VARIABLE MESSAGE SIGNS - Item No.

Special Provision No. 685S01 February 2016

1. SCOPE

This Special Provision covers the requirements for the design, installation and testing of colour full matrix variable message signs (VMS), VMS controllers, and all associated equipment.

2. REFERENCES

This Special Provision refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction:

OPSS 609	Grounding
OPSS 915	Construction Specification for Sign Support Structures

Ontario Ministry of Transportation Publications:

Designated Sources of Material (DSM)

CSA Standards:

S6-14	Canadian Highway Bridge Design Code
C22.2 No. 65-03	Wire Connectors
C22.2 No.75-M1983	Thermoplastic-Insulated Wires and Cables
C22.2 No. 35-M1987	Extra-Low-Voltage Control Circuit Cables, Low-Energy Control Cable, and Extra-Low-Voltage Control Cable
Electrical Bulletin No. 561A	Electrical Insulation Tapes

Electronic Industries Alliance / Telecommunications Industry Association:

EIA/TIA-232-E	Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Binary Data Interchange
TIA/EIA-422-B	Electrical Characteristics of Balanced Voltage Digital Interface Circuits
TIA/EIA-568-B	Commercial Building Wiring Standard
EIA-310-D	Cabinets, Racks, Panels and Associated Equipment

Institute of Electrical and Electronics Engineers:

IEEE 518	Guide for the Installation of Electrical Equipment to Minimize Electrical Noise; Inputs to Controllers from External Sources
IEEE 802.3	IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

International Organisation for Standardization:

ISO/IEC 17025 General Requirements for Competence of Testing and Calibration Laboratories – Standards Council of Canada

National Electrical Manufacturers Association (NEMA):

NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum) - NEMA 3R
NEMA TS 4-2005 Hardware Standards for Dynamic Message Signs (DMS) with NTCIP Requirements

Others:

Ontario Electrical Safety Code

3. DEFINITIONS

For the purpose of this Special Provision, the following definitions apply:

Cone of Vision: means the geometric figure (cone) used to define the area in which a message on a sign can be legibly viewed. It is measured in degrees. It is twice the angle from the axis of the pixel to the 50% brightness point on an LED display. The cone of vision type classification shall be as defined within NEMA standard TS4 - 2005:

Type 'b' – Horizontal angle ± 7.5°
Vertical angle -5°

Type 'e' – Horizontal angle ± 15°
Vertical angle -20°

Display Module: means a matrix of pixels. A matrix of display modules are used to make up the display area of the sign face. A display module is typically a size that can be managed by maintenance staff when display modules need to be replaced. Typical modules sizes include 14 rows of pixels vertically by 10 columns of pixels horizontally or 9 rows of pixels vertically by 15 columns of pixels horizontally.

ITS: means Intelligent Transportation Systems

MIBs: means Management Information Base

MTBF: means Mean Time Between Failures.

Pixel: means an assembly of LEDs that collectively form an image-forming unit. All LEDs in a pixel are turned on or off in unison.

VMS: means Variable Message Sign that includes sign structure, signcase, display elements, photocell sensor, VMS controller, and all other associated mechanisms and equipment required to form an operational display.

4. DESIGN AND SUBMISSION REQUIREMENTS

4.1 Design Requirements

4.1.1 VMS Design

4.1.1.1 The structural design for the sign case, including the load on the sign face and mounting hardware, shall comply with all relevant requirements of CAN/CSA-S6.

4.1.1.2 Design of the variable message sign with all internal components shall sustain the galloping, vortex shedding, natural wind gust and truck-induced wind gust loading based on the appropriate design standards.

4.1.1.3 Design of the VMS shall meet all appropriate ice loading design standards.

4.1.1.4 The structural design of the sign and the associated mounting, undertaken by the Contractor, shall be compatible with the design of the sign support structure. The sign case shall be designed as an integral part of the mounting truss as shown in the Contract Drawings.

4.1.1.5 The structural design of the Ontario Trillium Sign Tab and the associated mounting, undertaken by the Contractor, shall be compatible with the design of the sign case. The Sign Tab shall be designed as an integral part of the sign case as shown in the Contract Drawings. The Owner will supply the Ontario Trillium Tab Sign.

4.1.1.6 All structural design components (including all mass calculations) shall have the design attested to by an Engineer.

4.1.1.7 The catwalk to the sign case along the support structure shall be compatible with the entrance to the sign case. The catwalk shall be provided on the right-hand shoulder side of the support structure to allow access from the shoulder to the sign case unless otherwise indicated on the Contract drawings.

4.1.1.8 The catwalk shall include a hand rail for safety purposes. The handrail shall be continuous around the exposed perimeter of the catwalk, except for an opening for maintenance access. Safety points shall be included along the catwalk to serve as anchor points for the maintenance workers to clip their safety harness to as they cross the catwalk.

4.1.2 Software Design

4.1.2.1 The Contractor shall submit a software development plan, schedule and software architecture (high level) design to the Contract Administrator for review.

4.1.2.1 Software documentation, as required, shall be submitted for review and approval to the Contract Administrator in advance of site installation of the VMS.

4.2 Submission Requirements

4.2.1 Shop Drawings

The Contractor shall submit all designs, drawings and details to the Contract Administrator for review. The Contractor shall submit shop drawings for the following:

a) Sign case and sign face;

b) Access door, maintenance walkway (catwalk) and safety rails;

c) Light emitting assembly;

d) Display matrix including mounting details;

e) Environmental system;

f) Mounting hardware and details;

g) Photosensor system and dimming scheme;

h) Driver electronics;

i) Interconnection method; and

j) Associated cables and wiring.

Shop drawings relating to the VMS controller shall consist of:

- circuit schematics;
- functional block diagrams;
- relevant timing diagrams;
- equipment sizes;
- catalogue numbers and cut sheets; and,
- other relevant material necessary to fully describe the controller.

4.2.2 Pixel

As a minimum, the following design information for the pixel shall be submitted to the Contract Administrator prior to the manufacturing of the sign:

a) Type and characteristics of LEDs and other major components of the pixel, as appropriate.

b) Design of the pixels and associated calculations to verify how the optical and colour performance requirements are achieved.

c) The range of driving parameters of the light emitting elements to attain the required range of design output intensity.

d) The reliability information of the LEDs and pixels including predicted MTBF for the LEDs and pixels for continuous operations under the worst case operating conditions and the associated reliability information from the LED manufacturer to show the LED MTBF with respect to operating temperature.

e) Degradation characteristics of the pixel with respect to light output, colour shift, light propagation and reflective characteristics shall be minimal.

f) Evidence and / or certification of the LED manufacturer’s binning process.

