ITS Specification
Variable Message Sign – Fixed

Project Compliance: <u>Mandatory</u>

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More information

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The current version of this document is available on the Waka Kotahi website at http://www.nzta.govt.nz/resources/intelligent-transport-systems/

Document management plan

1. Purpose

The purpose of this document is to specify the minimum requirements for procurement of variable message signs (VMS) by Waka Kotahi. In addition, this specification will detail system integration requirement (eg protocols, interfaces, data standards etc) to ensure compliance with Waka Kotahi systems and standards.

2. Document information

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3. Key words

ITS, VMS

Record of amendments (this section is used post-ratification)

Amendment number	Section amended	Description of change	Updated by	Effective date

Record of artefacts for removal from this specification and inclusion in future ITS specifications

This section records any circumstances where a section from this specification will be removed for inclusion in a future ITS specification, where it makes sense to reference this information from more than one specification. For example, generic information about power supply.

PAGE NUMBER	SECTION REFERENCE	FUTURE DOCUMENT	CHECKED BY	ACTION
20	I	Time Synchronisation – NTP		
14	5.1.1	Environmental Conditions Specification		
18	6.1	Power Standard		

Reference to dependent standards and specifications

Standards and specifications that shall be conformed to in conjunction with this standard or specification. This section records all supporting documents, to assist with reviews and updates.

NAME OF SUPPORTING DOCUMENT	REFERENCE
Road vertical signs. Variable message traffic signs	EN 12966:2014
Communications protocols	Refer to Waka Kotahi
Waka Kotahi ITS specification – General requirements	ITS-01-01
Waka Kotahi ITS specification – Handover and commissioning process	ITS-10-01
Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Emission	AS/NZS CISPR 14.1:2013
Lighting for roads and public spaces; including all supplements of AS/NZS 1158	AS/NZS 1158
Cold-formed structural steel hollow sections	AS/NZS 1163:2016
Structural design actions – Permanent, imposed and other actions	AS/NZS 1170.1:2002
Structural design actions – Wind actions	AS/NZS 1170.2:2011
IP Degree of Protection	EN 60529
Coating Standard	AS/NZS 2312.1:2014

Contents

1.0 Introduction

The purpose of this document is to specify the minimum requirements for the procurement of variable message signs (VMS) by Waka Kotahi. In addition, this specification details system integration requirements (such as protocols, interfaces, data standards etc) to ensure compliance with Waka Kotahi operational and asset management systems.

The outcomes of the specification are to provide guidance in order to procure high quality, energy efficient and long-lasting VMS which have a proven track record in a similar operating environment to New Zealand. Additional requirements to support other applications will be added over time.

The specification **does not describe** the detailed **form** and **message configuration / limitations** of a VMS; these elements are detailed in the Waka Kotahi VMS standard (under development).

1.1 Strategic context

Waka Kotahi requires tools to disseminate predictive or current information to road users along motorways, expressways, rural and local roads on traffic conditions or to improve general conditions of network use. Those tools aim to contribute to improving road safety and user comfort. VMS play an important role for Waka Kotahi to achieve those goals.

VMS are generally located on motorways, expressways, rural and local roads to provide inter-regional and tactical messaging capability. This specification shall be applicable to all NZ state highways nationally and regional roading authorities.

The Waka Kotahi ITS framework is produced for procurement purposes only; it is not a legal instrument and does not relieve users of legal compliance requirements or regulations.

1.2 Strategic outcomes

By developing this specification, Waka Kotahi is to achieve the following strategic outcomes specifically to ensure and enhance the Waka Kotahi dynamic, in-trip messaging capability including (but not limited to):

- enhancing road user notification in normal and adverse conditions
- increasing road user awareness of traffic conditions to assist with improved safety, to provide journey options and to reduce congestion
- improving whole-of-life ITS-related costs by supplying quality VMS assets, including reducing the Waka Kotahi environmental footprint through reduced energy consumption
- minimising constraints associated with power and energy requirements to drive assets in rural applications.

1.2.1 Outcomes for road users

VMS are intended to provide a mechanism to advise users of road conditions, route availability and journey time estimates. The desired outcome is to keep road users well informed at all times and in all weather conditions, receiving timely information which will help them undertake their journeys safely and efficiently.

VMS infrastructure is used to advise of adverse weather conditions, road closures and detours, and traffic conditions in real-time, and to warn of advance works or events which may adversely affect road users' journeys.

1.2.2 Outcomes for road controlling authorities

VMS must be effective, reliable and durable as they are deployed in harsh outdoor environments and exposed to extremes of temperature and weather as required in Performance requirements (section 5.0). Trouble-free operation for many years is expected (section 5.1) (VMS are tools that enable road controlling authorities (RCAs) to actively manage incidents and roadworks.

1.3 Operational outcomes

The intended operational outcomes of this Waka Kotahi specification are to:

- increase road user acceptance of the information by improving the quality of information and images on VMS in normal and adverse conditions
- improve quality of transport operations centres' (TOCs') operational activities around VMS (VMS status condition and fault logging)
- minimise maintenance costs
- improve renewal cycles.

1.4 In scope

This document specifies procurement requirements for fixed VMS:

Sign Types	Motorway / Expressway	Regional Types A to D	Urban Type D (EJT)	Large Type D

1.5 Out of scope

This specification applies only to standard dimension, fixed location, 'discontinuous' VMS, ie those on which messages can be created because the finest individual elements (pixels) can be in multiple states (off or any available colour).

Continuous signs which are similar to fixed signs, are not covered by this specification. Note that the only difference between a fixed sign and a continuous VMS is the ability of the latter to show messages by some electro and/or mechanical means, eg rotating prisms.

This document does not cover any other form of electronic roadside signage such as relocatable (mobile) VMS, lane control signals, school zone signs, speed-activated warning signs and advance warning signs (regional intersection or ramp signal types A and B).

VMS types used exclusively by territorial local authorities are outside the scope of this specification.

