
TII492 Intelligent Transport Systems (ITS) Equipment Supply and Installation Framework

Volume A: Works Requirements

Part 3: Technical Specifications

Section 1: Variable Message Sign

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1. INTRODUCTION

1.1 Introduction

This document sets out the technical requirements for the supply, installation, testing and commissioning of Variable Message Signs (VMS), which shall be installed on new or existing cantilever or portal gantries and straight pole structures on the road network.

The Contractor shall supply and install VMS in accordance with this specification.

The Contractor shall test and commission VMS signage in accordance with this specification and Volume A - Part 4: Testing and Commissioning Specification.

The installed VMS shall facilitate the display of information transmitted by the MOCC such as journey times, accident information, event information and safety and warning messages.

This specification outlines the following for the VMS display equipment:

- Scope of Works;
- Signage Requirements;
- Design Requirements;
- Supply Requirements; and,
- Install Requirements.

All VMS shall be high-resolution with full colour RGB, free format matrix and shall allow different variations of display configurations

1.2 Scope of Works

The scope of works includes but is not limited to the following:

- The Contractor shall design VMS display equipment in accordance with the requirements of this specification.
- The Contractor shall supply and install VMS display equipment including Large Urban Sign, Small Urban Sign, Tactical Sign and Strategic Sign on existing and new structures, including all necessary mounting bracketry, power connections and communications interfaces in accordance with the requirements of this specification.
- The Contractor shall provide software to facilitate the maintenance and configuration of the parameters of the VMS. Provision of training to the TII Equipment Maintenance Contractor should be included.
- Removal and disposal of existing VMS currently mounted on the gantries on which the new VMS are to be mounted may be included in the works. If the call off includes for the removal of existing equipment, the Contractor shall remove and dismantle the specified equipment, make the equipment available to the TII Equipment Maintenance Contractor for harvesting of spares at a location in the Republic of Ireland and dispose of all removed equipment that the Employer advises cannot be harvested for spares.

- The Contractor shall facilitate and support the integration of the VMS within the MOCC operating systems including Network Intelligence and Management System (NIMS), Asset and Fault Management System (AFMS) and other Associated Services including communication links.

All works carried out under this Contract shall comply with the recommendations and requirements set out in the current edition of the following:

- EN 12966 Standards Publication for Variable Message Signs (VMS);
- Environmental Tests for Motorway Communications Equipment and Portable and
- Permanent Road Traffic Control Equipment TR2130;
- Safety, Health and Welfare at Work (Construction) Regulations 2013;
- Safety, Health and Welfare at Work (General Application) Regulations 2007;
- All appropriate European Union (EU) Health and Safety legislation;
- EU Waste Electrical and Electronic Equipment Regulations 2014;
- All publications as detailed within these requirements;
- DN-ITS-03029 Traffic Control and Communications Infrastructure Design;
- DN-ITS-03037 The Use of Variable Message Signs on All-Purpose and Motorway Roads;
- DN-ITS-03021 - VMS Standard;
- DN-TSM-03083 - VMS Policy; and
- DN-TSM-03084 - VMS Messaging Guidelines.

2. SIGNAGE REQUIREMENTS

2.1 General Requirements

The VMS display equipment shall consist of a display panel, with associated equipment and an outstation controller or integrated controller unit.

The purpose of the VMS display equipment is to contribute to the safe and efficient use of the road by providing clear and concise information to the motorists in a reliable and consistent manner.

The Contractor shall ensure that all equipment supplied has a design life of not less than 15 years within the motorway/road environment. The supplier shall provide warranties ensuring that spares will be available for a period of 10 years.

The Contractor shall be responsible for the installation of all equipment, mounting arrangements and power supply equipment.

The Contractor shall ensure that all the interfaces and elements used throughout shall comply with the current industry standards for VMS.

The Contractor shall ensure that the VMS display equipment complies with the requirements of relevant European Directives and Irish legislation, in particular those related to Product Liability, Safety, Electro Magnetic Compatibility, Waste Management and Restrictions on the use of Hazardous Substances, current at the Contract Date.

All VMS display equipment supplied under this Contract shall comply with the requirements and recommendations set out in current editions of the various standards and publications referenced in this specification. Where there is any conflict between Irish and other standards, the Irish standards shall take precedence.

All structural design and installation works associated with the supply of VMS display equipment supporting structures and enclosures shall comply with CC-SCD-01822 to 01831, DN-STR-03010 Portal and Cantilever Sign/Signal Gantries, Eurocodes and other relevant standards.

The Contractor shall submit all technical literature, information and documentation for VMS display equipment prior to substantial completion of the Works.

2.2 Design

2.2.1 Dimensions

The supplied VMS sign dimensions shall adhere to the dimensions stated in the current edition of DN-ITS-03021 - VMS Standard to ensure seamless integration onto the existing and new structures. VMS of other types and dimensions may be purchased under this Lot.

2.2.2 Optical Functional and Non-Functional Requirements

The VMS display panel shall be capable of receiving and actioning commands from the VMS controller or engineering terminal which are issued remotely or locally. Predefined messages (bitmaps) provided by MOCC shall be stored in the sign controller. The VMS installation shall facilitate efficient and organised regular maintenance conducted by competent personnel to prevent any issues including, but not limited to, blank spots, hardware faults, or damage that could affect the display of the sign. The VMS shall monitor and report any fault arising and being cleared, to the outstation controller or embedded/integrated controller unit. The controller shall transmit such fault status to the Associated Services.

The VMS display equipment shall be compatible with the electrical, communications and structural interfaces provided and shall be supplied new and manufactured from new components and materials.

The VMS display equipment shall be designed in accordance with the latest adopted version of EN 12966 Standards Publication for VMS.

The VMS display equipment must be designed in accordance with European Committee for Electrotechnical Standardisation (CENELEC) EN 50293:2012.

Removal or failure of any LED module shall not affect the operation of any other LED module or sign component or the structural integrity of any part of the VMS display equipment.

The VMS display panel shall be a matrix with full colour capability and shall be comprised of LEDs that shall be capable of displaying red, green, blue, white or amber colour.

The VMS array can be based on a continuous matrix with a display cell pitch of 20mm, but a compliant alternative will not be precluded.

The VMS display panel LED pixels shall have colour performance in accordance with the latest EN 12966 Standards Publication for VMS.