4.2.3 Other Submission Requirements

The following additional design and construction elements shall be submitted prior to the manufacturing of the sign:

4.2.3.1 A sample of the exterior sign case paint finish.

4.2.3.2 The proposed method for replacing modules, wiring and internal components within the sign case. A mock-up of the polycarbonate sheet sections shall be visually demonstrated to the Contract Administrator.

4.2.3.3 The design verification for the control of negative (out-forward) pressure for the sign face shall be carried out as specified by CAN/CSA-S6 and certified by an Engineer. Methods to control the negative pressure shall be submitted with the sign documentation.

4.2.3.4 The Contractor shall submit calculations for the estimation of the mass of the sign case and the total mass of the sign (sign case complete with all internal components).

4.2.3.5 The Contractor shall submit the design criteria used and the associated design calculations and drawings to the Contract Administrator prior to the manufacturing of the sign.

4.2.3.6 Calculations for energy consumption to demonstrate that the limits for power consumption are met.

4.2.3.7 Design of the environmental system shall be submitted. The submission shall state the predicted internal environmental conditions during normal operations and under the external environmental extremes. The predicted maximum temperature adjacent to the light source shall be provided. Associated heat analysis calculations shall be attested by an Engineer.

4.2.3.8 Proposed display module driver mounting and maintenance access scheme.

4.2.4 Module Prototype Requirement

4.2.4.1 The Contractor shall construct and test a sign prototype consisting of a minimum of two fully functional display modules (including the polycarbonate sheet and mask) prior to fabrication of the sign to demonstrate compliance of the sign design with the requirements included in this Special Provision. The prototype shall be of identical material and design of the sign to be supplied under the Contract.

4.2.4.2 The Contractor shall provide a demonstration of the prototype operation to the Owner representatives prior to manufacturing of the signs. The demonstration shall take place at a facility secured by the Contractor, in the Central Region of Ontario.

5. MATERIALS

5.1 Previous Suppliers

The following companies have supplied monochrome (amber) type LED VMS to the Owner in the past:

a) Ledstar Inc.
131 Westcreek Dr.
Woodbridge, Ontario L4L 9N6
Telephone: (905) 265-7800

b) Daktronics Canada
1130 Rue Levis, Unit 4
Lachenaie, Quebec J6W 5S6
Telephone: (450) 492-1003

The manufacturer of the VMS shall demonstrate his experience in providing walk-in type VMS using LED technology to North American standards, and operated using NTCIP compliant central software. Specifically, the manufacturer must meet or exceed the following minimum experience requirements:

Supply 5 reference projects completed within the past 5 years that supplied a minimum of 10 VMS used in freeway applications. For each project provide description of project that clearly demonstrates type of sign and application, project owner contact person's name, address, phone number and email address. Note: Contact must be Provincial Ministry of Transportation and/or U.S. DOT personnel.

5.2 Sign Case

5.2.1 The sign case shall be constructed of aluminum alloy or other approved non-ferrous, durable materials. The sign case shall provide the required protection and mechanical strength for the application.

5.2.2 The Sign case shall be designed to conform to the requirements of NEMA 3R outdoor enclosures.

5.2.3 The total mass of the sign component, including all internal and external components and the Ontario Trillium sign tab, shall not exceed 4,850 kg for the full size sign and 3,000 kg for the midsize sign. Any scale used to measure the total mass of the sign component shall be tested and certified conforming to the Government of Canada Weights and Measures Act and Government of Canada Weights and Measures Regulations.

5.2.4 The outside dimensions, excluding the Ontario Trillium sign tab, shall be as specified elsewhere in the Contract Documents.

5.2.5 The Ontario Trillium Sign tab, supplied by the Owner, is shown as part of the Contract Drawings. The Contractor shall provide the appropriate mounting and mounting hardware for the sign tab to the sign case as per the Contract Drawings.

5.2.6 The perimeter of the sign case shall include a 75 mm wide strip of high intensity retro-reflective fluorescent sign material, matching as closely as possible the amber colour 'traffic yellow'.

5.2.7 All structural hardware components shall be stainless steel unless otherwise specified. Nylon stop nuts shall be used. The hardware components shall prevent galvanic action, corrosion, and loosening under the conditions of the highway environment. All fasteners of less than 3 mm diameter shall use Robertson heads and all larger fasteners shall use hex heads.

5.2.8 The sign case seams shall be continuous welded. Seams shall be welded with gas metal arc (MIG) or gas tungsten arc (TIG) process using bare aluminum welding electrodes. Spot welding shall not be used. Corrosion protection shall be provided between dissimilar metals.

5.2.9 The sign shall be supplied with a minimum of two (2) lifting eyes to facilitate lifting of the sign without damage.

5.2.10 The Sign case shall be designed such that the sign case support is provided at the truss panel points or as approved by the Contract Administrator.

5.2.11 Colour shall be grey on all exterior surfaces except for the front face. The sign case shall be cleaned, treated with chemical conversion coating, or with a paint primer suitable to the sign case material, and finished with two coats of prime quality enamel. Alternatively, anodized aluminum or electrostatically applied powder coats are acceptable. The finish shall be of prime quality substantially free of flow lines, paint washout, streaks, blisters and other defects that would impair serviceability or detract from the general appearance. All visible surfaces on the front face shall be entirely matt black except for the high-intensity retro-reflective fluorescent border strip.

5.2.12 Walk-in maintenance access is to be compatible with the design of the sign support structure and the maximum dimensions of the sign.

5.2.13 The design shall permit easy access to modules, wiring and internal components for maintenance and diagnostic purposes from within the sign case. Modules shall be provided with a swing-down assembly such that all equipment can be inspected, removed, and replaced.

5.2.14 The minimum overhead clearance in a walk-in sign case for the internal walkway shall be 1850 mm.

5.2.15 The sign case walk-in maintenance access door shall be constructed on the right or left end of the sign as shown in the Contract Drawings. The door shall be a minimum of 597 mm in width and 1524 mm in height. A three-point latching mechanism shall secure the door. All sign case walk-in maintenance access door locks on all signs provided under this Contract shall be keyed alike. Two keys for each sign shall be provided to the Contract Administrator upon completion of the project.