Design and installation of fixed VMS sites is covered in the VMS standard (under development).

2.0 Terms and definitions

TERM	DEFINITION
API	Application programming interface
Bezel	Border surrounding the VMS front screen
Cantilever support	Support system with a single post and a cantilever arm supporting the VMS over the traffic lane(s)
CCM	Code compliance met
Cd	Candela
CIE	Commission Internationale de L'Eclairage (International Commission on Illumination)
CMS	Changeable message sign
Continuous VMS	Show sign faces of the types on fixed signs as defined in EN 12899-1:2007. VMS use electro and/or mechanical means to change between sign faces
Control device	Equipment used to execute a change of message other than by purely manual means
Discontinuous VMS	Create messages using discontinuous individual elements that can be in one of two states (or more) and can thereby create messages on the same sign face
Display surface	Visible part of a VMS that contains the elements that may be activated to display the message.
EJT	Estimated journey time
Element	Basic visual light emitting [and/or reflecting object or cluster of objects] in the display surface of a VMS, activated in conjunction with other elements to form the desired message. Note: words in purple are generic but outside the scope of this specification
Enclosure	The housing for the display and the electronics systems immediately associated with the display
External sources	VMS are typically monitored and controlled from transport operations centres (TOCs), however this is not universally applicable. VMS must be able to be controlled (with permission) from multiple remote sources
FAT	Factory acceptance test
Front screen	Screen protecting the display surface or the parts of it against dust, water etc. Note: front screens are not compliant with this specification
Gantry	Support system spanning a carriageway with at least one post either side of the carriageway supporting VMS mounted over the traffic lane(s)
GSM	Global System for Mobile Communications
IP	International Protection Marking (sometimes interpreted as Ingress Protection) classifies the degree of protection provided by mechanical casings and electrical enclosures against intrusion, dust, accidental contact and water [EN 60529]
ITS	Intelligent transport systems
Lantern	Multiple LEDs grouped uniformly in a circular array
L_a	Luminance with the VMS turned on
L_b	Luminance with the VMS turned off
LED	Light emitting diode
LoS	Level of service
LR	Luminance ratio
MAC	Media access control

TERM	DEFINITION
Message	Configuration consisting of symbols and/or text
MIB	Message information block
MTBF	Mean time between failure
MULTI	Mark-up language for transportation information
NTCIP	National Transportation Communications for Intelligent Transportation System Protocol
NTP	Network Time Protocol
Pixel	The smallest addressable visual light-emitting object in the display surface of a VMS
Pixel pitch	The shortest distance between the centres of adjacent pixels
RCA	Road controlling authority
RCD	Residual current device
RGB256	Red, green and blue can each have values from 0 to 255 using 8 bits (binary digits). This equates to the ability to display 255^3 (>16.5M) colour permutations.
Regional VMS	VMS mounted on structures typically adjacent to the roadway on rural state highways
SNMP	Simple Network Management Protocol
Support structure	Structure intended to maintain the VMS in its designated position (poles, posts, fixing, columns etc)
TCP/IP	Transmission Control Protocol / Internet Protocol
TMS	Traffic management system
TOC	Transport operations centre
UTC	Coordinated Universal Time
VMS	Variable message sign. An electronic sign where the information shown can be changed or switched on or off as required. The information can be text or symbols.
Waka Kotahi	Waka Kotahi NZ Transport Agency

3.0 Operational requirements

This specification for VMS contributes to the Waka Kotahi strategic fit, operational services, safety, efficiency and value for money.

VMS must provide a guaranteed delivery LoS (that is a mechanism to communicate to road users by the nature of VMS being positioned adjacent to, or above, traffic lanes) for messaging Waka Kotahi users.

These are the requirements. The VMS must:

- be able to display highly visible and legible messages to road users under all conditions
- be positioned in locations which maximise visibility both optically (optimising height and viewing angles) and logically (preceding important journey decision points). These aspects are covered in the Waka Kotahi VMS standard (under development)
- not constrain ability to deliver required messages (noting message configuration will change with operations requirements)
- provide operational status feedback to confirm that VMS are displaying the required message.

4.0 Functional requirements

This section describes the high-level functions that VMS must perform

4.1 Full colour or monochrome display

Full-colour VMS must be able to display text and graphics as defined in section 5.2.3. Monochrome VMS must display yellow colour as defined in section 5.2.4.

4.2 Display uniformity

The display of the VMS must appear to be uniform and consistent.

Physically the display must be formed using a regular matrix, that is the spacing between individual light sources in both the x and y axes is uniform. Optically there should be no visible variation in the colour of the light produced and display luminance ('brightness') should not vary across the display.

4.3 Display clarity and visibility

The display of the VMS must be clearly legible and highly visible throughout the required viewing range and be appropriate in all environmental conditions.

Automatic brightness control must ensure that the intensity of the display aligns with ambient lighting conditions.

The contrast ratio must ensure that all images displayed on the VMS are clearly legible under all conditions.

4.4 Fully operable display

The display must be fully operable, that is each individual display element (pixel) must be able to be controlled separately; in effect, the VMS is yellow monochrome or full colour (as required) and fully graphics capable – it is not constrained to use alphanumeric characters arrayed across a fixed number of lines.

Appendix A notes the minimum message display dimensions required by Waka Kotahi.

4.5 Remote message sources

The VMS must be able to be commanded to display messages received from approved external sources (such as TOCs or hosted applications).

The VMS must be able to communicate status including faults, confirm receipt and read-back messages, and communicate any required performance parameters to the approved external source(s).

4.6 Storage of text and graphics

The VMS must be able to display alphanumeric messages and graphics from an on-board library which can be commanded without sending the full content of the message. For example, a complex message could be stored with the label 'Message1'; receiving a properly formatted request to display Message1 would display the complex message.

4.7 Logging performance parameters including faults

The VMS must maintain logs and retain performance parameters including fault conditions until retrieved for resolution.