Under all conditions, the VMS display panel LED pixels shall have a uniform colour balance and be maintained at all luminance levels when different colours are on at the same time, in order to avoid a blooming effect.

Under all conditions, the VMS display panel shall emit the respective wavelength of light as specified in the performance classes within this specification.

Under all conditions, the various VMS display panel LED bins shall be distributed evenly throughout the sign display and shall be consistent from pixel to pixel. Random distribution of the LED bins shall not be permitted.

Under all conditions, the VMS display panel LED display face shall have colour uniformity and consistency as specified in EN 12966.

The VMS display panel matrix shall display continuous, uniform and unbroken messages visible to all motorists as specified in EN 12966.

The VMS display panel character sets, fonts, size and minimum dimensions shall be in accordance with the latest version of Traffic Signs Manual and EN 12966 for Size Range D and Size Range E.

The VMS display panel shall be capable of displaying the following, when requested by the VMS controller or the engineering terminal, depending upon the operation:

- Text messages using a proportional font;
- Speed Aspects (advisory or mandatory);
- Pictograms (e.g. roadworks symbol) with or without supporting text messages or additional text content;
- Legends, with or without additional text content; and,
- Combinations of the above, (together with/without virtual flashing lanterns).

Flashing of all or part of the message shall be possible.

The VMS display panel shall be capable of displaying virtual flashing lanterns, as well as seamlessly accommodate the incorporation of physical lanterns.

It shall be possible to enable any combination of virtual flashing lanterns settings and also to set all or no displays with virtual flashing lanterns.

Virtual flashing lanterns shall be positioned symmetrically around the VMS display panel.

The Contractor shall undertake design calculations for the optimal dimensions of the VMS display equipment and shall submit details to the Employer's Representative for review.

The VMS display equipment shall be equipped with an Ambient Light Monitoring (ALM) unit or Light Sensor unit to measure the external illumination from all directions and to provide signal inputs to the embedded/integrated or outstation VMS controller to adjust the display intensity. The display intensity shall also be adjustable using commands sent from Associated Services.

Adjustment of display intensity shall compensate for all lighting conditions including direct sunlight and darkness.

The display intensity of the VMS display panel shall vary in accordance with the ambient light level but shall have the option to be overridden by the MOCC operator.

All parts of the VMS display equipment shall be designed and manufactured in a modular fashion to facilitate simple maintenance and enhancement activities.

All parts shall be manufactured from suitable non-corrodible material. The arrangements for the VMS shall provide protection against bimetallic corrosion at the contact points with the gantry or cantilever structure.

All side and rear facing surfaces of the VMS display equipment shall be Grey 18B21 BS4800 (non-reflective) to achieve the required design life and/or reduce solar gain.

All front facing surface of the display equipment shall be matte black in colour.

All unpainted surfaces of the VMS display equipment shall be dulled.

All VMS display equipment finishes shall give a high-quality consistent appearance and retain their colour for the design life of the equipment.

The VMS display equipment shall be capable of being fully maintained and repaired safely whilst remaining installed on its mounting structure i.e., gantry or cantilever, without the need for lane closures. The Contractor shall confirm proposed VMS can fit on the allocation frame structure on gantry whilst ensuring that maintenance doors of the proposed sign can be opened unimpeded from inside the gantry.

The Contractor shall ensure that the VMS shall be equipped with doors that provide access to all components of the VMS for maintenance purposes and be fitted with automatic hold open stays locking at their opening limit.

The VMS and associated mounting arrangements shall provide the facility to provide the necessary visibility of the sign from the appropriate positions on the approach road.

VMS shall be positioned in locations which maximise visibility both optically (optimising height and viewing angles) and logically (preceding important journey decision points)."

For curved approaches, the VMS must be aligned to ensure:

- at the maximum reading distance, the inside edge of the curve is within the cone of visibility

- approaching the VMS, the outside edge of the curve remains within the cone of visibility for as long as possible.

The Contractor shall refer to EN 12966 section N.4.3 for further guidance.

2.3 Performance Requirements

All VMS display equipment shall meet the minimum requirements of European Harmonised Standards EN 12966 in the performance classes specified in Table 1 below:

Table 1 EN 12966 Performance Classes

EN 12966 Performance Classes		
Visual Performance	Colour	C2
	Luminance (La)	L3
	Luminance Ratio (LR)	R3
	Beam Width	B3
Physical Performance	Temperature	T1
	Ingress Protection	IP56
	Corrosion	D2/SP2
	Temporary deflections caused by wind load	WL8
	Temporary deflections caused by bending	TDB1
	Permanent deflections caused by Dynamic Snow Load	DSL4

The mean time between failure of a single LED pixel shall not be less than 100,000 hours at the brightest level and with all the display elements activated at the rated light output level for the maximum design output for the sign operations at an outside air temperature of 25°C and a relative humidity range of 50% to 100%.

Each sign shall consist of an aluminium enclosure with a front face configuration capable of displaying combinations of text or pictograms in conformance with these specifications.

The set of pictograms and characters shall conform to the Department of Transportation Traffic Signs Manual and be confirmed by the Employer’s Representative in each case. It shall be possible to download new pictograms to the VMS controller from the MOCC computer system.

The face of the VMS shall be constructed with a continuous matrix of full colour RGB LEDs.

The position of text and pictograms shall be configured in the VMS controller and shall be changeable at the controller. The initial settings for the display positions of text and pictograms shall be defined by the Employer.

Strategic VMS shall be provided with a 200mm diameter yellow flasher, constructed from LED pixels, at each corner of the sign. These flashers shall be outside the active matrix area. The area of LED

pixels forming the flasher shall be capable of flashing depending on the text or pictogram displayed and shall be capable of operating in conjunction with a blank message.

The minimum character spacing and minimum line spacing shall be as defined in EN 12966 Annex D Table D.1 and TII VMS Message Guidelines

The active display area of all signs shall be formed from pixels with a minimum pixel pitch of 20mm and a maximum pixel pitch of 25mm with the exception of signs with character height of 320mm and 400mm, where the Contractor shall propose the pixel array to support the standard 7 x 5 character font. The preferred pixel pitch selected by the tenderer shall remain constant throughout the sign.

The VMS display equipment shall maintain its optical performance characteristics to the stated performance classes of the latest EN 12966 Standards Publication for VMS, over the expected operational life, based on an anticipated minimum overall daily 33% duty cycle.

The VMS display panel shall provide a display which is free from reflections from likely external light sources (e.g. vehicle headlamps; street lighting).