5.2.16 Safety strips shall be mounted on the interior sign case ceiling and on all interior protruding members.

5.2.17 The internal maintenance walkway shall extend along the entire length of the sign case. Minimum walkway width shall be 508 mm. Obstructions in the walkway path shall be minimized. The walkway shall be constructed of a non-slip material.

5.2.18 The sign case shall be completely enclosed to prevent any tools from falling onto the roadway below during maintenance and repair activities.

5.2.19 The LED module section of the VMS shall be sectioned off from the general interior of the sign by means of sliding panels made of aluminum.

5.3 Sign Face

5.3.1 The sign face shall be protected by weather tight, dust proof, non-glare polycarbonate sheets. The polycarbonate sheeting shall be secured to the sign case as recommended by the manufacturer of the polycarbonate sheet and shall be designed with appropriate methods to withstand all applicable loads as required by CAN/CSA-S6. An aperture mask shall be provided in front of the polycarbonate sheets and shall be sized and positioned to accommodate the luminance and colour output requirements of the sign.

5.3.2 The sections of polycarbonate sheets shall be securely mounted to the front face of the sign. The protective screen shall be rigid and shall not deform as a result of wind or temperature.

5.3.3 Suitable segments and/or measures shall be provided to allow for the expansion and Contraction of the polycarbonate sheets. They shall be positioned, aligned and sized such that they do not block the pixels.

5.3.4 The sign case shall be designed to allow cleaning of the internal surface of the polycarbonate sheets.

5.3.5 The polycarbonate sheets shall exhibit a consistent degree of uniformity from one panel to another and across the entire sign face.

5.3.6 While the type and material selected for the polycarbonate sheets shall satisfy the requirements to protect the sign, the design of the polycarbonate sheets shall also be required to meet the overall optical performance of the sign display as stated herein.

5.3.7 The sign face including polycarbonate sheets and segments shall be appropriately sealed to prevent the ingress of moisture and debris and shall accommodate the required expansion and contraction.

5.4 Sign Display Matrix

5.4.1 The display shall be full matrix, as shown in the Contract Drawings.

5.4.2 The full matrix display of a full size sign shall have 70 rows and 360 columns of visible pixels. In the case of a display module that is 14 rows by 10 columns, the full matrix would consist of 180 display modules arranged in 5 horizontal rows and 36 vertical columns. In the case of a display module that is 9 rows by 15 columns, the full matrix would consist of 192 display modules arranged in 8 horizontal rows by 24 vertical columns (ie. the top and bottom row of pixels of the full sign display are not visible). The dimensions of the visible display area opening and border areas around the sign display area shall be constrained to the dimensions shown on the Contract Drawings.

5.4.3 The full matrix display of a med size sign shall have 60 rows and 210 columns of visible pixels. In the case of a display module that is 10 rows by 14 columns, the full matrix would consist of 90 display modules arranged in 6 horizontal rows and 15vertical columns. In the case of a display module that is 15 rows by 9 columns, the full matrix would consist of 96 display modules arranged in 4 horizontal rows by 24 vertical columns (ie. two columns of pixels of the sign display on each side are not visible). The dimensions of the visible display area opening and border areas around the sign display area shall be constrained to the dimensions shown on the Contract Drawings.

5.5 Sign Power Requirements

5.5.1 The power consumption shall not exceed 12 KVA for a full size sign class ‘b’ and 8kVA for a mid size sign class ‘b’ or ‘e’ with all fans, heaters, auxiliary equipment and 100% of the pixels operative in their maximum output setting for the colour white. Power usage shall be balanced between the lines with deviation not exceeding 25%.

5.5.2 The power factor shall be a minimum of 0.90. The Contractor shall provide power factor correction equipment, where necessary, to achieve this minimum power factor.

5.5.3 Two (2) duplex 110V receptacles with a ground fault interrupter (GFI) shall be provided inside the sign case for the use by maintenance personnel. The receptacles shall be easily accessible by the maintenance personnel.

5.5.4 Fluorescent tube lighting shall be installed inside the sign case to provide lighting during maintenance and repair activities. Control of the lighting shall be through a switch located within the sign case close to the maintenance access door.

5.6 Sign Display

5.6.1 General Display Properties

5.6.1.1 The sign display shall be light emitting type employing light emitting diode (LED) technology.

5.6.1.2 The Contrast Ratio requirements shall be as defined and specified within Section 5.2 of NEMA TS 4-2005.

5.6.1.3 The Cone of Vision Type Classification of the display shall be type class ‘b’ for full size sign and either class ‘b’ or ‘e’ for mid size sign and specified elsewhere in the Contract Documents. Class designations shall be as defined and specified within Section 5.3 of NEMA TS 4-2005.

5.6.1.4 The Luminance Intensity requirements shall be as defined and specified within Section 5.4 of NEMA TS 4-2005.

5.6.1.5 The Chromaticity Classifications and Limits requirement shall be as defined and specified within Section 5.5 of NEMA TS 4-2005.

5.6.1.6 The Moving Arrows requirements shall be as defined and specified within Section 5.8 of NEMA TS 4-2005.

5.6.1.7 The Test Parameters and Test Areas defined within Sections 5.9.1 and 5.9.2 of NEMA TS 4-2005 shall be used in the performance of all tests to verify and certify the optical, photometric, and colorimetric properties of the sign display.

5.6.1.8 Failure of a pixel or display module shall not cause failure of any other pixel or module. Failure of a single LED within a pixel shall not cause a failure of the pixel nor the loss of more than 25% of the pixel’s intensity. Failure of LEDs for a single colour within a pixel shall be deemed a pixel failure.

5.6.1.9 When pixels are operating in a pulse mode, no noticeable light flicker shall be visible by a human eye. The frequency of the pulse mode shall be minimum 90 Hz.

5.6.1.10 The sign display for all colours individually and combination of colours shall be clearly legible from a distance of between 75 m and 300 m under normal highway operating conditions from any part of the approaching lanes including the shoulders.

5.6.1.11 The sign display for all colours individually and combination of colours shall be visible from a distance of 500 m in all ambient light conditions.

5.6.1.12 The sign face shall be set at an angle of 3° (degrees) from vertical so that the pixels are aimed downward towards the roadway.

5.6.2 Display Module

5.6.2.1 Each display module shall be sized to be easily handled for maintenance operations and be made up of multiple pixels arranged in regular horizontal rows and vertical columns with pixel centres equivalently spaced. Acceptable configuration sizes of the modules shall be either 14 rows by 10 columns for the 33mm pixels or 9 rows by 15 columns for the 34mm pixel.

