				
10.2.10.11	The internal axial or strip heaters shall be thermostatically controlled. The thermostat shall meet the following requirements:				
10.2.10.11.a	Shall be manually adjustable to turn on and off between -20 degrees Fahrenheit to 50 degrees Fahrenheit				
10.2.10.11.b	On and off hysteresis shall not exceed 3 degrees Fahrenheit.				
10.2.10.11.c	The manual adjustment shall be graded in 5 degrees Fahrenheit increment scale.				
10.2.11	Redundant Power Supply The DMS display power supply and driver electronics shall meet the following requirements:				
10.2.11.1	Shall be auto-ranging regulated DC power source.				
10.2.11.2	Operate from 90 VAC, 60 Hz (or 240 VAC, 60 Hz). Require NEMA TS 2 voltage input requirements.				
10.2.11.3	Have an output of less than 24 VDC.				
10.2.11.4	Shall be wired in a redundant parallel configuration that uses multiple supplies to power a single load.				
10.2.11.5	Shall be rated such that if one power supply fails, the remaining supplies will be able to operate up to 75% of the pixels in their display section at full brightness.				
10.2.11.6	Shall incorporate short circuit protection.				
10.2.11.7	Shall incorporate power failed alarm under the following conditions:				
10.2.11.7.a	Output voltage below 15% of normal.				
10.2.11.7.b	Internal temperature outside the design operational range.				
10.2.11.8	Power supply failure alarm and power supply location or number shall be reported to the Sign Controller Unit.				
10.2.12	Sign Electrical Requirements				
10.2.12.1	The 120/240 Volt electrical service panel shall be rated for 100 amperes maximum.				
10.2.12.2	The panel shall have an interrupt rating of not less than 10KA.				
10.2.12.3	Internal sign case illumination shall meet the following minimum requirement:				
10.2.12.3.a	Mounted near the DMS ceiling.				
10.2.12.3.b	Provide uniform light distribution in the sign case.				
10.2.12.3.c	The lighting shall be via compact fluorescent lamps with a life of at least 10,000 hours of operation and a minimum 30 watt rating.				
10.2.12.3.d	A minimum of one (1) compact fluorescent light fixture shall be installed every eight (8') feet of DMS width. The lamps shall provide uniform light distribution throughout the inside of the assembly.				
10.2.12.3.e	The lamps shall be self-ballasted and be rated for cold weather.				
10.2.12.3.f	The lamps shall be shielded with a protective wire cage.				
10.2.12.3.g	The lights are to be controllable with a manual timer having an adjustable maximum on-time of four (4) hours.				
10.2.12.3.h	Two of the light fixtures shall be located approximately two feet from each end of the sign case, and one fixture shall be located in the center of the sign case.				
10.2.12.4	The sign case shall be constructed to prohibit any interior light from being visible from the outside when the door is shut.				
10.2.12.5	The sign case shall be equipped with three, 15 amp, 120 VAC duplex GFCI (NEMA 15-R) AC receptacles.				
10.2.12.6	Two AC receptacles shall be located approximately four feet from each end, and one receptacle shall be located in the center of the sign case.				
10.2.12.7	The AC receptacle shall be mounted on the back wall of the sign case.				
10.2.12.8	The interior lighting circuits shall be protected by ground-fault circuit-interrupters.				
10.2.12.9	The ground-fault circuit interruption shall occur on 6 mA of ground-fault current and shall not occur on less than 4 mA of ground-fault current.				
10.2.12.10	All lighting and receptacle circuits shall use #12 AWG wiring enclosed in thin wall ¼ or ½-inch conduit or other measures.				
10.2.13	Sign Controller Unit (SCU) The Sign Controller Unit (SCU) shall control the operation of all equipment housed at the Dynamic Message Sign site. The SCU shall meet the following requirements:				
10.2.13.1	Shall include a front panel interface with graphical LCD and keypad for direct (local) operation and diagnostics.				

