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VMS Standard

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TII Publications

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Background

Variable message signs (VMS) are an integral part of the road network, providing benefits by enhancing safety, providing journey time information and reducing the duration and cost of incidents. VMS also allow for the strategic management of the road network, providing flexibility when major events or incidents occur.

Furthermore, National Highways (formerly Highways England) have recently updated their VMS standards by consolidating all VMS positioning requirements into one single document (CD 146). This has created a shortfall of VMS standards applicable to non-smart motorways environments, such as those encountered on the TII road network. CD 146 is currently in the process of being updated to include requirements related to the positioning of VMS on all-purpose trunk roads.

The new TII VMS standard caters for the range of VMS utilised on the Irish road network, including VMS for the following environments:

a) Motorways

b) National roads

c) Tunnel approaches

This standard addresses the requirements for the various use cases including site selection, site layout, sign face appearance, sign construction, and functionality.

1. Introduction

Variable message signs (VMS) are used to direct and provide drivers with information relating to traffic conditions, route conditions or events, regulatory provisions (e.g. changes to speed limits), and weather events.

This Standard sets out the design standards and methodology for the choice and use of fixed VMS on the Irish road network, including motorways, and national roads. This standard shall be utilised by any designer appointed on a TII project to achieve uniformity of VMS design across the Irish road network.

This Standard addresses the specific VMS requirements for site selection, site layout, sign face appearance, sign construction and functionality, as applicable to each VMS type.

This Standard supersedes:

- Transport Infrastructure Ireland's (TII's) DN-ITS-03037, Standard TD 33/90 the Use of Variable Message Signs on All-Purpose & Motorway Roads (December 2000); and
- National Roads Authority's (NRA's) Guidelines for the Use of Variable Messages Signs on National Roads (2010).

This standard should be read in conjunction with the following related standards:

- European Committee for Standardisation *European Standard EN 12966 Road vertical signs – Variable message traffic signs;*
- Department of Transport's (DoT) *Traffic Signs Manual;*
- TII's *DN-GEO-03036 Cross Sections and Headroom;*
- TII's DN-REQ-03034 *The Design of Road Restraint Systems (Vehicle and Pedestrian) for Roads and Bridges;*
- TII's DN-STR-03010 *Portal and Cantilever Sign/Signal Gantries;*
- TII's DN-STR-03001 *Technical Acceptance of Road Structures on Motorways and Other National Roads; and*
- TII's GE-STY-01024 *Road Safety Audit.*

Exclusions

This standard does not cover:

a) Requirements for design, placement or operation of mobile VMS (refer to DoT *Traffic Signs Manual*, chapter 8, *VMS Messaging Guidelines and Temporary Traffic Management Design Guidance* for use of mobile VMS);

b) Requirements for design, placement of operation of lane control signs / advanced motorway indicators (LCS / AMI);

c) Standards and guidance for VMS messaging;

d) Operational requirements.

2. Definitions and Abbreviations

For the purpose of this standard:

- "Shall" indicates that a particular requirement is mandatory;
- "Should" indicates a recommendation; and
- "May" indicates an option.

The terms and definitions given in Table 2.1 shall apply.

Table 2.1 Terms and Definitions

Term	Definition
ADS	Advance Direction Sign
Backing board	The surround to the VMS, used depending on local circumstances, providing improved visibility of the VMS by means of broadening its size and by providing suitable visible contrast with the VMS background.
Cantilever support	Support system with a single post and a cantilever arm supporting VMS(s) mounted over the traffic lane(s).
Continuous VMS (or continuous matrix VMS)	A variable message sign (VMS) made of continuous pixels across the entire display area, with display elements existing between characters.
Control device	Equipment used to execute a change of message other than by purely manual means.
DoT	Department of Transport
Display surface	The visible part of a VMS that contains the elements that may be activated to display the message.
Element	The 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.
Front panel	The visible part of a sign comprising the display surface; and the backing-board when this is integrated in the front of the VMS.
Front screen	A screen protecting the display surface or the parts of it against dust, water, etc.
Gantry	Support system spanning a carriageway with one or more posts on each side of the carriageway supporting VMS mounted over the traffic lanes.
Horizontal reference plane	The horizontal plane containing the reference axis, when the VMS is positioned in such a way that the reference axis is horizontal.
Lantern	A flashing light source incorporated into a VMS which is designed to draw attention to the sign or signal. Required to accompany certain defined Aspects; see also TII's VMS Messaging Guidelines.
Lay-out	The physical arrangement of characters (text) and symbols, on the display surface.
Legibility distance	The legibility distance is a distance calculated based on letter height multiplied by a specific factor. This factor is dependent on various environmental and human parameters and is typically given a value in the range of 500 to 600. See also EN 12966.
LED	Light-emitting diode

Term	Definition
Luminance ratio (LR)	The ratio of luminance emitted from the sign in the ON state compared to the luminance in the OFF state. Luminance ratio shall be calculated as follows: LR = La – Lb/Lb Where La is the measured luminance of the sign in the ON-state when under external illumination Lb is the measured luminance of the sign in the OFF-state when under external illumination
Matrix	A grid whose intersections hold the centre of the elements used in a VMS. A matrix may cover the whole display surface or part of it. Axes X and Y of the grid may or may not be orthogonal.
MOCC	Motorway Operations Control Centre
Irregular matrix	The spacing of intersections on either X or Y or both axes is not constant.
Regular matrix	The spacing of intersections on the X and Y axes is constant but may be different.
Message	A configuration consisting of symbols and/or text.
Reference axis	The axis originating on the reference centre of the test module being perpendicular to the front of it, unless otherwise defined by the manufacturer.
Reference centre	A point on or near the test module which is designated to be the centre of the device for specifying its performance and which shall be defined by the manufacturer.
Test angles	The horizontal test angle is the angle between the test axis and the vertical reference plane; and the vertical test angle is the angle between the test axis and the horizontal reference plane. NOTE 1: When the test axis is lower than the horizontal reference plane the vertical component of the test angle is designated as negative. NOTE 2: When the test axis is to the left of the vertical reference plane as seen from the reference centre the horizontal component is designated as negative.
TII	Transport Infrastructure Ireland
TSM	Traffic Signs Manual
Test axis	The line from the reference centre of the test module to the luminance meter head.
Variable message sign (VMS)	A sign for the purpose of displaying one of a number of messages that may be changed or switched on or off as required.
Vertical reference plane	The vertical plane containing the reference axis.
VMS Background	The part of environmental scenery, which, to the viewer, immediately surrounds the VMS.