4.8 Messages currency (kept up to date)

The VMS must ensure that messages are kept up to date by maintaining regular contact with the message source. It must take agreed appropriate action(s) as defined in section 6.1.2 m (typically blanking the screen) if regular communication is lost.

4.9 Prompt message display

The VMS must ensure that the time difference between receipt and display of a message is compliant with Performance requirements (section 5.0).

4.10 Message queuing and prioritisation

The VMS must be able to prioritise incoming messages based on the priority of the message received and the hierarchy of the message source using NTCIP (v3 or latest) parameters for contention. Incoming messages must be stored, queued hierarchically pending display.

Message prioritisation (contention) is based solely on NTCIP parameters and must be independent of the physical ports on which messages are received.

4.11 Handling of fault conditions

The VMS must take appropriate action when faults arise. Under no circumstances can the VMS display to road users:

- brightness levels which are inconsistent with ambient lighting or are not uniform across the display
- partial, incomplete or otherwise potentially unintelligible messages.

4.12 Compliance with Waka Kotahi protocols and other control interfaces

The VMS must be configured to comply with prevailing Waka Kotahi protocols, and other control interfaces as specifically requested in the procurement documentation.

4.13 Integration with the existing Waka Kotahi traffic management system

VMS procured using this specification must be able to interface seamlessly with the current Waka Kotahi national traffic management system.

5.0 Performance requirements

Performance requirements describe key indicators that are measurable and can be independently certified.

5.1 Resistance to the effects of external conditions

The working environment of VMS can be relatively harsh. Equipment that is deemed fit for purpose is expected to continue to operate effectively exposed to the New Zealand environment (as per NIWA) for a minimum of 15 years. It is essential that materials and manufacturing processes take this into account.

VMS must be resistant to a wide range of challenging conditions including strong direct sunlight, high ultraviolet light levels, extremes of temperature, severe winds (gusts up to 250km/h), marine conditions (sea salt exposure), rainfall (up to 18 metres annually), snow and ice.

VMS shall comply with the following environmental requirements.

VMS shall be capable of continuous, normal operation (24/7 day and night) and maintaining performance criteria in the conditions described below:

a. installed and operated in direct sunlight
b. ambient temperature range between –25°C and +55°C (class **T2** as per EN 12966:2014) is required as per the table below:

Test / Class **T2**	Cold	Dry heat	Damp heat cycling	Solar radiation	Ambient temperature range
	Temperature °C				
lower	–25			n/a	–25
upper		+55	+55		+55

c. enclosure air temperature between –20°C and 75°C
d. maximum wind conditions likely to occur at the installation site as per AS/NZS 1170.2:2011
e. solar radiation with value of up 5000W/m² at direct sunlight, incident at an angle of 30° from the vertical
f. varied light intensity due to shadows
g. altitude up to 1000m
h. humidity between 10 per cent to 95 per cent non-condensing
i. conditions, both permanent and temporary, that may be unique to the specified location, for example instances of thick smoke and electromagnetic interference
j. vibrations expected in the installed location
k. marine environment
l. road surface reflection
m. seismic shock resistant to magnitude 8.5.

VMS operation shall cause no adverse effect on the surrounding environment in which it is installed. Conversely, VMS shall not be affected by adverse environmental conditions expected at the intended installation location.

5.1.1 Mechanical performance requirements

VMS shall be designed to ensure reliable transfer of all static and dynamic forces to the fixing and mounting structures.

VMS must meet class **WL9** as per EN 12966:2014 for wind loading, class **DSL4** as per EN 12966:2014 for dynamic snow loading, class **TBD6** as per EN 12966:2014 for temporary bending deflection. See section 4.5.2.5 of EN 12966:2014 for details of mechanical performance requirements.

5.1.2 Resistance of electrical / electronic components to the effects of pollution

The manufacturer shall declare the degree of resistance in accordance section 4.5.2.2 of EN 12966:2014.

5.1.3 Resistance of discontinuous VMS to surface corrosion

The surface protection of VMS enclosures against corrosion shall be class **SP2** as per EN 12966:2014 and meet requirements of section 4.5.2.3 of EN 12966:2014.

5.1.4 Enclosure: ingress protection against water and dust

VMS enclosures shall be protected against water and dust ingress in accordance with section 4.5.2.4 of EN 12966:2014. All VMS enclosures must meet a minimum IP rating of **IP56** (P3 as per EN 12966:2014).

5.2 Visual performance requirements

5.2.1 Display technology options

For all VMS applications, Waka Kotahi has selected LED technologies as the default choice for the displays. This technology provides good visibility under most viewing conditions, high reliability and low optical degradation, and has low maintenance requirements.

5.2.2 Key front screen parameters

The VMS display must consist of a full matrix and be capable of displaying a single steady screen and two alternating screens depending on message length.

Although not traditionally defined under visual performance requirements, the key front screen parameters which must be specified are:

Parameter	**Display area (height x width)**	**Pixel pitch** (uniform horizontal and vertical matrix)	**Bezel thickness**
	Specified in Appendix for different VMS types (based on road operating speed, location)	See sections 5.2.12 and 5.2.13	

5.2.3 LED colour palette

When observing the whole VMS front screen from all viewing angles within the specified beam width, colours shall not be discernible as individual red, green and blue light sources.

Each individual red, green and blue LED must be capable of displaying 256 shades of corresponding colours equating to 256 x 256 x 256 colour permutations (>16 million colours).

5.2.4 Colour

All VMS must meet colour class **C2** as per EN 12966:2014.

The chromaticity coordinates of the required colour parameters are defined in table 3 and figure 1 of section 4.4.2 of EN 12966:2014**.**

5.2.5 Luminance

L_a is the luminance with the VMS turned on; the VMS must achieve the minimum stated value $L_{a(min)}$. Luminance values must not exceed $L_{a(max)}$ with external illumination (solar simulator) turned on.