Section	Requirements	Contract Compliant		Cross-Reference to Attached Documentation	Status / Comments
		No	Yes		
10.2.13.2	Shall respond to the direct commands from the system computer and the portable, field-testing computer.				
10.2.13.3	Shall be mounted in the roadside DMS cabinet and not in the sign enclosure.				
10.2.13.4	Shall receive and interpret commands sent by the system computer and cause the immediate message to be displayed on the sign, and shall provide a return message to the computer that provides information concerning the status of the sign.				
10.2.13.5	Shall continuously monitor command messages from the system computer.				
10.2.13.6	Shall either blank the display, or continue to display a given message, depending on the option selected by the operator, when a computer system poll is not received within a user-definable threshold period.				
10.2.13.7	Shall maintain a library of not less than 60 different display messages and related parameters. The SCU shall support uploading and downloading the message library.				
10.2.13.8	Shall monitor and report internal sign case temperatures.				
10.2.13.9	Shall be capable of detecting power failures. Power failure is defined when the power is out of limits for 3 or more cycles.				
10.2.13.10	Shall include a battery backup that allows the controller to operate for a minimum of 30 minutes while the incoming AC power source has failed.				
10.2.13.11	The battery backup circuit shall supply enough power capacity to operate the following equipment:				
10.2.13.11.a	SCU				
10.2.13.11.b	All communication equipment within the DMS roadside cabinet				
10.2.13.12	Shall perform the following function when power is restored after a power failure is detected:				
10.2.13.12.a	Display the same message prior to power failure if the outage is less than the user specified period.				
10.2.13.12.b	The sign display shall be blank if the power is restored after the user specified period.				
10.2.13.13	Shall provide contact closure inputs alarms for the following functions:				
10.2.13.13.a	Sign case door switch.				
10.2.13.13.a	Roadside DMS cabinet door switch for each door.				
10.2.13.14	Shall perform the following actions upon receiving a contact closure input alarm:				
10.2.13.14.a	For sign case and roadside door open alarm, the SCU shall report a door open alarm.				
10.2.13.14.b	For over-height vehicle detection alarm, the SCU shall perform the following actions:				
10.2.13.14.b.i	Display a user programmable non-volatile message.				
10.2.13.14.b.ii	The message shall overwrite any current message.				
10.2.13.14.b.iii	The message shall be displayed for a user programmable time interval.				
10.2.13.14.b.iv	The operator at the TMC must be able to override the message if needed.				
10.2.13.15	Shall incorporate memory with the following requirements:				
10.2.13.15.a	Permanent memory.				
10.2.13.15.b	Non-volatile memory capable of retaining the data in memory for a minimum of 30 days without power.				
10.2.13.16	Schedule and all configurable controller data shall be stored in non-volatile memory.				
10.2.13.17	Shall have a user configurable IP address.				
10.2.13.18	Shall have a user interface that allows resetting of the sign control unit.				
10.2.13.19	Shall have a user interface that initiates a manual test of each pixel in the sign.				
10.2.13.20	Shall have circuitry to perform the following functions:				
10.2.13.20.a	Drive the sign display.				
10.2.13.20.b	Determine ambient lighting levels,				
10.2.13.20.c	Control pixel luminance levels and				
10.2.13.20.d	Monitor the internal sign case temperature by mounting temperature sensors on the sign case.				
10.2.13.21	Shall have a hardware watchdog timer that shall check its own operation. While the SCU program is running, the hardware watchdog timer shall be periodically reset. If the watchdog timer is not reset, the watchdog timer shall reset the SCU.				
10.2.13.22	A slide-out notebook shelf, power, and connections to the Sign Controller Unit shall be provided at the roadside DMS cabinet to allow for control of the sign from the roadside cabinet with a laptop computer.				
10.2.13.23	The presence of ambient radio signals, magnetic or electromagnetic interferences, including those from power lines, transformers, or motors within the proximity of any components of the system, shall not impair the performance of the system.				
10.2.13.24	The system shall not radiate any electrical or electromagnetic signals that could adversely affect any other electrical or electronic device.				
10.2.13.25	The sign controller as a function of the ambient light conditions shall automatically set the luminous intensity of the sign display pixels. Shall support brightness table with a minimum of 255 levels for automatic settings. Manually adjustable and may be set from 1% to 99% in 1% increments.				
10.2.13.26	The controller shall monitor ambient light levels through a photo sensor assembly that senses the ambient illumination level using three (3) photodiodes oriented as follows:				
10.2.13.26.a	Cell 1 –Monitors the change from “day” to “night” .				
10.2.13.26.b	Cell 2 – Facing towards oncoming traffic; monitors prevailing ambient light levels in the upstream traffic.				
10.2.13.26.c	Cell 3 – Facing passed traffic; monitors prevailing ambient light levels in the downstream traffic.				
10.2.13.27	In the event of communications failure, the sign shall blank and/or display a programmable stored message as determined by the Engineer at delivery time.				
10.2.13.28	In the event of a controller lock-up due to any circumstance, the sign shall blank.				
10.2.13.29	Shall be capable of auto line centering, left, and right justified in the specific line.				