3. Sustainability

The environmental impact of the design and construction of fixed VMS and associated equipment should be minimised as far as reasonably practicable.

This Standard sets out sustainability requirements for VMS materials, construction and power consumption in Section 8.

Transport Infrastructure Ireland (TII) is committed to developing, maintaining and operating the national road network in a safe, cost effective and sustainable manner.

4. Site Selection

This section outlines requirements and guidelines that should be considered when establishing the location of new VMS on the roadway network.

4.1 Use Cases

VMS can be deployed to support the operations of a road network in various ways. The three general uses of VMS include:

- Road user information systems;
- Tactical control; and
- Strategic traffic management.

These use cases are outlined in Sections 4.1.1 through 4.1.3. For greater detail on content displayed on VMS, refer to TII's *Variable Message Sign (VMS) Messaging Guidelines (DN-TSM-03084)*.

4.1.1 Road User Information Systems

Road user information systems provide road users with information about current or future events on the road network. VMS can provide road users with information either in advance or in real time, for incidents or events on the road network that may affect traffic conditions and journey times. The information may relate to the local network or extended network links such as ferry ports or airports. Events could include incidents, roadworks or major sporting events. Related applications could involve the provision of estimated journey time information, road safety campaigns or information on onward journeys (e.g. park and ride facilities).

4.1.2 Tactical Control

Tactical control provides information to road users in response to an incident or event occurring on the road network. Such incidents or events can include:

- Blocked lanes (as from collisions, disabled vehicles, and debris);
- Closures and/or detours;
- Roadway construction or maintenance activity;
- Emergency traffic restrictions (e.g., on vehicle weight, height, or width); and
- Adverse weather conditions such as snow, dense fog, flooding, etc.

4.1.3 Strategic Traffic Management

Strategic traffic management enables the network operator to provide road users with information and advice on network-wide traffic conditions.

4.2 Sign Type

VMS can be categorised by the geographic relevance of the messages they are intended to convey. Key VMS types accordingly include Strategic VMS and Tactical VMS.

Each new VMS should be positioned on the road network taking into account the VMS type (and accordingly, the types of messages they are intended to display).

For guidance on the messages that may be displayed on each type of VMS, refer to *Variable Message Sign (VMS) Messaging Guidelines (DN-TSM-03084)*.

4.2.1 Strategic VMS

Strategic VMS display messages that relate to traffic conditions on the entire road network and not just in a specific area. They may provide information in advance to road users in relation to an incident, event or traffic conditions on an adjoining route. While this message may not be relevant to all road users at that point, those who may be affected will have the opportunity to revise their route.

Strategic VMS are generally sited in relation to decision points on the network (see Section 4.3.1).

Photograph 4.1 Example of a Strategic VMS (on a Cantilever Gantry)

4.2.2 Tactical VMS

Tactical VMS are used to display messages relevant to the section of the road network on which they are installed. Tactical messages are localised for road users that are directly affected by the incidents, events, or traffic conditions such as from nearby roadworks.

Network links which may benefit from the use of tactical VMS include those which:

- Have high traffic volumes;
- Are regularly congested;
- Experience periodic hazards (such as traffic collisions);
- Experience local problems that require frequent regulatory information to be provided for road users; and
- Experience regular weather events.

Photograph 4.2 Example of a Tactical VMS (Portal gantry-Mounted)

4.2.3 VMS on Urban Approaches to National Roads

VMS on approach to national roads (Urban Approach VMS) can be used to enhance overall traffic control and provide information to road users at strategic locations within urban environments where the use of a strategic or tactical VMS is impractical.

Urban Approach VMS, and particularly their mounting structures, are designed to be smaller and more flexible to suit urban environments. They can be supported on a single post or on a pair of posts which should be sited to reduce obstruction to pedestrian and bicycle movements (in cases where the signpost is on a footpath / cycle track).

Photograph 4.3 Example of an Urban VMS (Post-Mounted)

4.3 Distances and Spacing

This section outlines the required distances between VMS sites and:

- Key road network features; and
- Fixed signage and other VMS.

4.3.1 Distance in Advance of Junctions

Depending on operational needs, strategic VMS may be installed in advance of decision-making points, including:

- Diverge exits at motorway-to-motorway interchanges; and
- Diverge exits at motorway-to-national road junctions.
- Diverge exits at motorway-to-regional and local road junctions

Where the operational need for strategic VMS in advance of a given interchange or junction has been established, the VMS siting requirements in this section should be followed.

If the designer is unable to meet sign placement requirements in this section, a departure shall be sought by the designer.

Advance direction signs are typically present in advance of interchange / junction diverge exits. New strategic VMS installed in advance of interchange / junction diverge exits should be positioned relative to the position of these Advance Direction Signs (ADS).

As per all relevant parts of the DoT *Traffic Signs Manual*, chapter 2, the approaches to diverge exits from motorways and grade-separated dual carriageways typically have:

- One ADS (the “primary ADS”) approximately 1 km in advance of the start of the diverge taper; and
- One ADS (the “secondary ADS”) approximately 500 m in advance of the diverge taper.

In advance of motorway-to-motorway interchange diverge exits, two strategic VMS should be present:

- One strategic VMS (the “primary VMS”) upstream of the primary ADS; and
- One strategic VMS (“the secondary VMS”) upstream of the secondary ADS.

The preferred location of the primary VMS is 1.25 kilometres upstream of the start of the diverge taper and should be located at least 200 meters upstream of the primary ADS

The preferred location of the secondary VMS is typically 750 m upstream of the start of the diverge taper and should be located at least 200 meters downstream of the primary ADS and 200m upstream of the secondary ADS.

See Figure 4.1 for the typical layout of ADS and VMS in advance of motorway-to-motorway interchange diverge exits.