All VMS must meet luminance levels to class **L3** as per table 4 to table 9 of section 4.4.3 of EN 12966:2014.

5.2.6 Luminance ratio

All VMS must meet luminance ratio class **R3** as per table 10 of section 4.4.4 of EN 12966:2014.

5.2.7 Beam width

Depending on application, the minimum beam width shall be in accordance with section 4.4.5 of EN 12966:2014. The table below provides additional information.

Beam width class	Beam angles				Typical	
	Horizontal			Vertical	Application	Character heights
B1	–5º	0º	+5º	0º 0º –5º	High-speed road, two running plus one safety lane. VMS gantry-mounted centrally over running lanes.	300mm 400mm
B2	–7º	0º	+7º	0º 0º –5º	High-speed road, three running lanes plus one safety lane. VMS gantry-mounted centrally over running lanes.	300mm 400mm
B3	–10º	0º	+10º	0º 0º –5º	High-speed road, four running lanes plus one safety lane. VMS gantry-mounted centrally over running lanes or at side of road requiring a wider beam to cover up to 2 lanes.	300mm 400mm
B4	–10º	0º	+10º	0º 0º –10º	As B3 above. VMS mounted at a height of 6m or more.	300mm 400mm
B5	–15º	0º	+15º	0º 0º –5º	As B3 above, but extra-wide VMS covering more than 2 lanes.	200mm 300mm 400mm
B6	–15º	0º	+15º	0º 0º	As B5 above.	200mm 300mm

Beam width class	Beam angles				Typical	
	Horizontal			Vertical	Application	Character heights
				–10°	VMS mounted at a height of 6m or more.	400mm
B7	–30°	0°	+30°	0°	For special applications, where very wide horizontal and vertical beam widths are required. In urban areas B7 could be suitable for cyclist and pedestrian audiences.	Not specified, however 200mm character height is minimum for urban roads in NZ.
				0°		
				–20°		

High-speed roads with two or more running lanes typically use beam width **B5** as per section 4.4.5 of EN 12966:2014. All other roads typically use beam width **B6.** It is the designer's responsibility to select the correct beam width and this should be reflected in procurement documentation.

Selecting beam widths that are too wide for the location costs money, wastes energy and creates light pollution. Further guidance on beam width selection based on road topology (eg steep gradients) can be found in the VMS standard (under development).

5.2.8 Uniformity of luminous intensity

There are two requirements around luminous intensity for which each colour (as specified in section 5.2.4) must be tested as follows:

Luminous intensity		Ratio of the output
Highest 12%	Lowest 12%	3:1
Highest 4%	Lowest 4%	5:1

5.2.9 Visible flicker – machine readability

During testing there shall be no visible light flicker, whether the LEDs of a VMS are operating at full intensity or are dimmed. Further, VMS messages must be 'machine readable' (eg by CCTV cameras).

The VMS must meet the frequency requirement of 100Hz or greater.

5.2.10 Design life

The specified design life (operational service life) of the VMS is 15 years.

5.2.11 Degradation of visual performance

VMS design solutions must consider the impact to visual performance (ie colour, luminance and luminance ratio) caused by ageing effects. The visual performance requirements are minimum requirements and must be achieved during the entire operational lifetime of the VMS (see Technical (unit) requirements, section 6.0).

5.2.12 Pixel pitch

The pixel pitch defines the resolution of the VMS. For legibility and particularly for accurate representation of graphical images, the higher the resolution, the more an image matches a fixed sign.

On large VMS installed above or alongside state highways, the **maximum** pixel pitch must be 20mm. For smaller VMS used on local roads, the **maximum** pixel pitch must be 16mm.

5.2.13 Bezel thickness

A thickness must measure between 5 per cent and 15 per cent of whichever measurement is smaller:

top + bottom border
or
right + left border

The bezel must be the same thickness on all sides. Refer to Appendix A.

6.0 Technical (unit) requirements

6.1 Electrical performance requirements

6.1.1 LEDs

a. VMS suppliers are required to provide evidence that LEDs supplied as part of any VMS meet the quality, luminous intensity ratings, batch requirements and life expectancy outlined in this document.

b. Details of the current rating of the proposed LEDs to be used, and what *actual* current they will be driven at to meet the luminous intensity requirements, must be provided.

c. LEDs must be sourced from the same batch / bin in order to mitigate the risk of minor variations in colour output.

d. No LED shall be 'overdriven' or supplied additional current above the stated rating.

e. The latest high-quality manufacturing techniques must be used to ensure that:

   i. exposure of components to mechanical or thermal stress is minimised
   ii. manual handing of sensitive componentry is minimised
   iii. conformal coatings are consistently applied to circuit boards to minimise exposure to condensation.

f. Whilst there is no standard size prescribed for the modules forming the display, they should be of a size that is easy to replace with the VMS in situ in the field and without the need to dismantle any part of the VMS. No soldering or heat-based bonding is permitted to be undertaken as part of VMS maintenance. Removal or replacement of display modules must be 'tool-free'.

6.1.2 Power supply

The following methods of supplying power to a VMS are acceptable:

- reticulated mains – 230V AC
- via solar panel
- other renewable energy sources, eg wind turbine.

The VMS shall have the necessary termination equipment to cater for reticulated mains power supply or other type(s) (specified during the procurement).

The VMS enclosure must not contain UPS or batteries; if required, alternative power source should be housed separately near to the enclosure.

6.1.3 Power consumption

Power consumption can be a significant operational cost factor.

Waka Kotahi wishes to act sustainably and responsibly minimising power usage and carbon footprint. Value for money and total cost of ownership are important considerations in the procurement of VMS.

a. Manufacturers must state typical and maximum power consumption figures throughout the expected design life for consideration in procurement evaluation

b. The maximum power consumption for VMS with all LEDs illuminated at maximum brightness must not exceed the ratings listed in VMS types.