Section	Requirements	Contract Compliant		Cross-Reference to Attached Documentation	Status / Comments
		No	Yes		
10.2.14	Communications The DMS controller shall provide interfaces for local and remote communications meeting the following minimum requirements:				
10.2.14.1	Communication interface shall be 10/100 Base TX Ethernet for all DMS devices. No serial to Ethernet converters (i.e., terminal servers) are permitted either internal or external to the controller.				
10.2.14.2	Communication interface shall comply with NTCIP 1203 v03 or later version.				
10.2.14.3	All DMS components shall be in compliance with FCC Part 15. All DMS components may not cause harmful wireless interference and must accept any interference received, including interference that may cause undesired operations. Manufacturer certification of compliance or declaration of conformity with FCC rules shall be provided to TDOT to ensure compliance.				
10.2.15	NTCIP Requirements This SP references several standards through their NTCIP designated names and numbers. Each NTCIP Component covered by these project specifications shall implement the most recent version of the standard that is available as of August 1, 2018, including any and all prepared Amendments to these standards as of the same date. Profile Implementation conformance Specifications (PICS) for each NTCIP standard required shall be submitted for review and approval to the Department.				
10.2.15.1	Ethernet Interface Communication interfaces using Ethernet shall conform at a minimum with all mandatory objects of all mandatory Conformance Groups of the following standards:				
10.2.15.1.a	1101 – NTCIP Simple Transportation Management Framework (STMF)				
10.2.15.1.b	1203 – NTCIP Object Definition for Dynamic Message Signs				
10.2.15.1.c	2301 – NTCIP AP-STMF				
10.2.15.1.d	2202 – NTCIP TP-Internet				
10.2.15.1.e	2104 – NTCIP SP-Ethernet				
10.2.15.2	RS-232 Interface Communication interfaces using RS-232 shall conform at a minimum with all standards:				
10.2.15.2.a	1101 – NTCIP Simple Transportation Management Framework (STMF)				
10.2.15.2.b	1203 – NTCIP Object Definition for Dynamic Message Signs				
10.2.15.2.c	2301 – NTCIP AP-STMF				
10.2.15.2.d	2201 – NTCIP TP-Transportation Transport Profile				
10.2.15.2.e	2104 – NTCIP SP-PMPP/RS232				
10.2.15.3	Subnet Level For each communication interface, the Subnet Level shall meet the following minimum requirements:				
10.2.15.3.a	NTCIP Components may support additional Subnet Profiles at the manufacturer's option.				
10.2.15.3.b	At any one time, only one Subnet Profile shall be active on a given communication interface.				
10.2.15.3.c	The NTCIP Component shall be configurable to allow the field technician to activate the desired Subnet Profile.				
10.2.15.4	Transport Level For each communication interface, the Transport Level shall meet the following minimum requirements:				
10.2.15.4.a	Communication interfaces may support additional Transport Profiles at the manufacturer's option.				
10.2.15.4.b	Response data-grams shall use the same Transport Profile used in the request.				
10.2.15.4.c	Each communication interface shall support the receipt of diagrams conforming to any of the identified Transport Profiles at any time.				
10.2.15.5	Application Level For each communication interface, the Application Level shall meet the following minimum requirements:				
10.2.15.5.a	All communication interfaces shall comply with NTCIP 1101 and shall meet the requirements for Conformance Level 1 (NOTE - See Amendment to standard).				
10.2.15.5.b	Optionally, the NTCIP Component may support SNMP traps.				
10.2.15.5.c	A communication interface may support additional Application Profiles at the manufacturer's option.				
10.2.15.5.d	Responses shall use the same Application Profile used by the request.				
10.2.15.5.e	Each communication interface shall support the receipt of application data packets at any time allowed by the subject standards.				
10.2.15.6	Information Level All communication interfaces Information Level protocol shall meet the following minimum requirements:				
10.2.15.6.a	All communication interfaces shall provide Full, Standardized Object Range Support of all objects required by these procurement specifications unless otherwise indicated below.				
10.2.15.6.b	The maximum Response Time for any object or group of objects shall be 200 milliseconds.				
10.2.15.6.c	All communication interfaces shall implement all mandatory objects of all mandatory Conformance Groups as defined in NTCIP 1203 and their respective Amendments.				
10.2.15.6.d	The sign shall blank if a command to display a message contains an invalid Message CRC value for the desired message and shall provide a return message.				
10.2.15.6.e	Shall also implement all mandatory objects of the following optional conformance groups of NTCIP 1201.				
10.2.15.6.e.i	Time Management Conformal Group				