5.6.2.2 Within the display module, each pixel shall be individually addressable to allow full colour, full graphics and proportional fonts capability with variable levels of luminous intensity.

5.6.2.3 The spacing between pixels shall be no less than 33 mm and no greater than 34 mm as measured from the centre of one pixel to the centre of adjacent pixels both horizontally and vertically. The horizontal and vertical spacing shall be equal. The above constraint is for the 14 by 10 and 9 by 15 pixel modules respectively.

5.6.2.4 Each display module shall be mounted and secured such that maintenance staff can easily remove the display module. All display modules within a single sign shall be the same size.

5.6.3 Pixels

5.6.3.1 The pixels shall be made up of a mix of the primary colour - Red, Green and Blue - LEDs as a minimum. Other non-primary colours will be considered if required to meet the color and luminance intensity requirements of the display. The luminance intensity of the pixel shall meet or exceed the luminance intensity requirements of Section 5.4 within NEMA TS 4-2005. The chromaticity limits and classifications of the pixel shall meet the requirements of Section 5.5 within NEMA TS 4-2005.

5.6.3.2 Each pixel shall be comprised of sufficient light emitting diodes (LEDs) to meet the optical requirements of this special provision while driving each LED sufficiently under the LED maximum limits to satisfy the end life and mean time between failures (MTBF) as specified elsewhere in this special provision. When turned on and viewed from 75 m, the pixel shall be visible as a solid dot and not as individual LEDs for all colours individually and combination of colours. The pixel shall not require external or supplementary illumination. Operation of each pixel shall be independent of the other elements such that failure of a pixel will not affect proper operations of the other elements.

5.6.3.3 All pixels of the sign shall be of identical material and design to ensure uniformity in characteristics. Design of the pixels shall meet the harsh environmental requirements of the intended installation within the component manufacturer's rated temperature range and operating characteristics.

5.6.3.4 The pixels shall be assembled in display modules to facilitate maintenance and replacement.

5.6.3.5 When activated, pixels shall be able to display 24Bit RGB colour as defined in Section 5.5 of NEMA TS 4-2005. When not activated, pixels shall be non-light emitting.

5.6.3.6 All pixels shall be securely mounted such that the nominal axis of the light output shall be perpendicular to the sign face and centred within the mask opening of the sign face..

5.6.3.7 The average luminance output from the highest 12% of the pixels to the lowest 12% shall be less than 3:1 for all colours individually and combination of colours. The ratio of the average luminance output from the highest 4% of the pixels to the lowest 4% shall be less than 5:1. The average luminance output from the left 12% of the pixels to the right 12% shall be less than 3:1 for all colours individually and combination of colours. The ratio of the average luminance output from the left 4% of the pixels to the right 4% shall be less than 5:1.

5.6.3.8 The pixel design shall be such that it minimizes the effect of heat build-up within the pixel. The LEDs shall operate within the LED manufacturer rated temperature range under the worst case operating conditions while still maintaining the targeted end life and mean time between failures (MTBF) as specified elsewhere in this specification.

5.6.3.9 Each pixel shall contain sufficient LEDs, such that the entire sign with the polycarbonate sheet and mask in front of the pixels shall fulfil the optical output, contrast, viewing angle, legibility and reliability requirements as specified elsewhere in this Special Provision.

5.6.3.10 The soldering of the LEDs shall be in accordance with the manufacturer's recommended guidelines.

5.6.4 LEDs

5.6.4.1 The Contractor shall choose the LED technology for each LED colour such that the desired luminance intensities, chromaticity limits and de-rated LED driving requirements are achieved while satisfying the end life and mean time between failures (MTBF) specified elsewhere in this specification.

5.6.4.2 All LEDs of the same colour shall be of industrial grade and of identical make and model from the same manufacturer.

5.6.4.3 The LED shall be highly reliable for the intended applications. With a target continuous operating period of five (5) years, the mean time between failure (MTBF) of a single LED shall not be less than 150,000 hours at the brightest level and with all the pixels activated within the maximum LED driving characteristics for the maximum design output for the sign operations at an outside air temperature of 35 °C and a relative humidity range of 5% to 100%. Failure of a pixel is defined as the inability to activate more than 25% of the LEDs in a pixel and/or achieving less than 25% of the intended pixel output intensity and/or failure of the LEDs for a single colour within a pixel.

5.6.5 Display Font

The sign shall display the fonts MTO1 and MTO2 as detailed in the Contract Drawings.

5.6.6 Display Performance

The time to display a 75 alphanumeric character message generated at the VMS controller shall not exceed 0.5 second from a blank state.

The time to display a graphic generated at the VMS controller shall not exceed 0.5 second from a blank state.

5.7 Sign Photosensor System

The sign shall have three photovoltaic sensors. One sensor (cell 1) shall be aimed in the northerly direction (away from nearby lights) and scaled for a reading of up to 100 lux (horizon type). The other two sensors (cells 2 and 3) shall be aimed in opposite directions and perpendicular to the sign face. These two sensors shall be scaled for a reading of up to 100,000 lux. The sensors shall be mounted on the top of the sign case near the right side for ease of maintenance. The aiming angle of the sensors shall be adjustable:

a) Cell 1 - Northern sky;

b) Cell 2 - Facing towards oncoming traffic (upstream); and

c) Cell 3 - Facing towards passed traffic (downstream).

5.8 Sign Environmental System

5.8.1 The sign enclosure and the equipment housed within shall be protected from moisture, rain, snow, sun radiation, dust, dirt and salt corrosion found in a highway environment.

5.8.2 A heating system and thermal insulation shall be provided, if required, to prevent adverse effect on the equipment due to condensation. Condensation may be controlled using thermostatically controlled strip heaters or axial fan heaters inside the sign face.

5.8.3 A forced ventilation system shall be provided, if required, to mitigate the effects of dust ingress and for providing air movement, thermal cooling, and thermal equalization to mitigate the accumulation of condensation and formation of “hot spots”. All fans shall be mounted in the top of the sign case. All forced intake air shall be filtered.

5.8.4 The environmental system shall maintain the internal environment of the sign within the operating range of all internal components, -40 to +65 °C, being employed for the design of the sign system for all external conditions encountered in Ontario.