6.1.4 Nominal voltages

The standard nominal voltage for connection to the public supply shall be taken to be 230V AC rms. single phase.

6.1.5 A.C. Operating voltage range

Variations in the nominal supply voltage defined in section 4.5.3.1.3 of EN 12966:2014 shall not affect the VMS functions. This shall be tested in accordance with table 16 and table 17 of EN 12966:2014 and shall meet the requirements given therein.

6.1.6 Mains frequency

Variations within the frequency range of 50 ± 1 Hz shall not affect the VMS functions.

6.1.7 Power-up activation

The VMS shall be ready for activation when the supply voltage reaches a value within its operating voltage range. At no time during power-up activation shall partial, incomplete or false messages be displayed.

6.1.8 Low voltage – switch-off voltage response

A drop in the nominal voltage of more than 13 per cent shall not cause partial, incomplete or false messages to be displayed or cause damage to the VMS.

6.1.9 Low voltage – voltage interruption

The effect of voltage interruption shall be as per section 4.5.3.1.6.2 of EN 12966:2014.

6.1.10 Low voltage – temporary over-voltage

When protection for temporary (not transient) over voltage is incorporated, the operating voltage range of the protective device shall be stated and shall be tested in accordance with table 16 of EN 12966:2014 and shall meet the requirements given therein.

6.1.11 Electrical safety

VMS shall conform to the latest Australian/New Zealand Wiring Rules, AS/NZS 3000 and to applicable European standards for internal componentry (which does not have external connection to the mains supply) as per section 4.5.3.2 of EN 12966:2014.

All serviceable components should be secured with fastening made from non-conductive materials.

The VMS enclosure must not have any exposed electrical contacts.

6.1.12 Electromagnetic emission and immunity

For all types of environment, the VMS shall conform to EN 50293:2012.

The performance of any external equipment must not be interrupted by any radio frequency or electromagnetic interference generated by the VMS or vice versa.

6.1.13 Electrical surge protection

All display equipment shall be internally protected against damage resulting from:

- lightning strikes near the VMS or gantry
- electrical transients on power cabling
- electrical transients on internal and external signal wiring

- electromagnetic interference
- static electrical discharge.

Surge protection shall be provided on the incoming power circuits and communications circuits.

6.2 Systems integration – sign control

6.2.1 Sign controller

1. The sign controller must be able to operate the VMS in both local-control mode (ie no external communications) and remote-control mode (ie communicating with an external central control system).
2. The embedded controller must support a fully featured, industry standard, embedded operating system.
3. The embedded controller must be able to support various industry standard protocols such as RS485/RS422, Ethernet IP and WLAN.
4. The controller must support NTCIP (NTCIP 1203 for Dynamic Message Signs) including MULTI and, as a minimum, support the elements defined in the NZ VMS MIB v3.
5. The controller must comply with Waka Kotahi or local authority (if applicable) security requirements.

The controller must be able to:

a. send, receive and interpret SNMP commands over TCP/IP protocol to/from the Waka Kotahi central control system

b. control the display of messages on the VMS

c. retain fault logs locally until retrieved by the Waka Kotahi authorised asset manager or logging system

d. report VMS fault conditions to the central control system as soon as the communication network is available

e. receive direct manual instruction from vendor proprietary software (local or remote)

f. store 150 text-based messages or graphic images for immediate display

g. have sufficient RAM memory to upload and download messages as defined above

h. incorporate a watchdog timer to detect out-of-program conditions and reset the controller

i. automatically blank which immediately clears the message in the event of internal or external critical failures such as a communications failure

j. provide an interface for a laptop computer running Microsoft Windows operating system for configuration, uploading and downloading messages, and diagnostic testing

k. in local mode, support operator selection of dimming level, pre-stored messages, and diagnostic routines capable of testing full VMS operation

l. display the message within an elapsed time of less than one second of receiving the command

m. support time synchronisation from an external clock, eg UTC, NTP.

6.2.2 Fault reporting

The sign controller must monitor the operation and health of the VMS and communicate status with the control room. Alerts on the Operators' workstation indicate whenever a problem occurs, which will prevent correct display of messages on the VMS.

There are several conditions which must be drawn to Operators' attention which must be provided by the VMS supplier. There are three levels of criticality:

1. Critical: detected fault results in unit outage or may have safety implications.
2. Urgent: detected fault prevents designed operation to support outcomes.
3. Routine: detected fault has no impact on operation to support outcomes.

The minimum error types are:

ERROR NAME	ERROR DESCRIPTION
Pixel error	Pixels can fail from time to time. A pixel error will be raised when pixels fail. Should multiple failures occur on an individual board, this may affect message interpretation, in which case the VMS will generate a pixel error and all LEDs will be turned off (the sign will 'blank'). The percentage of pixels or colour channels failing that will raise an error must be configurable in software and hardware and be capable of identifying the position of individual pixel faults. The configuration of display alarms is to be discussed post-contract award with the successful supplier. The display module(s) where faults have occurred must have a visible fault indicator to facilitate efficient maintenance removal and replacement.
Message error	The sign is not able to display any message either because of internal device failure(s) or because the VMS is unable to resolve a message in the format in which it is presented (for example, if the characters contained exceed the maximum message length).
Power error	This error is raised when one or more power supplies becomes faulty or the mains power supply fails.
Temperature error	If the internal temperature inside the enclosure exceeds a threshold level, the sign must be turned off to protect the sensitive electronic components from damage.
Photocell error	A pair of photocells are used to measure the ambient light at the sign and adjust the brightness of the LEDs to suit. If a photocell fails, the sign could become either too dim or too bright to be legible.
Internal communication error	This error advises a communication failure within the VMS unit.

6.3 Other considerations – physical characteristics

6.3.1 Finish

The finish of all VMS surfaces should not result in specular (mirror) reflection that distracts road users. The use of smooth, monolithic front screens (such as polycarbonate panels) is not permitted.