The VMS display panel shall be clearly legible from all lanes of the motorway from distances as defined in EN 12966 at all times and under all lighting conditions. The Contractor shall undertake the calculation to confirm the final legibility distances as per EN12966.

The VMS display panel shall meet the performance classes of the latest EN 12966 Standards Publication for VMS for all defined colours.

All VMS display panels installed shall be capable of receiving commands from the VMS controller, or from an operator connected remotely and locally for the setting of Aspect/ Text Message/ Pictograms/Legend displays, with any associated lanterns displays, at a frequency of every five seconds.

All VMS display panels shall be capable of performing all background testing and monitoring procedures constantly to enable all control source messages to be responded correctly.

All VMS display panels shall be capable of responding to requests from Ambient Light Monitor (ALM) unit at a maximum frequency of once every five seconds.

All VMS display equipment shall be capable of achieving the requirements set out in this document, with a minimum of 60% spare capacity in both processor cycles and memory, to allow for future upgrades.

The VMS display equipment shall not radiate electromagnetic signals that affect other electronic devices.

The performance of VMS display equipment shall not be affected by any presence of ambient radio signals and magnetic or electromagnetic interference.

Under all conditions, the VMS display panel LED shall have a minimum lifetime of 100,000 hours while maintaining 70% of their original brightness.

All equipment supplied shall have a Mean Time Between Failures (MTBF) in excess of four years.

VMS display equipment components shall operate at a minimum temperature of -15°C to +60°C and at a relative humidity of 0 to 95%, non-condensing.

2.4 VMS Controller

VMS devices that shall be supplied and installed under this Contract shall have one of the following controller options.

1. VMS Outstations Controller; or
2. Integrated VMS Controller

The controllers of the VMS shall comply with the requirements per EN12966, IRC, CE and NTCIP Standards.

All software, controllers, devices etc shall be the latest proven commercially available version for any given product.

The controllers, servers and workstations shall communicate natively via TCP/IP protocol. The system shall be designed, supplied, installed and commissioned to achieve energy efficient control and monitoring of the VMS and other sub-systems where nominated.

TCP/IP communications between all parts of the system shall be designed in such a way as to ensure that elements of the system do not have to be collocated within a single subnet (e.g. no requirement for a single broadcast domain).

2.4.1 General Functional Requirements

The Contractor shall comply with all the requirements of this chapter for an outstation controller or an integrated controller.

The VMS display equipment shall switch off displays when performance falls below the requirements in this specification.

The VMS controller shall comply with the requirements of this specification.

The VMS controller shall support at least 3 access levels in addition to the administrator from the NIMS.

The VMS controller shall store the following as a minimum:

- at least 2 changeable and 32 permanent pre-defined messages;
- at least 128 volatile messages;
- up to 100 pictograms each with a unique code;
- at least 1,000 events in the event log file;
- schedules and;
- other necessary files for controller operation.

The VMS controller shall have the capability of receiving transmitted files from Associated Services that update the files stored in the VMS controller.

The VMS controller shall have the capability of displaying any combination of stored pre-defined messages and pictograms on the VMS display panel.

Messages that have to be displayed on the VMS display panel and the codes to implement pictograms shall be transmitted by the Associated Services in accordance with the communication requirements.

The VMS controller shall have a front panel user interface graphical LCD and keypad/keyboard for direct operation and diagnostics. The functionality of the front panel may be provided via laptop

(engineer's terminal) as an option. All required software to configure and maintain the VMS and essential training shall be provided.

The access to the VMS controller front panel user interface graphical LCD and keypad/keyboard, where available, shall be password protected.

The full range of functionality available through the VMS controller front panel user interface graphical LCD and keypad/keyboard shall also be available via diagnostics software available for installation on a maintenance laptop (engineer's terminal) and connected to the maintenance port on the VMS controller or remotely via the communications network.

The VMS controller shall:

- Be capable of monitoring the status of the sign controller, including the status of all sensors and provide an RGB representation of the message visible on the VMS display panel.
- Be capable of performing diagnostics testing of various system components, including pixels, power systems and sensors and also manage messages that are stored in memory.
- Be capable of blanking the VMS display panel and starting and stopping the schedule.
- Have an internal clock and shall use Network Time Protocol (NTP) protocol to synchronise the time and date with Associated Services.
- Be capable of implementing messages on VMS display panels on a time-based schedule determined by the Associated Services.
- Be capable of configuring VMS display panel parameters, including display size and colour technology and brightness mode.
- Be capable of configuring communications and NTCIP settings.
- Have a minimum of two NTCIP compliant Ethernet ports with RJ45 connectors. These ports shall be used to connect to the communication switch and to one local engineer's terminal to facilitate software updates and communication with the NIMS instation.
- Have a power switch to turn the controller on and off and an LED "on" indicator.
- Have a local/remote switch with an LED indicator that places the controller in local mode such that it can be controlled from the front panel user interface graphical LCD and keypad/keyboard and/or local engineer's terminal instead of via the primary communications channel.
- Have a reset switch to quickly restart the controller, or an additional circuit with a switch performs the same function.
- Have an LED "Active" indicator that blinks when the controller is operating.
- Have an LED to indicate when any of the NTCIP communications channels are active.
- Have the capability to play volatile messages.
- Contain VMS-specific control firmware (embedded software) that monitors all external and internal sensors and communication inputs.

The VMS controller control firmware shall control the display modules as directed by the Associated Services and the front panel interface.

The VMS controller shall control the messages displayed on VMS display panel which must be either:

- Static Messages;
- Flashing Messages;
- Alternating Messages; and,
- Multiple Page Message.

The VMS controller shall set the messages displayed on the VMS display panel by one of the following ways:

- By a command issued automatically by Associated Services;
- By a command issued by an operator through the Associated Services user interface;
- By a command issued by an operator through the local communication interface on the VMS controller; and,
- Pre-set messages; those are displayed in certain events, such as communication failure with Associated Services.

The VMS controller shall provide confirmation to the Associated Services that a message or command was received correctly.

The message shall remain on the VMS display panel until the VMS controller receives a command to change the message or blank the sign or/and the message is amended from the engineering terminal.

The VMS controller shall support as a minimum, the ability to display alpha numeric characters (letters and numbers), punctuation and different character font styles.

The VMS controller shall support as a minimum, the ability to align the displayed text horizontally and vertically.