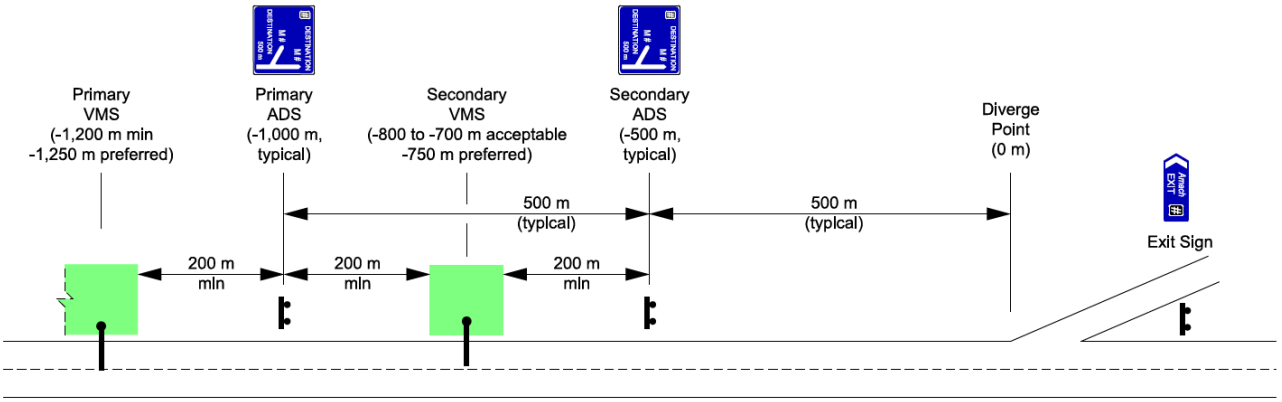

Figure 4.1 Typical Strategic VMS Placement in Advance of Motorway-to-Motorway Interchange Diverge Exits

In advance of motorway-to-national road junction diverge exits, one strategic VMS (the "primary VMS") should be present upstream of the primary ADS.

The primary VMS should be located 1.2 – 1.5km upstream of the start of the diverge taper.

See Figure 4.2 for the typical layout of ADS and VMS in advance of motorway-to-national road junction diverge exits.

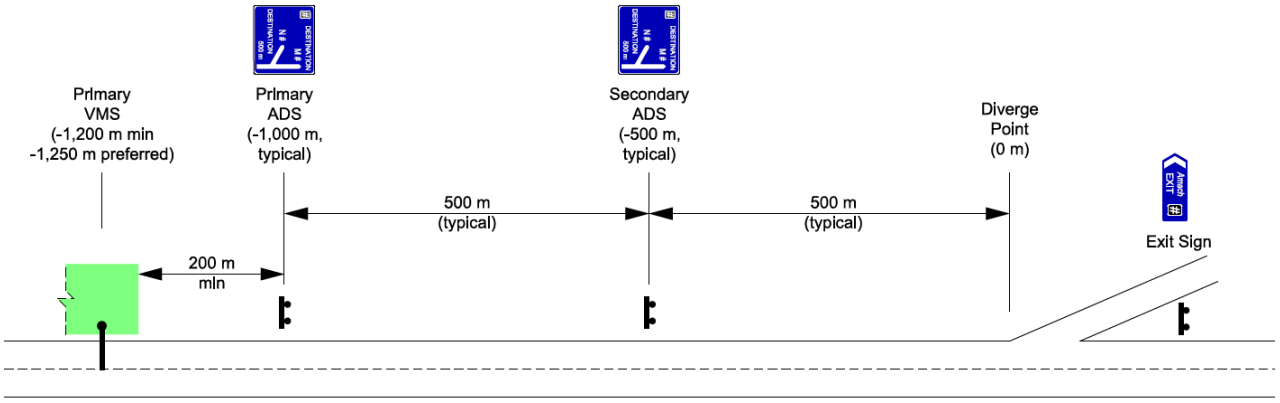

Figure 4.2 Typical Strategic VMS Placement in Advance of Motorway-to-Non-Motorway Junction Diverge Exits

4.3.2 Minimum Spacing / Inter-Sign Distance

VMS should be positioned such that the minimum required distances between signs given in Table 4.1 are maintained.

Table 4.1 Minimum Inter-Sign Distance Requirements

Between VMS	Minimum Distance	
	Preferred	Absolute
Any Two Verge-Mounted Signs	300 m	200 m
Any Verge-Mounted Sign and a Gantry-Mounted Sign	300 m	200 m
Any Two Gantry-Mounted Signs	-	300 m

4.3.3 Maximum Spacing

Road users may be confused by VMS messages too far upstream of abnormal roadway conditions (e.g., incidents, closures, detours).

Similarly, long road segments without VMS can limit the ability for the Motorway Operations Control Centre (MOCC) to communicate with road users in a timely manner. Accordingly, intermediate VMS should be considered for placement on sections of road where there is a long distance between junctions / interchanges (and associated strategic VMS) and/or where VMS are necessary to meet traffic management objectives.

4.4 Contravention of Fixed Signage

Wherever possible, the location and content of fixed signage and VMS in proximity should be coordinated such that VMS do not display messages conflicting with fixed signage.

4.5 Operational Coordination

The operational boundaries / conditions for the MOCC that will operate a new VMS need to be established. Any existing interactions with respect to traffic management operations should be identified and examined in order to determine:

- Any potential operational conflicts;
- Any potential for dual operation; and
- Any potential advantages to be gained from interactions between operators.

5. Site Layout

This section sets out the requirements for the placement of new fixed VMS in relation to the carriageway and traffic lanes once a VMS site location on the road network has been established (see Section 4 for discussion of VMS site selection). These requirements include roadway clearance, vehicle restraint systems, visibility, mounting locations, and maintenance needs.

5.1 Equipment

VMS sites should include the following features:

- VMS (one or many);
- Mounting structure(s);
- Equipment cabinet;
- Power supply;
- Conduits between equipment and to network-level communications;
- Vehicle restraint systems (if applicable); and
- Maintenance access (typically including maintenance bay).

5.2 Equipment Locations

VMS should be positioned to maximise functionality; however, within the tolerances allowed for the positioning of the primary and secondary VMS, the location should be chosen to minimise cost and the impact on the receiving environment. In choosing the location, maximising the ability of the infrastructure to service other needs should also be considered, such as sharing infrastructure with other serviceable apparatus. E.g., weather stations.

New VMS should be positioned in accordance with all relevant parts of the DoT *Traffic Signs Manual*, chapter 1.

To determine the precise location of a VMS, the following criteria must be considered during site surveying and planning:

- Roadway geometry
  - Roadway grade
  - Roadway horizontal & vertical curvature
  - Verge width
  - Clear zone
  - Speed limit
  - Lane configurations
- Existing site features
  - Existing signage (including fixed signage and VMS)
  - Right of way extents
  - Vehicle restraint systems
  - Power source

  - ITS communications equipment and ducting
  - Underground services
  - Vegetation
  - Geotechnical conditions
- Construction
  - Constructability
  - Traffic management
- Proposed VMS design
  - VMS display area size
  - VMS sign face alignment
  - Sightlines
  - Sustainability requirements
  - Maintenance access (and required traffic management)

An example plan layout of equipment at a VMS site is illustrated in Figure 5.1.