5.8.5 The environmental system shall be designed for proper continuous sign operations at 25% of the pixels with all possible pixel combinations for LED technology, at the brightest level, under the full external environmental range.

5.8.6 An adequate quantity of temperature sensors shall be provided inside the sign case with associated temperature monitoring functions to prevent damage of the components due to build-up of excessive heat.

5.8.7 The use of fans is required to provide comfortable working conditions within the sign during maintenance activities. When not in use, the fan openings shall be shut and turned off.

5.8.8 Liquid coolants shall not be permitted.

5.9 Sign Electronic Components/Electrical Components

5.9.1 The requirements of Section 8.2 - Components of NEMA TS 4-2005 shall apply to this work.

5.9.2 The requirements of Section 8.2.1 of NEMA TS 4-2005 shall apply to this work and is amended with the addition of the following.

All electrical/electronic components shall be of modular, interchangeable, plug-in type fabrication and shall be standard manufacturer's components and CSA certified, where possible. Failure of a single display pixel or module shall not affect operations of the other display pixels or modules. During replacement of defective driver boards or light emitting modules the sign shall remain operational.

5.9.3 The requirements of Sections 8.2.2 to 8.2.13 of NEMA TS 4-2005 shall apply to this work. Section 8.2.2.1 is deleted and replaced with the following.

Electronic components shall not be socket or jack mounted, except for LSICs (Large Scale Integrated Circuits) having 16 or more leads. If IC sockets are used, they shall have high grade, industrial quality, machined pin contacts and dual spring, gold plated type sockets.

5.9.4 The requirements of Sections 8.3 and 8.4 of NEMA TS 4-2005 shall apply to the work.

5.9.5 All components shall be capable of withstanding the extreme environmental conditions as specified without degrading their design life. The design shall be inherently temperature compensated to prevent abnormal operation. Circuit designs shall include compensation as is necessary to overcome adverse effects due to temperature in the specified environmental range.

5.9.6 All components including the LEDs shall be de-rated by a minimum of 20% with regard to applied voltage, current, and power dissipation unless otherwise specified such that material shortening of life or shift in values is minimized.

5.10 Sign Cables and Wiring

5.10.1 The Contractor shall provide low voltage (power) and extra low voltage (internal sign control) cables necessary to operate the variable message signs. The low voltage cables shall be sized based on the sign load requirements and the distance to the power supply.

5.10.2 Properly supported cable trays shall be provided for routing all wiring within the sign.

5.10.3 Low voltage (power) cables shall be stranded copper type TWH meeting the requirements of the latest CSA Standard C22.2 No. 75.

5.10.4 Extra low voltage (internal sign control) cables shall be type ELC meeting the requirements of the latest CSA standards C22.2 No. 35.

5.10.5 All cables shall be protected against lightning or over-voltage conditions with appropriate surge protectors. The low voltage circuits shall be protected by MOVs rated at 20 kA with a peak voltage of 350 volts.

5.11 Sign Connectors

5.11.1 Wire connectors shall be of the fork tongue compression type for terminal connections or the insulated wing nut vibration proof spring type for wire-to-wire connections and shall meet the requirements of the latest CSA standard C22.2 No. 65.

5.11.2 The sign case shall include a fibre connector suitable for connecting the interconnecting fibre cable to the VMS controller.

5.11.3 All connectors shall have suitable strain relief and positive retention.

5.12 Sign Grounding Materials

Grounding wire and connectors shall meet the requirements of OPSS 609.

5.13 Sign Driving Circuitry

5.13.1 Driver boards shall be mounted to the back of each display module.

5.13.2 Each driver board shall be uniquely addressable.

5.14 Sign Mounting Hardware

5.14.1 All assemblies within the sign case shall be mounted using shock, vibration and weather resistant hardware.

5.14.2 The sign structure shall be secured to the sign support structure as shown in the Contract Drawings.

5.15 VMS Controller

5.15.1 General

5.15.1.1 The VMS controller shall support the NTCIP functionality and protocols as specified elsewhere in the Contract Documents. Full and exhaustive compliance testing of the NTCIP protocols and functionality shall be required.

5.15.1.2 The VMS controller shall be a microprocessor based unit.

5.15.1.3 A watchdog timer for detecting controller failure and resetting the microprocessor shall be provided.

5.15.1.4 The VMS controller's front panel shall include a keypad and LCD. The device shall be used to perform the following functions with the sign controller and VMS:

a) Monitor the current status of the sign controller, including the status and representation of the message visible on the display face;

b) Perform diagnostics testing of various system components, including pixels, power systems, sensors, and more;

c) Activate messages stored in memory;

d) Configure display parameters, including display size and colors;

e) Configure communications port settings and NTCIP options.

5.15.1.5 The front panel interface shall also include the following:

a) Power switch to turn the controller on and off;

b) LED power "on" indicator;

c) "Local/remote" switch that places the controller in local mode such that it can be controlled from the front panel interface;

d) LED to indicate state of the "local/remote" mode switch;

e) Reset switch to quickly restart the controller.

5.15.1.6 All indicators shall have a +/- 45° cone of visibility with the axis perpendicular to the front panel. All indicators shall be readily visible at a radius of up to 1.22 metres within the cone of visibility.

5.15.1.7 The VMS controller shall be capable of communicating with a local field test computer and centrally located master controller.

5.15.1.8 The VMS controller unit shall support two forms of communication interface: Serial and Ethernet. The controller shall also support a fibre connection to the VMS sign case.

5.15.1.9 The controller communications shall be user selectable.

5.15.1.10 The controller shall have a unique address for communication with the VMS master controller. This address shall be stored in non-volatile memory/solid state disk.

5.15.2 Environmental

The controller shall be capable of operating over the temperature range of -30 to +65 °C.

5.15.3 Electrical Requirements

5.15.3.1 The VMS controller shall operate from a line voltage of 106 to 126 Volts AC and frequency of 60 +/- 0.5 Hertz.

5.15.3.2 The power consumption of the VMS controller, power supply, and permanently connected equipment shall not exceed 250 watts total.

5.15.3.3 All components, when housed in the controller chassis, shall be unaffected by transient voltages normally experienced on commercial power lines.

5.15.3.4 All equipment shall be capable of normal operation following opening and closing of contacts in series with the applied voltage to the cabinet at a rate of 30 openings and closings per minute for a period of 2 minutes in duration.

5.15.3.5 All electrical modules within the controller assembly shall fully comply with local governmental requirements concerning the suppression of unintended radio frequency emissions.