The VMS controller shall support as a minimum, the ability to adjust the spacing of messages horizontally or vertically.

The VMS controller shall support as a minimum, the ability to display a multiple page message and alternate between pages.

The VMS controller shall support the ability to display messages and graphics of any size up to the size of the entire VMS display matrix.

The Contractor shall provide the VMS controller with all the symbols and fonts pre-installed. The VMS controller shall support changing or replacing these from the Associated Services.

The VMS controller shall be capable of receiving and displaying any bitmap from the Associated Services.

The VMS controller shall select the brightness mode of operation. The brightness of the VMS display panels shall be controlled by ambient light over a minimum of 16 light levels with 16 being the highest light level.

The VMS controller shall monitor the ALM units constantly and adjust the LED to the level of display matrix intensity so the message on the VMS display panel is legible.

The VMS controller shall set the VMS display to a default minimum light level in case of any faults with the ALM.

The VMS controller shall automatically shut down the VMS display panel LED modules to prevent damage to the LED if the measured on-board temperature exceeds a maximum threshold temperature.

The maximum on-board threshold temperature shall be configurable and shall have a default factory setting.

The VMS controller shall be capable of automatically informing Associated Services if a fault arises or being cleared, or failure occurs on VMS display equipment components and systems.

The VMS controller shall detect failures in the communications link with the Associated Services or failure of the Associated Services itself and shall maintain the message displayed on the VMS display panel for a pre-set duration after which the VMS display panel shall default to a blank state if the failure has not been resolved.

The VMS controller shall enable the adjustment of the pre-set duration after which the VMS display panels shall default to a blank state if a failure has not been resolved.

Each VMS controller shall connect up to two VMS display panels. The first VMS display panel is typically located within 25m of the VMS controller and the second VMS display panel can be located up to 250m from the VMS controller. Full Span gantries with VMS display panels on both sides require one VMS controller.

The VMS controller shall be capable of controlling the VMS display panels connected to it individually or as a group. A group shall be a collection of signs that can be set together at the same time with the same or different messages.

The VMS controller shall perform the safe changing of the speed aspect by sequencing the change from the current speed limit, by a pre-set speed value step change for a pre-set duration (e.g. increase/decrease 20kph every 6 seconds), until the required speed limit is displayed.

The VMS controller shall enable the adjustment of the pre-set speed value step change and pre-set duration sequencing parameters to enable the safe changing of the speed limit.

The VMS controller shall provide confirmation to the Associated Services that the safe changing of the speed aspect was implemented correctly.

The VMS controller shall support all flash on times from 5 tenths of a second to 100 tenths of a second in 5 tenths of a second increments for all virtual flashing lanterns.

2.4.1.1 Performance Requirements

All VMS controller components shall operate at a minimum temperature of -15°C to +60°C and at a relative humidity of 0 to 95%, non-condensing.

2.4.2 Sign Controller Requirements

The VMS shall be provided with a facility to connect a laptop computer loaded with diagnostic software to the sign controller to perform the following functions with the sign controller and VMS:

- a) Monitor the current status of the sign controller, including the status of all sensors and a what-you-see-is-what-you-get (WYSIWYG) representation of the message visible on the display face.
- b) Perform diagnostics testing of various system components, including pixels, power systems, sensors, etc.
- c) Activate messages stored in memory.

- d) Configure display parameters, including display size and colours.
- e) Configure communications port settings and NTCIP options.
- f) The user control panel interface shall also include:
 - Power switch to turn the sign controller on and off.
 - LED power “on” indicator.
 - “Local/remote” facility that places the controller in local mode such that it can be controlled from the user interface panel, instead of via the MOCC computer system over the NTCIP communication channel.
 - Prominent visual indicator to indicate state of the “local/remote” mode.
 - Reset switch to quickly restart the controller.
 - LED “Active” indicator that blinks when the controller is operating correctly.
 - LED to indicate when any of the NTCIP communication channels are active.

The sign controller shall have non-volatile electronically changeable memory that can retain data for a minimum of 30 days following a power loss.

The sign controller memory shall be capable of storing a minimum of 100 changeable messages in non-volatile RAM.

The sign controller shall contain a computer-readable clock with a battery backup circuit that will keep the clock operating correctly for at least 5 years without external power and the clock shall automatically adjust for daylight savings time and leap year. The clock shall be set electronically by the sign controller microprocessor and shall be accurate to within one (1) minute per month.

2.4.3 Outstation VMS Controller

The VMS outstation controller shall occupy a maximum rack height of 4U.

2.4.4 Integrated VMS Controller

The integrated VMS Controller shall be complied with CE with the VMS as product as a whole.

2.4.4.1 Transient / Spike Protection

A surge protection device shall be installed to mitigate the indirect and direct effects of lightning or other transient overvoltage and shall comply with the latest IEC 61643-11:2011 and IEC EN 61000 standard.

All microprocessor-based controllers and other electronic equipment such as controllers, personal computers and peripheral equipment and communications equipment, must be capable of withstanding transient disturbances from the input power supply.

Suppressors shall be fitted to all controller input and output points for protection against voltage transients, spikes etc.

The controllers' communication network(s) shall be isolated against transient disturbances via optical couplers or other approved means.

2.4.4.2 Power Supply Tolerances

The equipment supplied shall be suitable for operation on site power supply and the supply voltage and frequency tolerances permitted by the Electricity Supply. Where necessary, each controller shall be served by a dedicated controls transformer or power supply. Failure of any one transformer or

transformer power feed shall not affect more than one controller.

2.5 Ambient Light Monitoring (ALM)

2.5.1 Functional Requirements

The ALM equipment shall incorporate two independent light sensors and be designed to measure the ambient light level in all directions from the vertical to the horizon.

The ALM equipment shall be positioned in accordance with MCX 1007 and must operate independently to detect illuminance from all directions.

The ALM equipment must comply with MCE0110 (Requirements for ALM Equipment).

The ALM equipment shall be designed to prevent the build-up of snow affecting their operation.

The VMS display equipment and flasher luminance shall be determined from the light sensor reading the highest ambient light level.

2.5.2 Performance Requirements

The ALM equipment shall cover the whole range of light levels from full daylight to darkness within their operating ranges, with an accuracy of ± 2 Lux or 5%.

The ALM equipment shall be calibrated to cover the full range of light levels from bright sunlight to darkness with accuracy within ± 2 Lux, $\pm 5\%$.