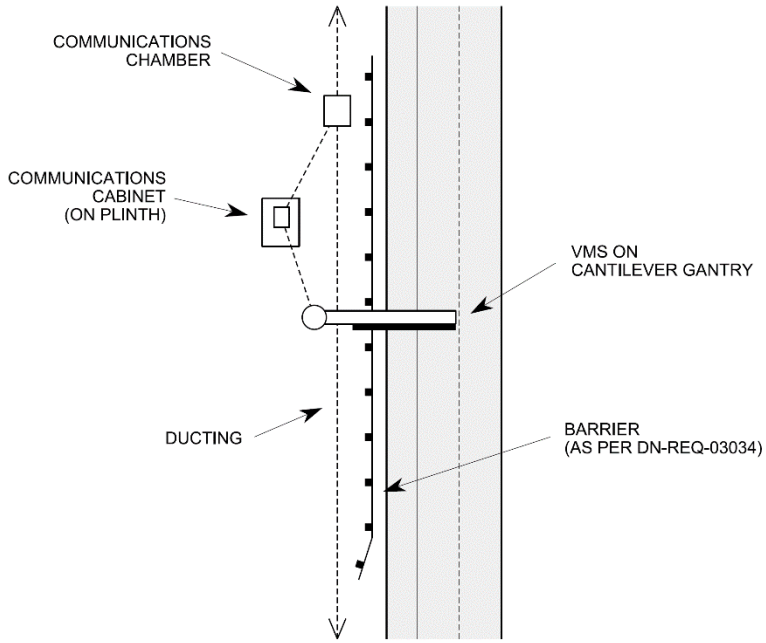

Figure 5.1 Plan View of Typical VMS Site (VMS on Cantilever Gantry Shown)

An example section view of a typical post-mounted VMS is illustrated in Figure 5.2. An example section view of a typical gantry-mounted VMS is illustrated in Figure 5.3.

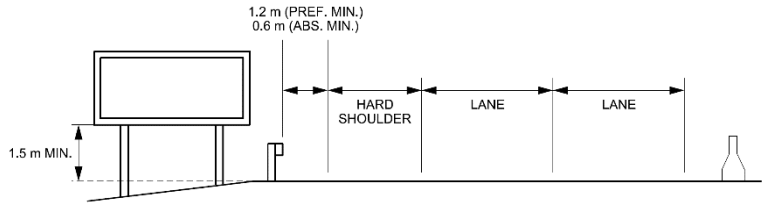

Figure 5.2 Section View of Typical Post-Mounted VMS

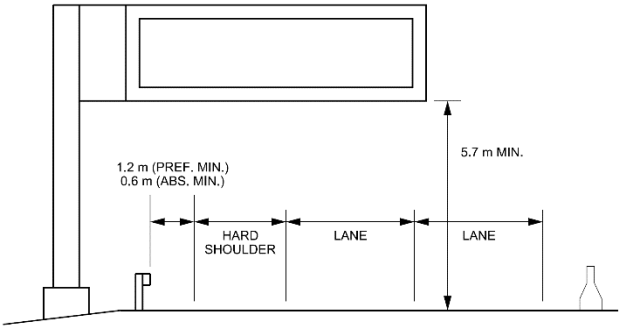

Figure 5.3 Section View of Typical Gantry-Mounted VMS (VMS on Cantilever Gantry)

5.2.1 Vertical Clearance

All new VMS and their supporting structures installed above roadways, cycleways and footpaths shall be positioned to maintain the headroom requirements noted in Table 5.1.

Table 5.1 Minimum Headroom Beneath VMS and Structures

VMS / Structure Location	Minimum Headroom Beneath VMS and Structures	Reference
Above Roadways and Motorways	**5.7 m**	**DN-GEO-03036 Cross Sections and Headroom, Table 5.1**
Above Footpaths & at urban approaches with Pedestrians	2.3 m	Traffic Signs Manual, Chapter 1
Above Cycleways & Urban Areas with Cyclists	2.5 m	Traffic Signs Manual, Chapter 1

5.2.2 Horizontal Clearance

New VMS and their supporting structures should be installed such that they do not infringe upon roadway cross-section requirements set forth in *DN-GEO-03036 Cross Sections and Headroom*. Vehicle restraint systems (VRS) protecting VMS and their supporting structure, which should be placed outside the working width of the VRS, should be installed in accordance with *DN-REQ-03034 The Design of Road Restraint Systems (Vehicle and Pedestrian) for Roads and Bridges and IS EN 1317*.

VMS and their supporting structures shall be protected by VRS, as VMS and their supporting structures cannot feasibly be located outside of a roadway's clear zone or be designed to be passively safe, as detailed in *DN-REQ-03034 The Design of Road Restraint Systems (Vehicle and Pedestrian) for Roads and Bridges*.

As per *DN-GEO-03031 Rural Road Link Design*, VMS and supporting equipment shall not be installed in locations that obstruct road user sightlines.

5.2.3 Visibility

As per all relevant parts of the DoT *Traffic Signs Manual*, chapter 1, VMS should be located such that road users have adequate visibility and sufficient time to react to the VMS message.

As per *EN 12966 Road vertical signs – Variable message traffic signs*, outlines the recognition time necessary for road users to read and understand a message is dependent on the posted speed limit of the roadway. Further requirements and specifications for recognition time are detailed in *EN 12966 Road vertical signs – Variable message traffic signs*, Annex N.

VMS shall be designed as close to the optimal position in three-dimensional space to maximise the duration that the VMS falls within road users' cones of vision. There should be an uninterrupted view from 250m upstream of the VMS to permit a sufficient cone of vision for road users.

In the case of high-speed dual carriageways and motorways, appropriate adjustments shall be considered to ensure sufficient visibility for road users to read the text properly and be able to react to the information.

The installation of new VMS immediately after a curve on roads should be avoided where possible.

On high-speed roads, clear sightlines from each lane to the VMS shall be maintained up to a point on the roadway 250m upstream from the VMS and if possible, should be maintained up to 400m upstream from the VMS.

For lower speed roads, the forward visibility distance shall be maintained in accordance with *EN 12966 Road vertical signs – Variable message traffic signs*, Annex N. The sign face of the VMS shall be oriented to allow for forward visibility.

VMS should be positioned such that obstructions including trees, bridges and other signage do not obstruct road user sightlines to the VMS.

VMS sites shall be maintained so that vegetation is prevented from obscuring the visibility of the VMS. For VMS positioned near vegetation, a paved area may be provided in front of VMS for such a distance as necessary to prevent VMS obstruction by the vegetation.

Post-mounted VMS can be obscured to vehicles in outer lanes if high-sided vehicles are present in the lanes nearer to the VMS. If adequate sightlines cannot be maintained to post-mounted VMS, gantry-mounted VMS should be considered. For additional discussion of VMS mounting structures, see Section 5.3.