The enclosure is to be aluminium or aluminium alloy with powder-coated finish.

The colour of the enclosure coating is to be matt black at the front and aircraft grey (BS381 693) on other surfaces.

The coating must facilitate the removal of graffiti.

6.3.2 Front panels

VMS front panels should be designed in such a way that no part of the message displayed is obscured when observed from the required viewing positions. They should be designed in such a way as to minimise the effects of ice and snow.

6.3.3 Front screens

Front screens adversely impact the intensity of light being transmitted from the VMS and can be prone to degradation caused by weathering and exposure to intense direct sunlight. Consequently, monolithic screens such as polycarbonate panels are not permitted.

VMS which allow portions of the front screen to be removed ('modular') may risk weather tightness of the enclosure and are not permitted.

6.3.4 Heating and forced ventilation

The provision of heaters and fans for supplementary environmental control within the enclosure is not permitted.

6.3.5 Doors and maintenance access

1. Must include physical security against unauthorised access.
2. All covers, doors, protective screens, plates, glands, external connectors etc shall be provided with rubber seals or equivalent materials which are maintenance free and shall remain effective for the design life of the equipment.
3. Where access doors are provided, they shall be fitted with a suitable retention 'stay' to hold the door in the open position for the safety of maintenance personnel working inside the enclosure. For security, access doors and panels shall be fitted with suitable locks (one lock per door / panel), designed for outside conditions. Unless specified otherwise, all access door locks shall have an identical key, and the supplier shall provide at least four copies of the key.
4. For regional VMS the enclosure is located approximately 3 metres above the ground. The design should ensure ease of access to components for ladder-based access or facilitate the use of portable access equipment (eg scissor lift or cherry picker).

6.3.6 Vertical alignment

Guidance on how the VMS is positioned in relation to the roadway is covered separately in the VMS standard.

The VMS shall **not** be fitted with louvres to shade or otherwise direct light emanating or directed onto the VMS.

6.3.7 Penetrations

All power supply, control and communication cabling shall enter the VMS enclosure through appropriately constructed, sealed and glanded entry holes. The location of the entry points is specified on design drawings approved by Waka Kotahi.

6.3.8 Electrolytic compatibility

Components shall comprise materials that when assembled into the VMS are electrolytically compatible and environmentally stable.

6.3.9 Lifting eyes

The enclosure shall be provided with at least two lifting eyes which enable the VMS to remain horizontal when lifting the enclosure onto the support structure. The lifting eyes shall be appropriately located ensuring sufficient structural strength to allow the VMS to be lifted or moved without causing any damage or deformation to any part of the VMS.

6.3.10 Mounting to support structure

The VMS must be designed to be mounted to the structure on which it will be supported. Modifications to the VMS enclosure are not permitted once it has left the place of manufacture. The VMS enclosure must be attached only at the points agreed in the design. Penetration through the enclosure for mounting is not permitted. Captive nuts in the VMS must be used to attach the structure to the VMS with appropriately sized fixings (bolts or screws).

6.3.11 Speed environment and character height

Guidance for VMS dimensions and site layout commensurate with operating speed environment are provided in the VMS standard.

6.3.12 Labelling

All LED display modules shall have unique serial numbers permanently marked, which cannot be removed and shall not ever be modified.

6.3.13 Transportation

VMS should be shipped in containers that protect their contents from damage in transit including extreme temperature, humidity, impact/shock etc. The units must be wrapped to prevent contamination and the packaging should be fitted with a device to indicate whether the unit has been subjected to rough treatment during its journey.

6.3.14 Pre-award certification

All VMS supplied to Waka Kotahi must include a declaration of conformity from the manufacturer and certification from an accredited independent testing facility demonstrating compliance with EN 12966: 2014. The supplier must provide supplementary report information from the testing facility stating the LED colour(s), pixel pitch, beam width, luminance, luminance ratio and IP rating of the specific VMS type being supplied under the Waka Kotahi contract.

6.3.15 Operations and maintenance considerations

VMS manufacturers must supply the following information:

ITEM	REQUIREMENT
a. General	i. VMS shall be designed to be installed and maintained by local technicians following manufacturers' supplied documentation ii. VMS shall be accessible for replacement in the field
b. Documentation	i. Maintenance and operations guidelines and manuals, which will include maintenance schedules and procedures, handling and storage, list of spares ii. A full inventory of serial numbers for all devices including enclosure, display modules and power supplies must be supplied

6.3.16 General

ITEM	REQUIREMENT
1. Accuracy	Unless otherwise specified, the VMS shall operate with at least 99 per cent accuracy.
2. Availability	99 per cent excluding mains power failure
3. Failure modes (power or communications failures)	a. Display or enter default mode b. Shutdown in safe manner where specified c. Automatic restart in safe manner upon restoration of power or communications
4. Privacy/security of data	Comply with AS/NZS ISO/IEC 17799:2006 and AS/NZS ISO/IEC 27001:2006
5. Functional safety	a. Shall comply with AS 61508 and IEC 61508 series b. Functional safety study in conjunction with Waka Kotahi to determine any safety integrity level (SIL) requirements
6. Traffic management protocol interface (API)	a. Interface to traffic management system via field processor b. Device driver compatible with a field processor
7. Alarms, events and status	Configurable and monitored from TOCs
8. Communications	Interface to the Waka Kotahi communications network
9. Mean time between failures (MTBF)	All VMS equipment shall have a specified MTBF of 55,000 hours or greater, unless otherwise specified or approved in writing by Waka Kotahi.
10. Disposal	VMS should utilise materials where possible which are recyclable to minimise the adverse environmental effect of disposal

6.3.17 FAT, SAT and commissioning, spare parts, servicing manuals, warranty, defects liability period

Spare parts must be available seven years after sign manufacture is discontinued.

Further requirements including (but not limited to) factory and site acceptance testing, spare parts inventory, service manuals, warranty, defects liability period and terms of payment must be specified Waka Kotahi in the procurement of VMS but are outside the scope of this specification. The VMS standard provides advice on many of these aspects.