2.6 Enclosure

2.6.1 Functional Requirements

All equipment installed on structures shall not be affected by the changing weather. Either the enclosure or the components themselves shall provide the weatherproof requirement.

The VMS display enclosure shall be corrosion resistant in accordance with EN 12899-1:2007 and environmentally controlled. The material used shall conform to the European Standards for the appropriate material.

The VMS display enclosure shall protect internal components from rain, ice, dust and corrosion.

All components and or enclosure of the VMS system shall meet the minimum compliance requirements of Category IP 55 or 56, as defined by EN 60529, ensuring adequate protection against dust and water ingress.

The VMS and all associated equipment and enclosures must be IEC 62368-1:2014 listed by accredited safety laboratories and will bear the CE mark on the outside of the VMS display enclosure.

Enclosures manufactured from aluminium or steel shall comply with EN 1090: Execution of steel structures and aluminium structures.

All VMS display enclosures shall be designed to allow dispersal of heat generated during operation.

2.6.2 Performance Requirements

The enclosure system shall keep the VMS display enclosure internal air temperature lower than $+60^{\circ}\text{C}$, when the outdoor ambient temperature is $+46^{\circ}\text{C}$ or less.

VMS enclosures shall be designed to retain full structural integrity for 30 years without maintenance.

VMS enclosures shall comply with class WL8 in EN 12899-1.

The deflection class for the enclosures due to temporary loads shall be TDB1 in accordance with EN 12899-1.

The deflection class for the enclosures due to dynamic snow loads shall be DSL4 in accordance with EN 12899-1.

All other loads and combinations for the enclosures shall be calculated in accordance with EN 12966.

2.7 Communications and Power

All equipment installed in this Contract will require a power connection. Power will be obtained from existing mini-pillars installed along the route. The Contractor will be responsible for all terminations to existing mini-pillars. Ducting shall be supplied and installed between the mini-pillar and the cabinet enclosure by others.

The power supply shall be 230 volts (+/- 6%), 50Hz (+/- 1%), 22A minimum. The Contractor shall take into account the number of devices and shall confirm power supply requirements.

2.7.1 Functional Requirements

The VMS controller shall use embedded National Transportation Communication for ITS Protocol (NTCIP) protocol to communicate with Associated Services, in accordance with NTCIP 1203 version v03 or latest available version.

2.7.2 Performance Requirements

Commands from Associated Services shall be implemented on the VMS display panel within 5 second of the commands being received by the VMS controller.

The conformation message, that the Associated Service command has been implemented on the VMS display panel, shall be transmitted to Associated Services from the VMS controller within 1 second.

The VMS controller shall transmit fault status messages to Associated Services within 1 second of the fault occurring or the fault being cleared.

2.7.3 Certifications

The Contractor shall analyse the VMS structural design and shall certify that the VMS meets EN12899 compliance.

The Contractor shall certify that the VMS display equipment will withstand the temporary effects of being lifted by the pick points provided and will comply with the applicable requirements of EN12899.

The Contractor shall analyse the complete VMS structural design. The structural analysis must include, but shall not be limited to:

- Sign housing;
- The quantity and type of lifting points to be provided;
- The quantity and type of mounting brackets to be provided;

- The quantity and type of hardware (nuts, bolts, washers) used to attach the mounting brackets;
- Verification that no dissimilar metals problem will exist and/or affect the structural integrity of the VMS-to-bracket attachment points; and,
- A recommendation of the number of attachment points, as well as the attachment locations that the Contractor should use when mounting the VMS display panel equipment to its support structure.

2.8 Electrical

All components used in the design shall be selected to minimise the creation of surge currents, harmonics and general electrical noise. Where equipment incorporates switched mode power supplies these shall include 'soft-start' technology.

All power and data cable connections to the VMS enclosure shall be provided, by the Contractor, using armoured cable and suitable glands in which the cable armour shall be correctly terminated and bonded to earth at both ends. Cable armour shall not serve as the protective earth connection.

Power cabling shall be terminated, by the Contractor, in the VMS enclosure within a power distribution unit fitted with an electrical isolator switch. Where applicable the form of this termination shall be in accordance with Irish Standards.

A suitable power distribution arrangement shall be provided, by the Contractor, within all VMS enclosures which should typically include the following:

- An isolator switch fitted to the incoming mains supply and capable of breaking the maximum rated load for the VMS.
- Where required, RCD protection shall be fitted to the incoming mains supply and capable of breaking the maximum rated load for the VMS.
- A surge protection device fitted to the incoming mains supply and capable of protecting the VMS from lightning, surges, spikes and radio frequency interference (RFI). The device shall be capable of attenuating a maximum surge current of 1.5kA and voltage of 5kV.
- A 230V ac maintenance socket with integral RCD protection.
- Miniature circuit breakers as necessary for internal ac power distribution.

Surge arresting/suppressing devices shall be installed as close as possible to the point of cable entry into the VMS enclosures on all cables connecting the VMS to the power supply/distribution and communications systems.

Earth bonding at such surge arresting components shall ensure a low impedance path to the main protective/lightning earth terminal.

Lightning protection shall be integral to the electrical design forming part of this Contract and shall conform to the requirements of I.S. 10101:2020, BS7671, BS7430 and EN 62305 or Irish equivalent.

VMS enclosures shall be suitably constructed to:

- a) prevent the formation of condensation occurring on both the VMS display windows and within the main body of the sign;
- b) prevent the build-up / pooling of water within the sign or on internal flat surfaces;

In the event of the formation of condensation or build-up of water, suitable drain holes or similar arrangements shall be provided to ensure the resulting water does not compromise the safety, reliability or longevity of the equipment so exposed.

Where the construction of the VMS requires the use of heaters and thermostats;

- a) Heaters shall only be operated when condensation or low temperature conditions prevail and shall therefore be controlled by a system using one or more thermostats and humidistats, suitably positioned within the equipment;
- b) Thermostats and humidistats shall be adjustable with the facility to lock the setting in any chosen position; and
- c) Thermostats and humidistats shall be easily accessible and clearly labelled with the Contractor's recommended setting information.

The control system shall include an over-temperature protection device to ensure there is no possibility of damage to any component due to excessive heat.

Over-voltage protection shall form an integral part of the VMS electrical equipment.