5.15.3.6 All circuits shall be sufficiently protected against stray static electricity so as not to be damaged during normal shipping, handling and operation.

5.15.3.7 The controller shall include appropriately sized lightning protection and surge protection. The protective devices shall be encapsulated hybrid suppressors and shall be bayonet mounted such that replacement can be done without removal of the housing or other equipment. The suppressors shall be EDCO Cat. # PC-642 or approved equal.

5.15.3.8 The general principles of minimizing the effects of voltage surges shall conform to the requirements of IEEE Standard 518-1982.

5.15.3.9 All fuses shall be easily accessible on the front panel unless otherwise specified and shall be replaceable without the use of any tools.

5.15.3.10 Test points shall be provided for monitoring all power supply voltages. All test points shall be readily accessible when equipment is opened in service position and the voltage level to be verified shall be clearly labelled beside the test point.

5.15.3.11 The power supply, if separate from the controller enclosure, shall be EIA rack mountable.

5.15.3.12 The power cable shall be easily detached from the controller for quick removal.

5.15.4 Communications

5.15.4.1 Serial

5.15.4.1.1 The controller shall be provided with two EIA/TIA-232-E serial communications ports for use with a plug-in field computer and for communications with the data modem.

5.15.4.1.2 The serial ports shall use a 9-pin socket connector; ITT DB-9S. The field test computer port shall be on the front face of the enclosure.

5.15.4.1.3 Communications through the serial ports shall be asynchronous in a half-duplex mode.

5.15.4.1.4 The standard baud rate shall be 9600 while allowing the selection of 9600 or 19200.

5.15.4.1.5 It shall be possible to easily switch from full-duplex to half- duplex and vice versa.

5.15.4.2 Ethernet

5.15.4.2.1 The controller shall be provided with one IEEE 802.3u 10/100Base-TX Ethernet port.

5.15.4.2.2 The Ethernet port shall have a RJ-45 female connector. The port shall meet Category 5 specifications and shall be compliant with EIA/TIA-568-B standard pin out.

5.15.4.3 Fibre Interconnect

The controller shall include an optical interface suitable for connecting the interconnecting fibre cable to the VMS sign case.

5.15.5 Storage

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

5.15.5.2 The controller memory shall be capable of storing a minimum of 100 two page messages in non-volatile RAM.

5.15.5.3 The controller shall store a minimum of 100 graphic symbols in non-volatile RAM.

5.15.5.4 The controller shall support a minimum of four fonts and 255 characters shall be burned in the non-volatile memory.

5.15.6 Control of Display

5.15.6.1 The controller shall be able to display messages of up to 75 alphanumeric characters and graphic symbols with colour on the variable message sign as commanded by the VMS controller or from the plug-in terminal.

5.15.6.2 The controller shall have the capability of detecting display on/off state element failures. As a minimum, the following failure modes shall be reported:

a) A complete module fails;

b) A complete column of pixels fails;

c) A complete row of pixels fails;

d) More than 8% of all pixels fail; or

e) One or more of the photosensors fail.

5.15.7 Control of Sign Luminance

5.15.7.1 The controller shall provide means to change the brightness of the display matrix manually or automatically.

5.15.7.2 The manual intensity control will allow the user to select one of at least 15 intensity levels. The brightness shall remain at that level until the user changes the level or sets the controller to automatic mode.

5.15.7.3 The automatic intensity control mode shall monitor the ambient light sensors on the VMS and will use a mathematical algorithm to automatically select one of the 15 or more intensity levels.

5.15.7.4 The 15 automatic intensity control levels shall have five (5) ranges controlled by the prevailing outdoor illumination levels and software, and a minimum of three (3) levels within each of the five (5) ranges selected on the basis of message importance.

5.15.7.5 Sensing of ambient light levels shall be through the three VMS photosensors connected through an analogue to digital converter card using separate channels. The analogue-to-digital converter shall have a minimum resolution of eight bits and a multiplexer of four channels.

5.15.7.6 The controller shall be equipped with pulse width modulation (PWM) circuitry with the peak current not exceeding the de-rated forward current recommended by the LED manufacturer for the specified LED cluster and as further constrained by the life cycle and MTBF requirements specified elsewhere in this specification.

5.15.7.7 In the case of a critical photosensor system failure, the light output of the sign display elements shall be defaulted to the night range setting. Failure notification of photosensor failure, both locally and at central, shall, if the sensor is not a single unit, indicate which photosensor has failed.

5.15.8 Controller Software

The software for the VMS controller shall meet all of the functional requirements specified elsewhere in the Contract Documents.

5.15.9 Physical and Mechanical Requirements

5.15.9.1 The dimensions of the complete controller, including the power supply and all connectors, shall not exceed 775 mm high, 480 mm wide, and 530 mm deep.

5.15.9.2 The controller shall be EIA 480 mm rack mountable.

5.15.9.3 There shall be no serviceable parts within the controller.

5.15.9.4 All connectors shall be keyed to prevent accidental insertion of the wrong connector;

5.15.9.5 The design life of the controller and its components, under 24 hours a day operating conditions in their circuit application, shall not be less than ten years.

5.15.9.6 No internal item, component or subassembly shall emit a noise level exceeding the specification outlined by CSA C108.8-M1983.

5.15.9.7 All aluminum components shall be anodized. The anodic coating shall have a minimum thickness of 0.178 mm and a minimum coating weight of 42 grams per square metre. Prior to the anodic coating, the component shall be cleaned and etched.

5.15.9.8 The manufacturer's name or logo, model number, serial number, and circuit issue or revision number shall appear and be readily visible on all items supplied. All serial numbers shall be at least 3 mm in height and shall be either etched or engraved on all items supplied.

5.15.9.9 Different components of the controller equipment including all the wires, connectors, control LEDs, switches, etc. shall be identified with labels of engraved lamacoid or with permanent transfers. The identifiers shall correspond to the labels used in the equipment documentation and maintenance material.

5.16 Sign to Controller Interconnect Wiring

5.16.1 All interconnecting cables between the controller and the sign shall be fibre optic outdoor rated for installation in underground ducts or aerial on messenger cable. The cable shall include the number of fibres required for communication between VMS and the VMS controller plus two spare fibres. A tracer wire shall be provided either integral to the cable or external.

5.16.2 The fibre connectors shall match interface requirements. The spare pair of fibres shall be terminated on each panel in the sign case and controller cabinet with appropriate patch cords.