Appendix A – Waka Kotahi VMS types

Waka Kotahi has made significant investment in VMS.

Regardless of their geographic location, all VMS are controlled from transport operations centres in Auckland and Wellington (and Lyttleton Tunnel, Christchurch) using the DYNAC ES traffic management system (TMS). Consequently, a key operational requirement of VMS procured using this specification is to interface seamlessly with the DYNAC TMS. It is worth noting that the Waka Kotahi current version of DYNAC is not able to display multicolour messages (which many of the latest signs feature), however Waka Kotahi has an ATMS modernisation project underway which aims to update TMS functionality.

VMS types

TYPE	MOTORWAY	REGIONAL				URBAN EJT TYPE D
		TYPE A	TYPE B	TYPE C	TYPE D	
Location	Motorways (urban state highways) and expressways	Rural state highways throughout NZ				Local road approaches to motorway interchanges
Minimum character height (mm)	400	300		200		
Lines of text	3	4	2	4	2	3
Minimum characters per line (DYNAC messages)	18	16				9
External VMS dimensions	7600 x 2300	4980 x 2390	4980 x 1590	3300 x 1590	3300 x 1060	1675 x 990
Minimum display area dimensions (w x h) (mm)	7040 x 1760	4800 x 2080	4800 x 1280	3072 x 1280	3072 x 768	1536 x 896
Minimum pixel dimensions	352 x 88	240 x 104	240 x 64	192 x 80	192 x 48	96 x 56
Maximum pixel pitch (mm)	20			16		
Maximum power consumption (W)	2000	1,500 (460 typical)	1250	1250	800	440 (105 typical)
Maximum weight (kg)	800	625	400	280	200	60
Procurement documentation must require that structural supports and foundation are acceptable to accommodate both the dead weight and sail area of the VMS.						

References

Mechanical performance requirements

CONDITION	APPLICABLE STANDARD	ADVICE		REQUIREMENT	
		SECTION OF APPLICABLE STANDARD	FACTOR	SECTION OF APPLICABLE STANDARD	STATEMENT
Temporary deflections caused by wind loads	EN 12899-1:2007	5.3.1	Wind load	5.4.1	Not to exceed the maximum for the relevant class
Permanent deflections caused by dynamic loads	EN 12899-1:2007	5.3.2	Dynamic snow load		Not to exceed 20% of the temporary deflection using the same load
Impact resistance	EN 60598-1	Impact tests shall be conducted on horizontally mounted VMS / test module front panel using a steel ball of 50mm diameter with a mass of 0.51 kg dropped from a height of 1.3 m to produce an impact energy of 6.5 Nm.			
		The VMS / test module shall be conditioned at a temperature of 20 ± 2 °C and then be subject to three single impacts, at the weakest point on the front panel of the VMS / test module.			
		The VMS / test module shall be cooled to a temperature of -5 ± 2 °C, which shall be maintained for three hours. Whilst the VMS / test module is at this temperature it shall be subjected to three single impacts at the weakest point on the front panel of the VMS / test module.			
		After the test the VMS / test module front panel or parts of it shall show no damage other than small indentations in the front surface; it shall exhibit no cracking. The VMS / test module shall continue to meet all the requirements of the standard.			
				No damage observed; CCM	
Vibration resistance	EN 60068-2-64	Mounting:	The VMS / test module shall be securely fixed to the vibrating table.		
		Reference and check-points:	The reference point shall be chosen on the vibrating table; in the case the VMS / test module is larger than the table it shall be a virtual point, where the reference signal spectrum will be defined as the arithmetic mean of ASD (Acceleration Spectral Density) values of signals measured at the check points.		
		Frequency range:	10 Hz to 200 Hz.		
		ASD levels:	0.013 g²/Hz (10 Hz to 50 Hz). 0.013 g²/Hz (50 Hz to 200 Hz with a negative slope 3 dB/octave). Overall r.m.s. acceleration 1.2 g.		
		Duration of conditioning:	90 min in each of 3 axes.		
		Reproducibility:	Low.		
		Initial measurements:	Visual inspection and function test.		
		Functioning during conditioning:	No.		
		Final measurements:	Visual inspection and function test. After the test no parts appear loose, all functionality unchanged.		
				No damage observed; CCM	

Resistance of discontinuous VMS to surface corrosion

CONDITION	APPLICABLE STANDARD	REQUIREMENT	
			STATEMENT
Resistance to corrosion - Salt spray test	EN ISO 9227:2012	Initial measurements:	Visual inspection and function test.
		State of the VMS / test module during the test:	Unpacked, locked and switched off.
		Duration of test:	240 hrs
		Operating conditions:	35 °C ± 2 °C, neutral salt spray
		Treatment after test:	Rinse with fresh, deionised water
		Final measurements:	Visual inspection and function test. After the test corrosion shall not be observed on any parts inside or outside the VMS / test module.
			No corrosion observed; CCM

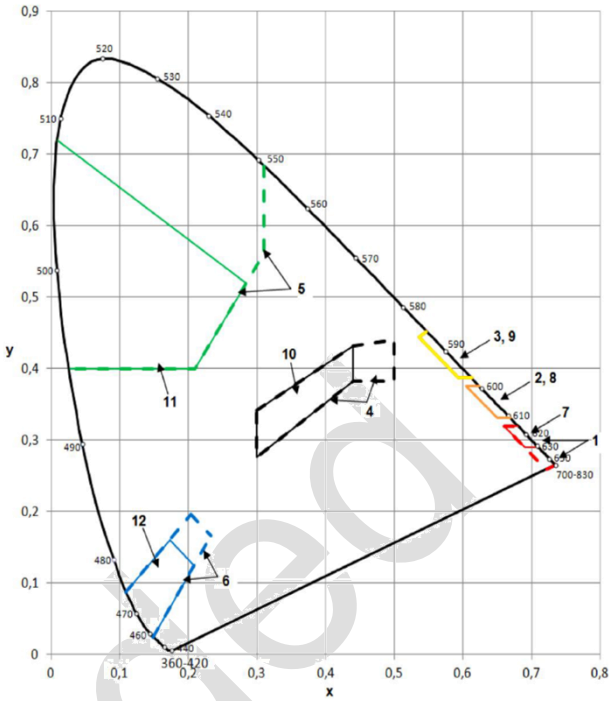
Enclosure: Ingress protection against water and dust