2.9 Hardware Requirements

To the greatest extent possible all hardware elements of the VMS equipment shall meet the following requirements:

- Industry standard;
- Readily available from multiple suppliers;
- Modular in design;
- Flexible, allowing for enhancement of hardware/functional capabilities;
- Low maintenance;
- Constructed from lightweight materials;
- Easily serviceable; and
- Designed with health and safety in mind.

All parts of the VMS shall be designed and constructed in a modular fashion to facilitate simple servicing and enhancement activities.

Material combinations which, when in contact, give rise to electrochemical corrosion shall not be used without the provision of protective barriers guaranteed to be effective for the design life of the equipment.

All cable glands, fasteners, locks, hinges, fittings, screws, nuts, bolts, etc. which form part of any closure system or any removable panel or any fixing shall be manufactured from suitable non-corrodible material.

All external glands for cable and conduit entries shall be fitted to downward facing or side surfaces only. Cable drip loops shall be provided.

The control system shall be microprocessor based.

Microprocessor systems shall be of modular design and consist of standardised hardware and software packages. It shall be possible to expand and modify systems in stages at a later date with

the minimum of changes and without disturbing existing modules. The systems shall be continuously self-monitoring and malfunctions shall be reported to the main display.

Particular attention shall be paid to the removal of all sharp edges and to the neatness and alignment of equipment, cable, conduit and other materials during manufacture and installation.

All stranded cable cores shall be terminated via crimped ferrules prior to insertion in 'screw clamp' terminals.

All wiring within cabinets, racks and other units shall be neatly looped and run in plastic slotted trunking with capping or secured with insulated cable ties. Segregation between mains-supply cables and low voltage cables shall be maintained.

When multiple compatible assemblies and components are supplied each shall be fully interchangeable.

Keyed connectors or other suitable means shall be used so as to make it impossible to install modules incorrectly.

The design, assembly and site installation of equipment shall consider the future maintenance of equipment, with particular attention to safe and unobstructed access for maintenance personnel to all components.

All equipment, modules and cable terminations shall be installed so that they are easily accessible for servicing and replacement.

All equipment shall be designed to ensure that installation and servicing can be accomplished to the greatest extent possible without the need for special tools.

Mounting attachments and electrical connections on equipment shall incorporate locking mechanisms to prevent loosening caused by vibration.

Printed circuit boards shall be coated with a protective lacquer material finish to prevent damage by moisture.

All data cable cores shall be identified at each end using identification collets or sleeves.

Protective disposable covers/caps shall be fitted to all new and/or unused connectors and for bracketry bolts. Where unmated connectors are provided for maintenance purposes protective covers/caps shall be provided with a retaining chain or similar.

2.10 Light Emitting Display Requirements

All light emitting VMS display equipment shall employ LED technology and shall comply with EN 12966-1.

All VMS display panels shall be red/green/blue as defined by EN 12966-1 and specified for each sign type.

Sequencing of VMS messages shall be possible, allowing the use of alternating messages to be displayed on all types of permanent VMS.

Flashing of all or any part of a VMS message shall be possible.

The VMS message shall be updated in a manner that appears instantaneous.

Character sets available to construct VMS messages shall include both upper and lower-case fonts and as defined in the latest version of Traffic Signs Manual, Chapter 3.

Default and fail-safe message functions shall be incorporated as follows:

- a) In the case where no other default VMS message has been configured, a blank fail-safe message shall be displayed in the event of power failure, display module failure or the failure of any major equipment associated with the control of VMS.
- b) Default VMS messages are controlled by the designated MOCC computer system. VMS design shall permit these messages to be configured and downloaded to VMS.
- c) In the event of a communications failure VMS shall be configured to display a default message.

The intensity of the VMS display and flashing amber lanterns shall vary in accordance with the ambient light level and may be overridden by the designated MOCC computer system.

Light sensors shall be incorporated into the VMS to measure the external illumination of the VMS from all directions. Adjustment of display intensity shall compensate for all ambient conditions including direct sunlight and darkness.

The ability to determine and display the prevailing ambient level of illumination and corresponding VMS display intensity level at any time during operation of the VMS shall be provided.

2.11 Power Consumption

Total maximum power consumption of the VMS, which includes display panel, LEDs, VMS controller, fan & heating (if applicable), flashers and power supply unit, shall not be greater than 8kW.

2.12 Sign Control & Communications

2.12.1 General Requirements

The VMS will be controlled by the designated Motorway Operations Control Centre (MOCC) operation system. The VMS shall have the capability of being controlled from a number of systems with a control system in place to allow for the implementation of prioritisation rules for messages.

The physical interface from the designated MOCC computer system to the VMS shall use optical fibre, cellular (4G/5G) or wireless Ethernet. The Employer shall specify the communication method for each Contract.

The Contractor shall develop the necessary interface to the MOCC computer system based on the overall functionality of the VMS being provided and in accordance with this section.

The transport/network level protocol will be TCP/IP over Ethernet.

Each VMS shall be assigned an IP address and port number and will be polled using Windows sockets to obtain status and device data and for the purposes of sending sign settings. The IP Design Authority shall provide details of the specific IP addressing information to be configured by the contractor.

Each VMS shall include a sign controller, provision for auxiliary control such as via laptop computer and associated equipment. The Contractor shall provide all the materials, software and services necessary to install sign controllers, auxiliary control and associated equipment that fully comply with the functional requirements.

Each VMS shall be controlled and monitored by their own sign controller. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with the designated MOCC computer system in order to perform most VMS control functions.

The sign controller shall meet the following operational requirements:

- a) Communicate with the designated MOCC computer system using the NTCIP 1203 protocol standard for VMS signs using SNMP. The Engineer shall specify the protocol for each Contract.
- b) Contain memory for storing changeable and permanent messages, schedules and other necessary files for controller operation.
- c) Diagnostics - Software shall include diagnostic routines which check hardware for correct operation. All hardware faults shall be broadcast to the operator's station(s).
- d) Minimum of one network connection to the sign for configuration and diagnostics shall be provided. The same shall also be interrogated remotely via IP network.
- e) Contain a minimum of two (2) NTCIP compliant Ethernet ports with RJ45 connector.
- f) Contain VMS specific control firmware that shall monitor all external and internal sensors and communication inputs and control the display modules as directed by the MOCC computer system.

The NTCIP 1203 protocol shall be natively supported in the VMS controller. External protocol converter or translator devices shall not be allowed.

2.12.2 Communications

All remote communications to/from the MOCC computer system shall be NTCIP compliant.