5.16.3 There shall be appropriate electronics to enable a laptop connection to the ground control cabinet's controller from within the sign case.

6. EQUIPMENT – Not Used

7. CONSTRUCTION

7.1 Timing of Work

7.1.1 The Contractor shall ensure that sign controller units are installed, tested and ready for operation before installing the variable message signs.

7.1.2 All installation work shall be carried during permitted times for lane closures as specified elsewhere in the Contract.

7.1.3 The Contractor shall coordinate communication and central software configurations with the Owner. At least one month notice shall be provided by the Contractor to allow for any configuration work required by the Owner.

7.2 Sign Installation

7.2.1 The requirements of OPSS 915 shall apply to this work.

7.2.2 All mechanical hardware for initial attachment shall be attached and secured prior to the reopening of lanes to traffic. Attachment of all hardware shall be completed prior to the release of crane cables.

7.3 Controller Installation

7.3.1 The controller shall be installed in the designated space in the field cabinet in locations as indicated in the Contract Drawings.

7.3.2 Only Robertson head or combination of Robertson and slot head screws shall be used for mounting assemblies on the controller cabinet rack. Slotted thumbscrews may also be used for assembly mounting. All screw type fasteners shall utilize locking devices or locking compounds. All screws, nuts, and washers accessible to the maintenance staff shall be made of stainless steel.

7.3.3 All protective devices such as lightning arresters and surge protectors shall be mounted external to the VMS controller enclosure but within the cabinet.

7.3.4 All mounting hardware and wire connections shall be easily accessible and removable with hand tools.

7.3.5 The front panel and chassis shall be connected to the cabinet ground bus from a single point only.

7.4 Installation of Sign to Controller Interconnect Cables

7.4.1 The Contractor shall complete all wiring between the VMS sign case and VMS controller. The interconnect power and communications cables shall be installed in liquid tight conduit in inconspicuous locations, between the nipples on the sign support and the sign case. The interconnecting cables shall use the sign support beams and legs as raceways and shall be installed in continuous, unspliced lengths between the sign case and the controller cabinet. Sufficient slack shall be left to ensure that the connection to the power source will be possible without the need to add or splice any cables. Cables and connectors shall not be stressed during or after installation.

7.4.2 All fibre optic control cables shall be properly terminated on industry standard termination panels within the sign case and field cabinet with fibre optic patch cords used between the panel and all control equipment.

7.4.3 All fibre optic interconnection cables shall not exceed the minimum bending radius specified by the manufacturer.

7.4.4 All interconnection cables shall be installed inside two (2) ducts connecting the cabinet pad and the sign footing (see Contract Drawings).

7.4.5 Low-voltage cables and fibre optic cables installed in the cabinet shall be routed on opposite sides of the cabinet and shall not be routed parallel to other low-voltage cables.

7.4.6 All electrical installations shall meet the requirements of Ontario Electrical Safety Code.

7.5 Pre-delivery Repair

The procedures listed below shall be followed in the repair of equipment before shipment:

7.5.1 Any defects or deficiencies found by the inspection system involving mechanical structure or wiring shall be fed back through the manufacturing process or special repair process for correction.

7.5.2 Defects in printed circuit boards or electronic circuit components shall be specially treated as follows:

a) A printed circuit board may be flow soldered a second time if copper runs and joints are not satisfactorily coated on the first run;

b) Under no circumstances shall a printed circuit board be flow soldered more than twice;

c) Hand soldering may be used for printed circuit repair;

d) A printed circuit board may be factory repaired not more than two times during the warranty period. A third failure shall result in replacement of the printed circuit board. A circuit board whose components or printed conductor become damaged during factory repair shall also be replaced by a new board; and

e) All factory repairs shall be described in detail on a form to be furnished by the Contract Administrator. The completed form shall be returned together with the repaired unit.

7.6 Quality Control

The Contractor is responsible for all testing and documentation required to establish approval and acceptance of installation and operation of this equipment. The framework of the approval process shall be as specified elsewhere in the Contract Documents.

The following table details the clauses within this Special Provision, which are to be validated through the PIT, POP, and SIT processes as indicated:

Clause	PIT	POP	SIT
4.2.3.2	√		
4.2.4.1	√ [1]		
5.2.3	√		
5.2.4	√		
5.2.11	√ [2]		
5.3.3	√		
5.3.5	√ [3]		
5.3.7	√		
5.5.1	√		
5.5.3	√	√	
5.5.4	√	√	
5.6.1.2	√		
5.6.1.3	√		

Clause	PIT	POP	SIT
5.6.1.4	√		
5.6.1.5	√ [3]		
5.6.1.6	√		
5.6.1.7	√		
5.6.1.8	√		
5.6.1.10	√ [4]	√ [4]	
5.6.1.11		√ [4]	
5.6.1.12		√	
5.6.2.2	√ [5]		
5.6.2.3	√		
5.6.3.1	√ [3]		
5.6.3.2	√		
5.6.3.5	√ [6,7,8]	√ [7,8]	
5.6.3.6	√		
5.6.3.7	√		
5.6.3.8	√ [9]		
5.6.3.9	√		
5.6.4.2	√		
5.6.5	√ [10]		
5.6.6	√	√	
5.8.4	√ [16]		
5.8.5	√ [11]		
5.9.2	√		
5.10.5	√	√	
5.15.1.1	√		
5.15.1.4	√		
5.15.1.5	√		
5.15.1.7	√ [12]	√ [12]	√ [12]
5.15.1.8	√ [13]	√ [13]	
5.15.1.9	√		
5.15.2	√ [14]		
5.15.3.2	√		
5.15.3.4	√ [15]		
5.15.4.1.1	√		

Clause	PIT	POP	SIT
5.15.4.1.4	√	√	√
5.15.4.1.5	√		
5.15.4.2.1	√	√	√
5.15.5.1	√		
5.15.5.2	√		
5.15.5.3	√		
5.15.5.4	√		
5.15.6.1	√ [17]	√ [17]	√ [17]
5.15.6.2	√ [16]		
5.15.7.2	√	√	
5.15.7.3	√	√	
5.15.7.7	√		
5.16.3	√	√	

Testing Footnotes:

[1]

i) Each prototype shall exhibit dimming functions as specified for the full size sign.

ii) Each prototype shall be equipped with a polycarbonate sheet cover including the intended aperture mask.