Section	Requirements	Contract Compliant		Cross-Reference to Attached Documentation	Status / Comments
		No	Yes		
10.2.15.6.e.ii	Report Conformal Group. Table 4 indicates the modified object requirements.				
10.2.15.6.f	Implement all objects of the Font Configuration Conformance Group, as defined in NTCIP 1203.				
10.2.15.6.g	Implement all objects of the DMS Configuration Conformance Group, as defined in NTCIP 1203.				
10.2.15.6.h	Implement all objects of the Multi Configuration Conformance Group, as defined in NTCIP 1203.				
10.2.15.5.i	Implement all objects of the Multi Error Configuration, as defined in NTCIP 1203.				
10.2.15.5.j	Implement all objects of the Illumination/Brightness.				
10.2.15.5.k	Sign Status, as defined in NTCIP 1203.				
10.2.15.5.l	Status Error, as defined in NTCIP 1203.				
10.2.15.5.m	Pixel Error Status, as defined in NTCIP 1203.				
10.2.15.5.n	Since the display of graphics is currently not defined within the NTCIP Standards or their amendments, the vendor shall propose, and provide detailed documentation (i.e., interface protocol description level), how the specified graphical shapes can be displayed.				
10.2.16	NTCIP Compliance Documentation Software shall be supplied with full documentation of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:				
10.2.16.1	The relevant version of each official standard MIB Module referenced by the device functionality.				
10.2.16.2	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.				
10.2.16.3	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.				
10.2.16.4	A MIB containing any other objects supported by the device.				
10.2.16.a	Additionally, the manufacturer shall provide a test procedure that demonstrates how the NTCIP compliance of both, the data dictionaries (NTCIP 1201, 1203, and their amendments) and the communications protocols have been tested. The manufacturer shall allow the use of any and all of this documentation by any party authorized by the Procuring Agency for systems integration purposes at any time initially or in the future, regardless of what parties are involved in the systems integration effort.				
10.2.17	Dynamic Message Sign Operation The Dynamic Message Sign shall support three distinct modes:				
10.2.17.1	System Control: System control is the normal mode of operation. The SCU responds to commands from the system computer.				
10.2.17.2	Local Control: This is the mode of operation that is used to test the sign operation. In this mode, the SCU responds to commands from a portable computer that is interfaced to the SCU.				
10.2.17.3	Failed Condition: This is the mode of operation that is used when the hardware watchdog timer or the communications watchdog timer is not reset, or a communications error is detected, or an error is detected by the SCU. In this mode, the sign face is blank (all LED pixels are off).				
10.2.18	Sign Control Test Software The Contractor shall provide Test Software that meets the following requirements:				
10.2.18.1	The software shall operate on a laptop computer.				
10.2.18.2	The software shall interface with the SCU using the SCU Ethernet port and crossover cable.				
10.2.18.3	The software shall provide interface using Active Directory Service Interfaces (ADSI).				
10.2.18.4	The software shall initiate a test pattern that energizes and verifies each individual pixel in the sign.				
10.2.18.5	The test pattern shall be supported by a test report that documents the results of the test.				
10.2.18.6	The software shall include a communication monitoring function that meet the following requirements:				
10.2.18.6.a	Display on the screen of the portable computer the commands received by the SCU from the system computer.				
10.2.18.6.b	Display the response transmitted by the SCU to the system computer.				
10.2.18.6.c	Display function shall be real-time and be functional when the SCU is operating in the system control mode.				
10.2.19	Central Control Sign Software The Contractor shall provide Test Software that meets the following requirements:				
10.2.19.1	The software shall operate on TMC operator's workstation PCs. It shall be a client-server type architecture, and be able to be installed on an existing server running Windows Server 2016. The relationship shall support multiple operator-client workstations that interface with the Server. One server license shall be required for multiple PC use.				
10.2.19.2	The Display Control, the software shall be able to view, group and monitor multiple DMS's in real time.				
10.2.19.3	Shall be able to communicate to any NTCIP-compliant sign communicating with the TMC, including portable NTCIP-compliant signs.				
10.2.19.4	Shall be able to support list view and map view of signs. The map shall be configured to show all applicable signs in the Region, as required by the Engineer.				
10.2.19.5	Shall support full-color text, shape and graphic message creation.				
10.2.19.6	Shall be able to change messaging based on various input data, including time, temperature, date and speed				
10.2.19.7	Shall be able to generate graphics, such as roadway signs and interstate shields, as well as clip art, shapes and free form creations. Standard MUTCD symbols shall be included in the graphics generator. The editing tool shall be able to move text and images on the editing area with graphical editing tools.				
10.2.19.8	Shall be able to display multiple graphics, including shields and arrows for lane designation, or lane management.				
10.2.19.9	Shall be able to schedule by date and time, up to one minute increments via a calendar view, with options for schedule recurrence.				