The sign controller shall be able to receive instructions from and provide information to the MOCC computer system using the following communication modes:

- a) Remotely via Ethernet communications.
- b) Locally via direct connection with a laptop computer that is connected directly to the sign controller using an RJ45 null modem connection or Ethernet connection.

The sign controller shall contain a minimum of one (1) 10/100Base-T Ethernet communication port. This port shall be available for communicating from the MOCC computer system to the sign controller when an Ethernet network is available. The Ethernet port shall have a standard RJ45 connector.

Communications using the Ethernet port shall be NTCIP-compatible using the NTCIP 2202.

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

The VMS sign controller shall contain a minimum of two (2) NTCIP compatible RJ45 communication ports. This port shall support multiple communication interfaces, including, but not limited to, direct null-modem (for local laptop control), dial-up and leased-line modems, radio systems, cellular modems and fibre optic modems. The RJ45 port shall all have a standard RJ45 connector.

The baud rate, connection type and NTCIP communication protocol shall be configurable. The RJ45 port shall support a data rate of 1200 bits per second.

The RJ45 port shall be capable of supporting either of the following sub network profiles: NTCIP 2101 (PMPP) or NTCIP 2103 (PPP). It shall also be capable of supporting either NTCIP 2201 (Null) or NTCIP 2202 (Internet) transport profiles.

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

2.12.3 Message Display

The sign controller shall be capable of displaying the required messages on the VMS with the display requirements defined in this specification.

The VMS shall be capable of displaying messages within 5 seconds of receiving prompted to do so.

It shall be possible to activate messages on a VMS in the following ways:

- a) The MOCC computer system instructs a particular message to be activated.
- b) An operator using the user interface panel keypad if available.
- c) Certain events, like a power loss, may trigger the activation of pre-configured messages when they occur. These events must be configured using the sign control software.

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

- a) The message's duration timeout expires.
- b) The controller receives a command to change the message.
- c) The controller receives a command to blank the sign.
- d) A special event, such as a loss of communication, occurs that is linked to message activation.

2.12.3.1 Status Monitoring and Fault Notification

The sign controller shall be capable of monitoring and reporting the status of the sign components and subsystems in real-time and/or manual modes as required.

If a user interface panel LCD available, all status and diagnostic data shall be available via the user interface panel LCD screen, all major component and subsystem errors shall be displayed. Otherwise, this function shall be provided with laptop connection or remotely.

The sign controller shall automatically communicate the status of all sign components and subsystems to the designated MOCC operation system via NTCIP communication, including the occurrence of important events and subsystem failures.

The controller shall be capable of sending event notifications to the designated MOCC operation system via SNMP "traps" as allowed by NTCIP standards. When one of these events occurs, the sign controller shall create a data packet for transmission to the central controller that shall contain details about the event. The transmission of traps shall be governed by the NTCIP standards.

The controller shall be configurable to enable or disable the transmission of traps for each event or error type. This configuration will include the automatic initiation of these traps, including establishing telephone modem connections if appropriate, when the NTCIP network permits transmission initiation by the sign controller.

The status monitoring and fault notification shall include but not be limited to the following:

- a) Detect in real-time the status of each of the display's pixels and reporting their on/off status. This monitoring shall take place without interfering with the display of data on the VMS face. Alternatively, the LED modules can be directed locally or remotely to perform diagnostic tests of all their pixels.
- b) Monitor and report the functional status of regulated DC power supplies located in the VMS by monitoring diagnostic outputs located on the supplies. The controller shall monitor the output voltage of each power supply and the status of each output fuse. The power supply voltages shall be measured to the nearest tenth of a volt and the fuse status shall be indicated as pass or fail.
- c) If the VMS or control equipment cabinet is available, it shall be equipped with access doors and sensors to monitor their open status, the controller shall monitor the status of those doors.
- d) The VMS controller shall monitor the readings of all light, temperature and humidity sensors installed in the VMS housing.
- e) The VMS controller shall continuously monitor the VMS housing's temperature sensors and shall automatically shut down the VMS if the internal cabinet temperature exceeds a safety threshold. This threshold shall have a default value of +55°C and shall be configurable at the controller.
- f) If the temperature approaches the threshold the controller shall reduce the brightness of the sign face. If the temperature continues to increase and exceeds that threshold, the controller shall trigger a warning notification event and blank the face of the sign. The sign face will remain blank until the temperature begins to drop. As the temperature drops, the controller will gradually increase the brightness of the display face, eventually returning to full brightness.
- g) When the VMS controller detects that it has been restarted due to a manual reset or error condition, it shall send a trap notification to the central system. It shall also automatically activate a default-reset message as configured to do so.
- h) When the VMS controller detects that it has lost power, it shall automatically indicate that on the front panel LCD. It shall also send a trap notification to the central system and activate a power loss message as configured to do so.
- i) The VMS controller shall automatically monitor the major power systems in the sign and detect when one of them has failed. These failures will be reported on the front panel LCD and transmitted to the central system in the form of a trap. Trap message will be sent by sign controller.
- j) When the sign controller detects that one of the sign and/or control cabinet (if available) doors has been opened, it will transmit a trap to the central system indicating which door has opened.
- k) The VMS controller shall monitor the frequency of communication packets from the central system. If the controller detects that communication has not occurred between the controller and central system for longer than a configurable timeout, then the controller will automatically activate a communication loss message as defined by NTCIP. This communication loss message shall be configurable and may be disabled as allowed by NTCIP standards.

3. SUPPLY

3.1 General Requirements

The Contractor shall supply and install any additional shock and vibration interface to the VMS to ensure that they are not affected by the vibration and wind caused by the motorway/road environment.

The Contractor shall supply all the materials, software and services necessary to install all VMS controllers, auxiliary control panels and ensure associated equipment that comply with the functional requirements of this specification.

The Contractor shall supply all brackets and fixtures required to mount the equipment on to the existing and new structures.

4. INSTALL

4.1 Location

The VMS display equipment will be installed onto existing and new infrastructure, i.e. cantilever gantries and straight poles that are currently in place.

The Contractor shall be responsible for ensuring that all VMS can be mounted to the structures prior to the placing of any orders.

All VMS display equipment shall be securely fixed in place and provide no opportunity for tools or equipment to fall to the roadside. For this purpose, the Contractor shall supply and install a custom-made detachable closing off plate between the VMS display panel enclosure and the mounting structure.