CONDITION	APPLICABLE STANDARD	TEST CRITERION	
Water ingress	EN 60529	Severity:	In accordance with EN 60529.
		Pre-conditioning:	None.
		Initial measurements:	Visual inspection and function test shall be conducted before commencing the conditioning period.
		Conditioning:	The equipment shall be hosed on all faces and at all angles from vertically down to horizontal concentrating on points to be —"most likely" to result in water ingress.
		Intermediate measurements:	The equipment shall be switched on and function test shall be continuously repeated throughout the test.
		Final measurements:	Visual inspection and function test. Acceptance in accordance with EN 60529. Ingress is allowed provided it has no harmful effect.
Dust ingress	EN 60529	Severity:	In accordance with EN 60529 category 2.
		Pre-conditioning:	None.
		Initial measurements:	Visual inspection and function test shall be conducted before commencing the conditioning period.
		Conditioning:	The equipment shall be switched OFF.
		Intermediate measurements:	None.
		Final measurements:	Visual inspection and function test. Acceptance in accordance with EN 60529 category 2.

Colour chromaticity diagrams

The solid coloured lines in the chromaticity diagram show the areas for the colours of class **C2**.

Colour	Axis	Colour coordinates of corner points			
		1	2	3	4
Red	x	0.660	0.680	0.710	0.690
	y	0.320	0.320	0.290	0.290
Orange	x	0.624	0.605	0.650	0.669
	y	0.370	0.370	0.331	0.331
Yellow	x	0.536	0.547	0.613	0.593
	y	0.444	0.452	0.387	0.387
White	x	0.300	0.440	0.440	0.300
	y	0.342	0.432	0.382	0.276
Green	x	0.009	0.284	0.209	0.028
	y	0.720	0.520	0.400	0.400
Blue	x	0.109	0.173	0.208	0.149
	y	0.087	0.160	0.125	0.025



1: Red, 2: Orange, 3: Yellow, 4: White, 5: Green, 6: Blue, 7: Red, 8: Orange, 9: Yellow, 10: White, 11: Green, 12: Blue

Luminance and luminance ratio levels

The * superscript denotes the luminance and luminance ratio levels required for scenarios when the sun is low in the sky.

Row ref.	VMS illuminance (lx)	Luminance limits for specified colour on reference axis – L3, L3(*) (cd/m²)					
		White		Yellow		Orange	
		$L_{a(min}$	$L_{a(max)}$	$L_{a(min}$	$L_{a(max)}$	$L_{a(min}$	$L_{a(max)}$
1	40,000	12,400	37,200	7440	22,320	4800	14,400
2	10,000	12,400 (*)	37,200	7440 (*)	22,320	4,800 (*)	14,400
3	4000	2200	6600	1320	3960	852	2556
4	400	600	1800	360	1080	232	696
5	40	250	750	150	450	100	300
6	<= 4	75	225	45	135	28	84

Row ref.	VMS illuminance (lx)	Green		Red		Blue	
		$L_{a(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$
1	40,000	3720	11,160	3100	9300	1240	3720
2	10,000	3720 (*)	11,160	3100 (*)	9300	1240 (*)	3720
3	4,000	660	1980	550	1650	220	660
4	400	180	540	150	450	60	180
5	40	75	225	63	189	25	75
6	<= 4	23	69	19	57	7.5	22.5

Class	Colour	Minimum luminance ratio					
		White	Yellow	Orange	Green	Red	Blue
R3	On reference axis	16.7	10	6.5	5	4.2	1.7
	Vertical off axis	8.35	5	3.25	2.5	2.1	0.85

Operating voltages tests

TEST SEQUENCE	VOLTAGE VALUE	MEASUREMENTS
1	No power	No power supply
2	Nominal	Switch ON the VMS / test module and check that there is no partial, incomplete or false display
3	Nominal	Function test
4	Drop to the minimum voltage	Check that there is no partial, incomplete or false display
5	Drop to 50% of the nominal voltage	Check that there is no partial, incomplete or false display
6	Nominal	Check that there is no partial, incomplete or false display
7	Nominal	Function test
8	Raise to the maximum voltage	Check that there is no partial, incomplete or false display
9	Nominal	Check that there is no partial, incomplete or false display
10	Nominal	Function test
11[a]	Maximum voltage stated by the protection device	Check that there is no partial, incomplete or false display No visual damage of the VMS / test module
12[a]	Nominal	Check that there is no partial, incomplete or false display
13[a]	Nominal	Function test
[a] Test only to be undertaken if a protection device is incorporated		

Table 1: AC operating voltage tests

The functional test shall be repeated for different combinations of voltage and frequency in accordance with the following table:

TEST SEQUENCE	FREQUENCY VALUE	VOLTAGE VALUE
1	Lower	Lower
2	Nominal	Nominal
3	Upper	Upper

Table 2: Permutations of voltage and frequency

Low voltage interruptions. The effect of voltage interruption shall be as follows:

DURATION (ms)	EFFECT
Less than 50	No effect
50 to less than 100	The VMS shall continue to display the current message but may be affected by a variation of luminance during the voltage interruption
Greater than or equal to 100	Shutdown is allowed unless specified by the purchaser. This shall not cause partial, incomplete or false messages to be displayed or cause damage to the VMS When the power supply is restored the VMS shall behave as described in Power-up activation (see section 6.1.7)