Section	Requirements	Contract Compliant		Cross-Reference to Attached Documentation	Status / Comments
		No	Yes		
10.2.19.10	Shall be able to configure message flash rates, scrolling, beacons, templates and fonts to provide optimal DMS legibility.				
10.2.19.11	Shall provide spell check and be able to create a list of prohibited words that can only be accessed for edit by an administrator.				
10.2.19.12	Shall be able to log events and subsystem failures.				
10.2.19.13	Shall be able to run diagnostics and alert for all system failures, including pixel tests and failures, power failures, environmental status, and other failure notifications.				
10.2.19.14	Shall have built in security levels of access, including login/password access.				
10.2.19.15	The software shall be provided with the ability to install the client on Operator Workstations.				
10.2.19.16	The Central Software shall include full software maintenance support for a duration of three years.				
10.2.19.17	The software shall also include the following functionality:				
10.2.19.17.a	Full diagnostic test of peripherals				
10.2.19.17.b	Remote SCU reset and password override				
10.2.19.17.c	Set/view brightness levels				
10.2.19.17.d	View NTCIP conformance group values				
10.2.19.17.e	Separate windows for multi-monitor display				
10.2.19.17.f	Support the latest NTCIP 1203 font table changes and graphics objects				
10.2.19.17.g	Display real time date/time/speed/temperature fields				
10.2.19.17.h	Variable spacing between characters				
10.2.19.17.i	View and Run Schedule Day Plans by week, month, year				
10.2.20	Roadside DMS Cabinet (Type C Cabinet) The Contractor shall provide a ground-mounted cabinet for each DMS. The DMS cabinet is labeled as a Type C cabinet in the Plans (See section 10.2.13 for additional Roadside DMS Cabinet requirements). The cabinet shall meet the following requirements:				
10.2.20.1	Shall meet the same lighting, 19" rack, and ventilation requirements as Caltrans Type 170 model 332 cabinet.				
10.2.20.2	Shall meet the applicable requirements of a Type C equipment cabinet in Section 6. Shall be ground mounted.				
10.2.20.3	A slideout notebook shelf, power, and connections to the Sign Controller Unit (SCU) shall be provided at the roadside DMS cabinet to allow for control of the sign from the roadside cabinet with a laptop computer.				
10.2.20.4	Shall be ground mounted.				
10.2.20.5	Shall be constructed of 5052 sheet aluminum alloy with a minimum thickness of 1/8 inch.				
10.2.20.6	All inside and outside edges shall be free of burrs.				
10.2.20.7	The outside surface of the cabinet shall have a smooth, uniform, and natural aluminum finish.				
10.2.20.8	All welds shall be neatly formed and free of cracks, blow holes, and other irregularities.				
10.2.20.9	All welds shall be made by using the Heliarc welding method.				
10.2.20.10	The cabinet should be of sufficient size to hold all of the DMS support equipment (i.e. controller, power distribution panel, etc.), cabinet accessories (slide-out notebook shelf, etc.), and communication equipment as shown in the Plans.				
10.2.20.11	Cabinet hinges shall be 14 Gauge diameter stainless steel or 1/8 inch diameter aluminum.				
10.2.20.12	The hinge pins shall be constructed of stainless steel.				
10.2.20.13	Shall be furnished with a three point latching system (top, bottom, center locations).				
10.2.20.14	Shall be furnished with a doorstop, which retains the door at a 90 degree and 120 degree positions.				
10.2.20.15	Shall have thermostatically controlled fan located at the top of the cabinet.				
10.2.20.16	Minimum fan rating of 100 cubic feet per minute.				
10.2.20.17	Fan thermostat shall have a user adjustable range from 80 to 125oF.				
10.2.20.18	Minimum of 2-½ inch galvanized anchor bolts shall be used to secure the cabinet to the foundation.				
10.2.20.19	Shall be provided with a minimum 20-Watt or equivalent light source.				
10.2.20.20	The lamp shall automatically turn ON when either cabinet door is open.				
10.2.20.21	Shall include a three wire GFCI 115 VAC duplex convenience receptacle.				
10.2.20.22	The receptacle shall be protected by a 15 Amp circuit breaker.				
10.2.20.23	Shall include a main circuit breaker, which shall turn off all power to the cabinet and the DMS sign case.				
10.2.20.24	Shall include separate circuit breaker to power the sign case.				
10.2.20.25	Shall include transient suppression meeting the following requirements:				
10.2.20.25.a	Shall be UL Listed and labeled to UL 1449.				
10.2.20.25.b	Shall have an I-nominal rating of 20kA.				
10.2.20.25.c	SPD surge current rating shall equal or exceed 50 kA per mode. Per phase rating shall equal or exceed 100kA per phase.				
10.2.20.25.d	Leads shall be as short and straight as possible				
10.2.20.25.e	All metal oxide varistors used for surge protection shall be rated in the appropriate voltages and it's operational status shall be monitored via visual indicator.				
10.2.20.25.f	SPD operating temperature shall be between -40°F to 185°F				
10.2.20.26	Shall include both serial and Ethernet communication cable surge protection devices with the following characteristics:				
10.2.20.26.a	Hybrid Multi-stage Suppression components, including gas tube and silicon avalanche diode				
10.2.20.26.b	Response time to greater than 1 nanosecond				
10.2.20.26.c	UL listed (UL 1449, UL 497, 497A, 497B, etc as appropriate) and bonded to the same single-point ground point. Any DIN rail mounted SPD's shall be grounded via conductor and shall not rely solely upon the DIN rail's mechanical connection as a grounding point.				
10.2.20.26.d	Sides shall be clearly marked 'protected'and 'unprotected'				