Weather conditions such as fog, dust, snow, or rain can adversely affect the visibility of VMS. Such conditions can reduce the contrast between the VMS messages and the background. Contrast between the VMS messages and the background can be improved by variable display area brightness informed by light level sensors (see Section 6.1.3) and the inclusion of a backing board (see Section 6.2).

5.2.4 Supporting Equipment

Where possible, the site's equipment cabinet should be installed downstream of its corresponding VMS.

5.2.5 Road Safety Audits

As part of the planning and design of a VMS site, consideration should be given to conducting a road safety audit to identify potential safety hazards that could affect road users. Requirements for where and how road safety audits should be conducted are given in TII's *GE-STY-01024 Road Safety Audit*.

5.3 VMS Mounting Structures

New VMS should be installed on one of three following types of mounting systems:

- Post-mounted;
- Cantilever gantries; and
- Portal gantries.

VMS should not be installed on bridges or other non-ITS-related structures.

- VMS shall be installed on standalone structures specifically designed for the intended VMS as per TII's DN-STR-03010-03 - Portal and Cantilever Sign/Signal Gantries and DN-STR-03001 – Technical Acceptance of Road Structures on Motorways and Other National Roads. Table 5.2 outlines preferred mounting systems for each type of VMS.

Table 5.2 Preferred VMS Sign Mounting Systems, by VMS Type

VMS Type	Mounting System		
	Post-Mounted	Cantilever Gantry	Portal Gantry
Strategic VMS	-	Preferred	Preferred
Tactical VMS	Accepted	Preferred	Preferred
Urban Approach VMS	Preferred	Accepted	Accepted

See Section 7.2 for design & construction requirements for sign and gantry structures.

5.3.1 Post-Mounted VMS

VMS may be mounted on roadside posts on the near-side verge of a carriageway. Such post-mounted VMS are typically mounted on posts 3 to 5 m above the level of the top of the adjacent roadway surface.

Post-mounted VMS are economic and easy to install, and relatively straight forward to maintain. However, post-mounted VMS can be obscured to vehicles in outer lanes if high-sided vehicles are present in the lanes nearer to the VMS. VMS obstruction to vehicles may be overcome with the provision of identical repeater signs.

Tactical and Urban Approach VMS may be post-mounted. Strategic VMS are rarely post-mounted.

5.3.2 Cantilever Gantry VMS

VMS may be mounted on a gantry near-side verge "cantilevering out" above the roadway lanes. Mounting VMS on a cantilever gantry structure improves visibility of the VMS and reduces obscuration of messages by high-sided vehicles.

Limitations of mounting VMS on cantilever gantries include:

- The civil engineering works required to install the concrete foundation, which can cost more than the VMS itself; and
- The installation of the cantilever gantry and VMS can require significant traffic management.

Strategic and tactical VMS should typically be mounted on cantilever gantries.

5.3.3 Portal Gantry VMS

Portal gantry structures (also known as cross-carriageway gantry structures) shall be used to mount strategic and tactical VMS where the optimum positioning and visibility of the sign cannot be achieved through the use of a cantilever structure, or where a dual-purpose gantry structure is proposed. Portal gantry structures may span a single carriageway or across both carriageways.

Lane control signs are typically mounted on portal gantry structures directly above each running lane for traffic management and control purposes.

Mounting VMS on gantries provides superior visibility and larger display capabilities as detailed in the DoT *Traffic Signs Manual*, chapter 3.

Gantries, including cantilever gantries, can also be used to mount additional ITS infrastructure such as ANPR, CCTV cameras and vehicle detection systems.

5.3.4 Tunnel Environments

For requirements relating to the installation and operation of VMS on tunnel approaches and within tunnels, refer to *DN-STR-03015 The Design of Road Tunnels*.

5.4 Maintenance Site Access

Site components for VMS shall be positioned such that inspections and maintenance activities as described in the DoT *Traffic Signs Manual*, chapter 1, may be performed.

VMS sites should have lay-bys for maintenance access. However, in some cases, multiple VMS sites may share a single lay-by or be served by other maintenance access where they are no more than 100m from the base of the gantry.

Structures with VMS shall have ladder access as noted in Table 5.3. Access to ladders shall be controlled to prevent vandalism.

Table 5.3 Required VMS Maintenance Access by Sign Type, Road Type, and Mounting Structure

Urban	Low-speed Road	Post-mounted	Portable
Tactical	Dual Carriageway	Post-mounted	Permanent
	Motorway	Cantilever Gantry	Permanent
		Portal Gantry	Permanent (one ladder on each side of carriageway)
Strategic	Motorway	Cantilever Gantry	Permanent
		Portal Gantry	Permanent (one ladder on each side of carriageway)

Gantries that support VMS shall be designed to provide fixed maintenance access in accordance with the requirements detailed further in *DN-STR-03010 Portal and Cantilever Sign / Signal Gantries,* Appendix E. The design requirements for fixed maintenance access include walkways or platforms, mitigation of vandalism and theft, handrails, ladders, lifting equipment and variable actions (imposed loading).

VMS should be mounted on gantries in a position such that VMS access panels can be opened and accessed for maintenance and inspection purposes without obstruction.

VMS without ladder access shall be accessible via a mobile access platform. Gantries should have an access ladder where possible, but implications associated with mobile access platforms for inspection and maintenance purposes must be considered with respect to lane closures during the design stage of VMS.

6. Sign Size and Face Appearance

This section sets out requirements for the appearance of new VMS installed on the road network including the display area, frame and accompanying flashing beacons.

6.1 Display Area

Each sign shall consist of an aluminium enclosure with a display area capable of displaying combinations of text or pictograms. The display area shall be constructed with a continuous matrix of full colour RGB LEDs.

The display area of a VMS contains elements which may be activated to display messages as per *EN 12966 Road vertical signs – Variable message traffic signs*.

The display area of a VMS shall comply with the relevant design considerations, as applicable, detailed in the DoT *Traffic Signs Manual*, chapter 3.

For guidance on the messages that may be displayed on each type of VMS, refer to *Variable Message Sign (VMS) Messaging Guidelines*.

6.1.1 Display Area Size

New VMS shall have display areas sized based on the VMS sign type as given in Table 6.1.

Table 6.1 VMS Display Area Dimensions, by VMS Type

VMS Type	Example Dimensions (mm)			Preferred Dimensions (mm)	
	VMS Model	Width	Height	Width	Height
Strategic VMS	MS3	7,680	1,920	7,000 – 8,000	1,800 – 2,200
Tactical VMS	MS4	3,840	1,920	3,000 – 4,500	1,500 – 3,000
	VMS-P	3,840	2,560		
Urban VMS	Urban VMS	3,840	1,600	3,500 – 4,500	1,200 – 2,000

6.1.2 Display Area Pitch

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.