The Contractor shall submit details of the proposed cabling system to the Employer's Representative for review, within 20 working days of the Contract Date. The Contractor shall supply and install all cable management.

If appropriate the Contractor shall ensure that the VMS controller provided can be installed in the existing ITS communications cabinet on site.

4.2 Mounting Structures

In cases where the mounting framework (framework of minor steel members or brackets, fixed to the main Support Structure, onto which the VMS will be fixed by bolts) has previously been installed, the Contractor will supply appropriately-sized replacement bracketry for each new sign type to suit the existing Mounting Structure and match as closely as possible the previous mounting framework in terms of member sizing, spacing and total number of brackets and as specified in this section.

In all cases, ladders and walkway access shall be provided in accordance with DN-STR-03010.

Full maintenance access for the VMS shall be provided to all equipment from the walkway.

The types of Support Structures are:

1. Cantilever Gantries: these structures are cantilevered out over the carriageway, supported on a single vertical post located on the left-hand side of the carriageway.
2. Straight Poles: these structures are standalone straight vertical poles located on the left-hand side of the carriageway.
3. Portal Gantries: These structures span across the carriageway, supported by vertical posts on either side of the carriageway.

In those cases where the Contractor is to install VMS on gantries installed previously by a third party, the Contractor shall liaise with that contractor's designers to mutually confirm the VMS gantry mounting arrangements for each sign type are acceptable. In some cases, the Contractor may need to modify the standard mounting arrangements for a new sign to suit the requirements of an existing mounting framework.

All structural design, checking, certification, testing and installation work associated with the supply of VMS supporting structures, VMS enclosures and VMS walkway housings and access arrangements shall comply with the regulations, requirements, standards, specifications below as applicable:

- S.I. No. 637/2006 - Road Traffic (Signs) Regulations 2006
- RoHS Directive
- EN 12966

Compliance is also required with the following standards, incorporating all applicable amendments by TII:

- The TII Design Manual for Roads and Bridges, including DN-STR-03010 and AM-STR-06030.
- The requirements of TR 2140 and TRH 1642, published by the Traffic Control & Communications Division of the UK Standards for Highways.

It can be taken that in all cases the minimum vertical clearance between the overhead signs/structures and the carriageway will be 5.7m.

4.3 Mounting Requirements

The Contractor shall comply with all the requirements of this section.

In all cases, it is the Contractor's responsibility to ensure that the new VMS display equipment will be properly installed and aligned on all structure arrangements. Additionally, the bottom of the VMS should not extend below the bottom member of the gantry.

The VMS display panel mounting arrangements shall include the facility to adjust and align the optical axes of the VMS display panel according to the road geometry.

Optical alignment of the VMS display panel in the vertical plane shall include an offset of – 4 degrees down towards the direction of approaching traffic. The optical axis of the enclosure shall be adjustable from the offset position over the range +4 degrees (0 Degrees Down Offset) to –2 degrees (-6 Degrees Down Offset).

Prior to the production or procurement of VMSs, the Contractor shall carry out a dimensional survey of the existing gantry VMS framework in accordance with Clause 1537.1AR of Volume A - Part 2: Works Specification. The Contractor shall confirm all of these dimensions from on-site measurement and shall confirm their proposed VMS solution for each VMS frame within 40 working days of the Contract Date.

This shall be achieved through the installation of a min. 4 mm thick aluminium closing off plate, cut and installed on site to eliminate the possibility of any tools or other debris falling onto the carriageway during maintenance. For the avoidance of doubt, it shall be the responsibility of the Contractor to design and fabricate the drop plates. It is the responsibility of the Contractor to ensure that the drop plates are fabricated and fitted correctly.

All bolts, with the exception of high strength friction-grip bolts, shall have locking nuts to prevent loosening by vibration.

All works that include studs, nuts, anchor plate and bolt frame, or a template, shall be designed in accordance with DN-STR-03018 Design of Support Structures for Roadside Furniture, Eurocodes or relevant standards.

It is the responsibility of the Contractor to design, supply and install brackets and mounting equipment. Brackets and poles used shall be designed to take into account the maximum load, wind factor and the height at which equipment is required to operate.

Brackets and poles used shall be installed in accordance with the manufacturer instructions.

Brackets and poles used shall be installed such that access and maintenance is not restricted.

Brackets and poles used shall be protected against environmental degradation (galvanised and painted).

The Contractor shall submit details of the mounting arrangements for each VMS display equipment to the Employer's Representative for review.

The VMS display equipment structural assembly hardware and mounting brackets hardware shall be stainless steel or galvanised high-strength steel and shall be appropriately sized for the application.

All mountings, bolts, screws and any other fixing hardware shall be galvanised to EN ISO 1461:2022.

4.4 Co-ordination

The Contractor shall participate in collaboration meetings with the ITS EMC Contractor, NIMS Contractor, MMaRC Contractor, MTFO EDC Contractor and / or PPP Contractor and the Motorway Operations Control Centre (MOCC) Operator to agree all matter to support the programming of works, joint responsibilities and the successful testing and commissioning of all VMS display equipment for the duration of the Installation.

4.5 Integration

The Contractor shall collaborate with the equipment maintenance contractors and operators to ensure the integration of all VMS display equipment provided, with the Associated Services.

The VMS display equipment shall be integrated with the Associated Services such that it can receive and implement commands and automatically set messages on the signs, in accordance with the VMS display equipment performance and communication requirements.

The Contractor shall provide one VMS and a controller required to control the VMS plus one extra controller and any required integration test units to support Associated Services interface development at the MOCC complex within 40 working days of Contract Date.

The Contractor shall liaise with the equipment maintenance contractors and operators to integrate the VMS with the Associated Services and enable the activation processes as agreed during integration meetings.

The VMS display equipment shall be integrated with Associated Services such that the VMS display equipment can report faults that occur and faults that have been cleared, in accordance with the VMS display equipment performance and communication requirements.

The Contractor shall collaborate with the equipment maintenance contractors and operators to implement configuration changes as required, including but not limited to:

- adding new sites to existing systems;
- assigning or changing IP addresses; and,
- updating or amending GIS mapping data.

4.6 SAT & Commissioning

The Contractor shall submit details of all VMS display equipment to the Employer's Representative for review and shall be subject to tests to demonstrate compliance with this specification, EN 12966 and TR 1100.

The Contractor shall be responsible for testing and commissioning of all VMS display equipment in accordance with the requirements of Volume A - Part 4: Testing and Commissioning Specification.