Section	Requirements	Contract Compliant		Cross-Reference to Attached Documentation	Status / Comments
		No	Yes		
10.2.20.27	Provide sunshields and mounting fasteners on all roadside DMS cabinets. Sunshields and fasteners shall meet the following minimum requirements:				
10.2.20.27.a	Sunshields shall be 0.125 inch aluminum with smoothed, deburred edges and rounded corners. Provide cutouts for door handles and/or locks as required.				
10.2.20.27.b	Cabinets shall be equipped with press-in threaded inserts on the cabinet interior. Sunshields shall be mounted by fasteners and aluminum or stainless steel standoffs tightened into the threaded inserts. Provide a minimum of four inserts/fasteners for top face sunshields.				
10.2.20.27.c	Provide a minimum of six inserts/fasteners for any door or side sunshield.				
10.2.20.27.d	For doors or sides greater than 54 inches tall, provide inserts and fasteners sufficient for a maximum vertical or horizontal distance of 27 inches between any fasteners.				
10.2.20.27.e	Furnish and install a top face sunshield on all cabinets.				
10.2.20.27.f	Furnish and install door or side sunshields on any cabinet face that is within 60 degrees in either direction of due south. A minimum of two door or side faces shall have sunshields on any cabinet. A cabinet with a face exactly perpendicular to the south shall have three shields.				
10.2.20.28	Provide agency name, device name and ID labels on all roadside DMS cabinets. Labels shall meet the following minimum requirements:				
10.2.20.28.a	Labels shall be flat black lettering on a reflective white background. Lettering shall be a minimum of 1 inch in height.				
10.2.20.28.b	Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.				
10.2.20.28.c	The agency name labels shall be "TDOT ITS" in one continuous adhesive sheet.				
10.2.20.28.d	The device ID labels shall include the acronym and hyphen "DMS-" and shall be one continuous adhesive sheet.				
10.2.20.28.e	The device ID shall be numerals corresponding to the location and shall be installed adjacent to the acronym sheet. Examples are "DMS-02401" and "DMS-07503".				
10.2.20.28.f	Labels shall be installed along the top of the cabinet door (front cabinet door on DMS cabinets), with TDOT ITS label at the top and the device ID labels immediately underneath.				
10.2.21	Warranty The complete Dynamic Message Sign assembly shall carry a one-year manufacturer's warranty from the date of final acceptance against any imperfections in workmanship or materials. The warranty shall include but not be limited to sign face panels (LED), Sign Controller Unit, sign communications hardware, and sign ventilation system.				