6.1.3 Display Area Visual Performance

New VMS deployed on the road network shall be of a type that meets the visual performance requirements of *EN 12966 Road vertical signs – Variable message traffic signs*, section 4.4. Visual performance requirements include colour, luminance (La), luminance ratio (LR) and beam width. Manufacturers shall demonstrate product compliance with the specification.

In accordance with *CC-SPW-01400 Specification for Electrical Work for Road Lighting and Traffic Signs*, section 10, the failure rate of LED drivers shall be a minimum of 100,000 hours in terms of operational lifetime, with a minimum survival of 90% during this period.

New VMS should be selected and installed such that beam widths are not unnecessarily wide. VMS with unnecessarily wide beam widths waste energy, cost money, and create light pollution.

In instances where a message is not being displayed or there are display issues, VMS shall exhibit a default black area as a failsafe blanking out mode.

6.1.3.1 Dimming Sensors

VMS shall be equipped with light level sensors and the VMS display area shall be capable of adjusting brightness levels accordingly in response to ambient light conditions. As per *EN 12966 Road vertical signs – Variable message traffic signs*, tables 4 to 9 in section 4.4.3.2 display potential dimming levels of VMS that are dependent on ambient light conditions.

6.2 Frame

The VMS frame (also known as the backing board) shall be nonreflective and black in colour.

The VMS frame should have a width similar to the example frame widths given in Table 6.2 below.

Table 6.2 Example VMS Frame Dimensions, by VMS Type

Strategic VMS	MS3	320
Tactical VMS	MS4	320
	VMS-P	356
Urban Approach VMS	Urban VMS	75

6.3 Accompanying Flashing Lanterns

MS3 and MS4 VMS shall have accompanying flashing lanterns positioned external to the display area and within the frame area (i.e., surrounding the display area).

VMS-P and urban approach VMS shall have the capability to display virtual flashing lanterns within the display area.

Any flashing lanterns that accompany a VMS shall be authorised by the DoT before being used on any road, in accordance with all relevant parts of the DoT *Traffic Signs Manual*, chapter 3.

As per the DoT *Traffic Signs Manual*, chapter 3, in instances where accompanying flashing lanterns are required, four flashing amber lanterns shall be provided. Two lanterns should be positioned above the displayed message and two below the displayed message. The lanterns shall be positioned at or near each corner of the sign.

In cases such that VMS are constrained by sign dimensions or sighting difficulties, lanterns shall be positioned at either side of the displayed message.

Lanterns shall flash at a rate of 60 flashes per minute (0.5 seconds on the top and 0.5 seconds on the bottom).

7. Sign Construction

This section sets out materials and construction requirements for new VMS and their supporting structures.

7.1 VMS

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

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

New VMS deployed on the road network shall be of a type that meets the requirements of *EN 12966 Road vertical signs – Variable message traffic signs*. Manufacturers shall demonstrate product compliance with the specification.

7.1.1 Physical Performance

The physical performance of a VMS type shall be in accordance with *EN 12966 Road vertical signs – Variable message traffic signs*, Section 4.5. Use of sustainable materials should be employed where feasible.

VMS shall be of a type that can operate with external temperatures as low as -15°C and as high as +60°C and meet the requirements for Temperature Range Class T1 as specified in *EN 12966 Road vertical signs* – Variable message traffic signs, Section 4.5.2.1.

VMS shall provide protection against the ingress of pollution, and all outstation and electrical/ electronic equipment shall be housed in suitable enclosures as specified in *EN 12966 Road vertical signs – Variable message traffic signs*, Section 4.5.2.2 to the minimum class D2 level and comply with the degree of resistance to pollution in accordance with *EN 60664-1 Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*.

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, 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.

VMS Mounting

VMS mounting arrangements shall include the facility to adjust and align the optical axes of the VMS according to the local road geometry, considering the optical performance of the particular VMS.

Optical alignment of the VMS 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).

The method of optical alignment shall employ multi-turn bolts, which can be locked in the desired position.

The optical alignment of the VMS in the horizontal plane shall be incorporated into the design and orientation of the structure.

VMS Lifespan

New fixed VMS shall have a lifespan of at least 20 years.

7.1.2 Visual Performance

The visual performance of a new VMS type shall be in accordance with *EN 12966 Road vertical signs – Variable message traffic signs*, Sections 4.3 and 4.4.

7.1.3 Electrical Requirements

General

All electrical systems and equipment supplied or employed to complete the electrical installation shall be designed, manufactured, installed, tested and commissioned in compliance with the appropriate and current European standard, published as I.S. EN or CENELEC harmonisation document or the equivalent Irish standard, or in the absence thereof, with the appropriate international standard. Equipment for which none of these standards exist shall comply with the appropriate IEC, ISO, or BSI standard.

All electrical works shall comply with the following:

- National Standards Authority of Ireland's (NSAI) I.S. 10101:2020 National Rules for Electrical Installations;
- Current ESB Networks regulations, codes of practice and guidelines; and
- All requirements, guides and codes of practice of the Health and Safety Authority.

Supply of electrical and electronic equipment shall comply with the Waste Management (Waste Electrical and Electronic Equipment) Regulations 2012 and the Waste Management (Restriction of Certain Hazardous Substances in Electrical and Electronic Equipment) Regulations 2012.

All equipment and components shall be compatible with one another and suitable for the use as intended and for the conditions to be expected in normal service and in fault conditions.

Mechanical Protection

Degrees of protection codes for equipment shall be in accordance with:

- I.S. EN 50102 Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code);
- I.S. EN 60529 Specification for degrees of protection provided by enclosures (IP code).

EU Directives and CE Mark

All equipment supplied or employed to complete the electrical installation shall be clearly CE marked and shall conform to the requirements of all relevant EU Directives including the following:

- Energy-related Products (ErP) Directive 2009/125/EC;
- Low Voltage Directive (LVD) 2014/35/EU;
- Electromagnetic Compatibility (EMC) Directive 2014/30/EU;
- Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU; and
- Restriction of Hazardous Substances (RoHS) Directive 2011/65/EU.

Electrical Supply Characteristics

The nominal low voltage electrical supply is 400/230V. Small power services shall be 230 VAC.

The nominal supply frequency is 50 Hz.

Supplies to existing mini-pillars are single-phase alternating current.

Single phase installations shall be designated L, N, E.