iii) Each prototype shall display the following test patterns:

a) All elements on;
b) Activation of alternate rows;
c) Letters A-to-Z and numerals 0 to 9; and
d) All elements off.

iv) The Contractor shall demonstrate to the Contract Administrator that the legibility distance, viewing angles, pixel intensity, dimming, spacing between pixels, uniformity of pixel intensity and contrast ratios, as defined in this Special Provision, are met.

v) All equipment shall continue normal operation when subjected to the low temperature test: With the item functioning at a line voltage of 106 VAC for all items in its intended operation, the ambient temperature shall be lowered from 20 °C to the minimum temperature defined for the sign case and controller at a rate of not more than 18 °C per hour. The item shall be cycled at this temperature for a period of five (5) hours and then returned to 20 °C at the same rate. The test shall be repeated with a line voltage of 126 VAC.

vi) All equipment shall continue normal operation when subjected to the high temperature test: With the item functioning at a line voltage of 106 VAC in its intended operation, the ambient temperature shall be raised from 20 °C to the maximum temperature defined for the sign case and controller at a rate of no more than 18 °C per hour. The item shall be cycled at this temperature

for five (5) hours and then returned to 20 °C at the same rate. The test shall be repeated with the line voltage of 126 VAC.

2 The Contractor shall demonstrate that the sign case shall suffer no coating loss by the following method: Two samples of 100 mm x 200 mm, made of the same material and coating as the sign case supplied, shall be used for the test. Two 225 mm diagonal scratches exposing bare metal will be made on a sample. It will be soaked in de-mineralized water for 192 hours. A 25 mm strip of masking tape shall be tightly affixed to this surface and removed with one quick motion; evidence of blistering, softening or peeling of the paint and/or coating from the base metal shall be cause for rejection.

3 Subjective assessment of colour uniformity.

4 Visibility tests including test drives during day and night conditions to verify the legibility distance. Testing at dawn or sunset will be required depending on site location. Pixel luminance shall vary automatically during the tests and be supplemented with manual input.

5 All the display modules shall be turned on and off several times to demonstrate that all driving circuitry and/or multiplexing circuitry is functional.

6 Demonstration of all pixels activated/deactivated in alternating mode using a checkerboard test pattern for 30 minutes minimum.

7 Demonstration of operation with the VMS controller, including demonstration of the use of all software commands capable of controlling the pixels on/off state.

8 Continuous operation over 168 hours using a message display change every 15 minutes. Any pixel failures during this test will require satisfactory repeat of the complete test. Demonstration of various pixel luminance levels, set and operating in accordance with the specifications, is required. The sign case shall not be covered during this operation.

9 The LED pixels shall be tested to ensure suitability for the application. As a minimum, the LED pixels shall pass the following test:

a) A random sample of not less than 200 pixels shall be activated continuously at the brightest design output level at the predicted maximum temperature adjacent to LED pixels inside the sign case. The duration of the test shall be sufficient to verify satisfactory operation of all pixels to simulate a total pixel operation of not less than 150,000 hours. The test shall be considered as failed upon any single failure of the pixel in the test sample.

b) Prior to the manufacturing of the sign, the Contractor shall provide proof of certified testing by the manufacturer or conduct the above test to the satisfaction of the Contract Administrator. The Contractor is responsible for any re-test or design modification of the pixel to satisfy the above test criteria.

10 Downloading of messages with and without graphic symbols shall be carried out using all variations of attributes or other variables. Recovery of all messages and graphic symbols from the appropriate memory slots shall be demonstrated at least three (3) times.

11 Demonstration of the maximum internal sign case temperature for proper operation of the equipment inside the sign case. Measurements shall be conducted with the sign displaying a test pattern defined by the Contract Administrator. A minimum of 10 test points identified by the Contract Administrator

shall be measured. The temperature shall be measured when the internal environment of the sign case reaches a steady state. The maximum internal sign case temperature shall be verified with respect to the specification with necessary adjustment for the worst-case ambient conditions. If the maximum internal sign case temperature as identified in the test exceeds the predicted temperature as identified in the specification, the test for pixels as specified in the specification shall be repeated to verify that the reliability requirements of the pixels are met. The Contractor is responsible for any re-test or design modification to satisfy the test criteria.

12 The Contractor shall demonstrate proper controller operation with the communication subsystem and master controller by downloading and uploading the message library and by demonstrating that all software commands, as embedded in the communications protocol, are functional. The field test computer may be used for master emulation. The Owner shall provide the simulated central software for the purpose of testing. A laptop shall be used to initiate all commands required in the software specifications. The controller must respond correctly within 30 seconds of issuing the command and must transmit the correct reply. All commands shall be held for a minimum of 15 minutes.

13 The controller, when subjected to a loss of communication, shall resume operation with the VMS displaying a blank message.

14 All controller environmental tests to be carried out by the Contractor shall employ the services of an accredited testing laboratory in compliance with ISO/IEC 17025 (general requirements for competence of testing and calibration laboratories) Standards Council of Canada. The controller unit shall be submitted to a low temperature test by cooling to -10 °C for 24 hours and then demonstrating reaction to commands as in tests above. The controller unit shall then be de-energized for 30 minutes and then re-powered and the tests performed again.

15 The controller, when subjected to a loss of power, shall resume operation with the VMS displaying a blank message.

16 All subassemblies (including all electronic components mounted in the sign) shall be environmentally tested for a minimum of 24 hours by cycling over the full operating temperature range of the equipment prior to installation in the signs.

17 The Contractor shall demonstrate that the controller unit turns all sign display modules on and off by calling up test patterns from the local field test computer and central master controller.

8. QUALITY ASSURANCE

The Owner or Contract Administrator shall be provided the opportunity to perform quality assurance testing including, but not be limited to, the following:

a) Tests of sign display visibility under various ambient conditions;

b) Measurement of pixel luminance;

c) Testing of maintenance accessibility features;

d) Testing of redundancy features;

e) Testing of trial messages by transmission from the VMS Master Controller;

f) Systems integration tests with the Communications and VMS Master Controller subsystems;

g) Quality inspection of all fabricated items;

h) Testing on site with a field test computer (locally).

9. MEASUREMENT FOR PAYMENT

Measurement for payment of the number of variable message signs is by Plan Quantity.

The unit of measurement is each.

10. BASIS OF PAYMENT

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment and Materials required to do the work including manufacturing, delivery, installation, testing and the production of all drawings, text and test results, except for SIT which is paid for under a separate item.