**INTELLIGENT TRANSPORTATION SYSTEMS
QUALIFIED PRODUCTS LIST**

ITS/QPL

**QPL 10 COLORED DYNAMIC MESSAGE SIGN
ACCEPTANCE TEST FORM**

TEST DATE _____ MANUFACTURER_____

MODEL_____

		PASS	ISSUE
ALL ON	ALL ON/OFF - ALL ON, ALL OFF, REPEAT	<input type="checkbox"/>	<input type="checkbox"/>
PIXEL TEST	VERIFY NO PIXEL ERRORS	<input type="checkbox"/>	<input type="checkbox"/>
DISPLAY	DISPLAY ALL CHARACTERS AND SYMBOLS LEGIBILITY ACCEPTABLE MANUAL ILLUMINATION CONTROL FUCTIONING BLANK THE DISPLAY	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
CONTROLLER	VERIFY COMPATABILITY WITH TMC SOFTWARE	<input type="checkbox"/>	<input type="checkbox"/>

INTELLIGENT TRANSPORTATION SYSTEMS
QUALIFIED PRODUCTS LIST
ITS/QPL

**QPL 10 COLORED DYNAMIC MESSAGE SIGN
ACCEPTANCE TEST APPROVAL**

Purpose:

The purpose of the test is to demonstrate that the Colored Dynamic Message Sign can integrate with TDOT TMC software.

Procedure:

The vendor shall supply a DMS panel and controller for testing from the TMC in a manner equivalent to the normal day-to-day operation of the system. The test will exercise the DMS from the TMC using TMC Operations software.

1. Use the TMC software to confirm the operations of the DMS and log the results on the attached form. Number any Issues and explain at the bottom of the results form.

When all procedures outlined on the Acceptance Test Form have been successfully completed the System will be deemed ACCEPTED and added to the TDOT ITS Qualified Product List.

Vendor Representative

Traffic Operations Division Representative

TMC Representative

TMC IT Representative

INTELLIGENT TRANSPORTATION SYSTEMS
QUALIFIED PRODUCTS LIST

ITS/QPL

QPL 10 COLORED DYNAMIC MESSAGE SIGN - CONTACT LIST

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INTELLIGENT TRANSPORTATION SYSTEMS

ITS/QPL

QPL 10 COLORED DYNAMIC MESSAGE SIGN

QUALIFIED PRODUCTS LIST

All tests on QPL 10 COLORED DYNAMIC MESSAGE SIGN procedure have been successfully completed on the following list of products. The below listed COLORED DYNAMIC MESSAGE SIGNS are deemed ACCEPTED to the Qualified Product List.

- Daktronics VF2020 96x400-20-RGB
- Ledstar VMS190-96X400-20-C-W