Standard voltage levels shall be as per Table 7.1.

Table 7.1 Standard Voltage Levels

Voltage Level	Declared Supply Voltage U_o
Low Voltage (LV)	230V (single phase)

Standard voltage ranges shall be as per Table 7.2.

Table 7.2 Standard Voltage Ranges

Band	Nominal voltage phase to earth U_n	Nominal r.m.s. voltage U_n
Low Voltage (LV)	50V < Un ≤ 600V	50V < Un ≤ 1000V

Electrical supply earthing will be the TN_C-S system.

In all cases refer to *I.S. EN 50160:2010 Voltage characteristics of electricity supplied by the public electricity networks*.

Low Voltage Electrical Distribution and Protection

Each VMS shall be provided with a suitably designed low voltage electrical distribution and protection circuit. The principles of electrical discrimination shall be observed at each installation.

A 2-pole isolator switch shall be fitted at the incoming mains supply in the roadside cabinet. Isolators shall be an enclosed, non-fused switch-disconnector model, designed to *I.S. EN 60947-3*. Isolators shall be rated for:

- 63 A, 230 VAC, single-phase 50 Hz
- Type AC23A

- Multiple-operation short-circuit breaking capacity of 9 kA rms (minimum)
- IP65

A suitably rated residual current device (RCD) or residual current circuit breaker with overcurrent protection (RCBO) shall be fitted to the incoming mains supply and be capable of breaking the maximum rated load for the VMS and other electrically supplied equipment at the site. RCBOs shall be industrial C-type rated devices. The RCD or RCBO shall be located in the in the roadside cabinet.

RCDs and RCBOs shall be in accordance with I.S. *EN 61008* and *IS EN 61009*, respectively.

A suitable power distribution board consisting of suitably rated industrial C-type MCBs shall be fitted internally at the VMS. Local isolation to the VMS may be provided by the main MCB at this distribution board. Where MCBs are intended to be used as isolating devices, a 'lock off' facility shall be provided.

MCB devices shall be in accordance with *I.S. EN 60947* for use on the specified operating voltage of the network.

Surge protection shall be provided on the incoming mains supply and be capable of protecting the VMS from lightning, mains supply surges and spikes, and radio frequency interference (RFI). Surge protection 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 and communications network. Devices shall be capable of attenuating a maximum surge current of 1.5 kA and voltage of 5 kV.

All components used in the VMS 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.

Electrical Cabling

Cable types and conductor sizes shall be suitably rated as per the recommendations of *I.S. 10101:2020 National Rules for Electrical Installations*.

Electrical cabling supplying power to the VMS enclosure shall be armoured type.

All cable conductors shall be stranded copper, regardless of the conductor size.

The system of colour coding of conductors shall be as per the European harmonised core colour code as follows:

230V AC single phase circuits:	Phase – Brown Neutral – Blue
Earth/Protective conductor:	Green/Yellow

Conductors of each type (phase, neutral and protective) shall not be converted (e.g., by sleeving) for use as any other type of conductor than that specified.

Cable Terminations

All cable cores shall be terminated with correctly crimped compression lugs or bootlace ferules, as appropriate.

All lugs shall be accompanied by a PVC heat shrink tube sleeve of the same identifying colour(s) as the cable insulation with which it is associated as per the European harmonised core colour code.

Cable Glanding

All cable glands shall be to *I.S. EN 50262* with metric threads and sized to suit the cable being terminated.

Gland types in general areas shall be as per Table 7.3.

Table 7.3 Gland Types in General Areas

Cable Type	Gland	Material	IP Rating	Impact Category
SWA	CW	Brass	IP66	6
Unarmoured	A2 A2P	Brass Nylon	IP66	6 4

All glands, seals, shrouds etc., shall be LS0H type.

Cable Identification

Each end of every power and data cable shall be fitted with an identification tag bearing the cable number adjacent to the gland shroud or termination.

All cables running underground shall be fitted with identification tags at all entries to ducts and at all cable chambers.

All control cable cores shall be fitted with correctly sized number/letter identification ferules.

Earthing and Equipotential Bonding

All electrically supplied equipment and furniture shall be earthed and bonded in compliance with *I.S. 10101:2020 National Rules for Electrical Installations* and the latest ESB Networks codes of practice.

Electrical earth bonding between the VMS and the cantilever structure shall utilise PVC insulated stranded copper cable.

Cross-sectional area of bonding connections shall be no less than the largest protective earth conductor in the current carrying conductors supplying power to equipment on the structure.

Structures will be provided with pre-provided terminals for the termination of electrical earth and lightning protection bonding. Earthing cables to be bonded to the structure shall be provided with terminal lugs and shall be bonded to the structure at these points only with a suitable nut, bolt and locking washer arrangement.

Where armoured cable is employed, the cable armour shall not serve as the primary protective earth connection.

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

Earthing and bonding at surge protection devices shall ensure a low impedance path to the main protective earth terminal.

Lightning protection shall conform to the requirements of EN 62305-4:2011 Protection against lightning – Part 4: Electrical and Electronic Systems Within Structures.

Control of Condensation and Temperature

VMS enclosures shall be suitably constructed to:

- Prevent the formation of condensation on both the VMS display windows and within the main body of the sign.
- 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:

- 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.
- Thermostats and humidistats shall be adjustable with the facility to lock the setting in any chosen position.
- Thermostats and humidistats shall be easily accessible and clearly labelled with the manufacturer's recommended setting information.

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

Other Electrical Standards

Installations of new VMS shall be in accordance with the following electrical standards and regulations:

- I.S. 10101:2020 'National rules for electrical installations'
- I.S. EN 61140:2016 'Protection against electric shock – Common aspects for installation and equipment'
- IEC 60364-5-54:2011/AMD1:2021 'Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors'
- I.S. EN 50160:2010 'Voltage characteristics of electricity supplied by the public electricity networks'
- I.S. EN 60947-2:2017&A1:2020 ' Low-voltage switchgear and control gear - Part 2: Circuit breakers'
- I.S. EN 61008-1:2004+A12:2009 'Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) - Part 1: General rules'
- I.S. EN 61009-1:2012 'Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) Part 1: General Rules'
- I.S. EN 60947-3:2009 ' Low-voltage switchgear and control gear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units'
- I.S. EN 50262:1999 'Metric cable glands for electrical installations'
- I.S. EN 62305-4:2011 'Protection against lightning – Part 4: Electrical and electronic systems within structures'
- I.S. EN IEC 62561 'Lightning protection system components'

- BS 951 'Electrical earthing. Clamps for earthing and bonding. Specification'
- I.S. EN 13601 'Copper and copper alloys – Copper rod, bar and wire for general electrical purposes'
- I.S. EN 1652 'Copper and copper alloys – Plate, sheet, strip and circles for general purposes'

7.1.4 VMS Maintenance Requirements

All VMS components shall be within easy reach from the access panels via the maintenance walkway.

All VMS components shall be designed such that there is no risk of components falling onto the roadway.

7.2 Gantries & Sign Structures

7.2.1 General

New gantries and sign structures shall be constructed in accordance with the following documents:

- TII's DN-STR-03010 – *Portal and Cantilever Sign/Signal Gantries;* and
- TII's DN-STR-03001 – *Technical Acceptance of Road Structures on Motorways and Other National Roads*.

Except as required by unusual site conditions, new cantilever and portal gantries constructed to support VMS on high-speed roads should be constructed based on the standard drawings noted in Table 7.4.

Table 7.4 TII Gantry Standard Drawings

Gantry Type	Description	Drawing Numbers
Gantry Group 6	Portal Gantry (Single Carriageway)	CC-SCD-01814 through CC-SCD-1817
Gantry Group 7	Portal Gantry (Two Carriageways)	CC-SCD-01818 through CC-SCD-01821
Gantry Group 8	Cantilever Gantry (MS3)	CC-SCD-01822 through CC-SCD-01824
Gantry Group 9	Cantilever Gantry (MS4)	CC-SCD-01825 through CC-SCD-01827
Gantry Group 10	Single-Post Gantry (MS3)	CC-SCD-01828 through CC-SCD-01829
Gantry Group 11	Single-Post Gantry (MS4)	CC-SCD-01830 through CC-SCD-01831

A cable management system in accordance with CC-SPW-01500 shall be provided for all cable runs to ITS equipment to be installed on the gantry. The gantry cable management system shall have adequate electrical continuity to ensure equipotential bonding and connections to earth.

7.3 Foundations

7.3.1 General

New gantry and sign structures shall be constructed in accordance with TII's *DN-STR-03010 – Portal and Cantilever Sign/Signal Gantries* and in concert with Section 5.

7.3.2 Ducting & Chambers

New gantry foundations shall include ducting passing through the gantry foundations and up to the gantry structure.

7.4 Sustainability

In addition to meeting materials and construction requirements set forth in the preceding subsections, new VMS installations should be designed and constructed to optimise functionality, while reducing costs and resource usage throughout their lifecycle. Sustainability strategies for VMS installations include but are not limited to:

- Positioning infrastructure to minimise ground and structural works;
- Maximise the functionality of the infrastructure constructed;
- Selecting equipment to minimise power consumption;
- Including on-site renewable power generation;
- Selecting materials to maximise equipment durability;
- Selecting materials ultimately can be recycled (reducing end-of-life waste); and
- Selecting materials to enable circular use.

8. Functionality

8.1 Control and Communications

8.1.1 Interface Protocols

The interface protocol is the method by which the control system communicates with VMS and by which diagnostic and operational status information is provided. There are many different interface protocols that can be used. While some of these are proprietary, there are also a number of vendor-independent protocols available for use as follows:

- **National Transportation Communications for ITS Protocol (NTCIP)**
  - NTCIP is a family of communications standard for transmitting primarily data and messages between computer-controlled devices used in ITS applications. NTCIP is being developed and promoted by the U.S. Federal Highway Administration (FHWA), the Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the National Electrical Manufacturers Association (NEMA) to allow interoperability between traffic management devices. It has been used by many highways authorities worldwide and has been adopted by TII as the standard to be used for VMS deployed on the road network. In Ireland the new VMS for motorway applications should be compatible with NTCIP v3 to allow integration with TII traffic operation platforms.
- **Urban Traffic Management and Control (UTMC)**
  - UTMC is similar to NTCIP but is a suite of UK standards more suited to ITS in the urban environment. UTMC has been used in the UK and Ireland by many local authorities. UTMC-compliant systems are widely available from major ITS equipment suppliers.

8.1.2 Communications

The method of communicating with specific VMS is greatly influenced by the VMS' location. TCP/IP-based communications have been widely adopted by the ITS community and it is recommended that such communications be used for VMS deployments on the road network.

Typical options for transmission include but are not limited to:

- Ethernet over fibre-optic or copper;
- Microwave point-to-point (P2P) radio;
- GPRS / 3G UTMS; and
- 802.11 Wireless Ethernet Standards (Wi-Fi, WiMax, Mesh).

8.2 Cybersecurity

8.2.1 Relevant Standards

Installations of new VMS shall be in accordance with the following regulations:

- Department of Environmental, Climate and Communications *Public Sector Cyber Security Baseline Standards*;
- European Union's *General Data Protection Regulation (GDPR);* and

- Ireland's *Data Protection Act*.

Installations of new VMS shall be in accordance with the following guidelines:

- ISO 27001 *Information technology — Security techniques — Information security management systems — Requirements and*
- *NIST Cybersecurity Framework.*

8.2.2 Access Control Procedures

The controlling authority must establish procedures which define access to and operation of the VMS control system. These procedures should include:

- Network security of the VMS control system and associated communications infrastructure;
- Operational access should be limited to authorised and trained personnel;
- Other than in exceptional instances, only prescribed and approved messages should be allowed; and

Suitable arrangements shall be made for control system maintenance.

8.3 Testing

VMS shall be subject to the following testing requirements:

- Factory Acceptance Tests (FATs)
- Site Acceptance Tests (SATs)

FAT and SAT tests must be undertaken in accordance with testing regimes and witnessed by an Employer representative, as detailed further in *CC-SPW-01500 Specification for Traffic Control and Communications*, section 36.4.

8.3.1 FATs

A FAT shall be performed on each VMS to ensure they are operating correctly and are in accordance with the requirements. FATs shall be conducted at the Contractor's facility or at a facility chosen by the Employer in accordance with the approved test plan and test procedures. Additional requirements for FATs are detailed in *CC-SPW-01500 Specification for Traffic Control and Communications*, section 36.4.

The sign off on the FAT confirms that the manufacturer of the sign has met the relevant specifications and the VMS fulfils its purpose. After the FAT is signed off, all subsequent signs can be delivered. Once installed, all signs will be tested on fitness for operation and will then be handed over for maintenance.

8.3.2 SATs

A SAT shall be performed once the contractor has proposed a SAT procedure, inclusive of all required tests to be completed and any subsystem tests. Additional requirements for SATs are detailed in *CC-SPW-01500 Specification for Traffic Control and Communications*, section 36.4.

The SAT shall be valid once the Contractor and the Employer's representative have signed off on it.

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