ROADS AND MARITIME SERVICES

ROAD NETWORK OPERATIONS

SPECIFICATION NO. TSI-SP-011

INTEGRATED SPEED LIMIT
AND LANE USE SIGNS

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# RECORD OF AMENDMENTS

<table>
<thead>
<tr>
<th>Version</th>
<th>Summary</th>
<th>Date</th>
<th>Approved by</th>
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<tbody>
<tr>
<td>1.0</td>
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| 2.0     | Second Issue.  
Main changes from Version 1.0:  
- ....... | 22/06/2010 | A/Mgr, TSI  |
| 3.0     | Third issue  
Main changes from Version 2.0:  
- A complete rewrite of Version 2.0.  
- Major editorial and scope changes.  
- Covers integrated speed and lane use signs, not just speed limit signs.  
- With requirements for design, construction, performance and quality assurance of integrated speed and lane use signs, but not installation or maintenance.  
- Requires compliance with Australian Standard for electronic speed limit signs and RMS Specifications TSI-SP-016 for outdoor electronic equipment.  
- With updated requirements for sign communications, including IP-based communications. | 25/02/2014 | A/Mgr, TSI  |
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- Changed title from Integrated Speed and Lane Use Signs, to Integrated Speed Limit and Lane Use Signs.  
- Editorial changes associated with change to document title.  
- Changed the sign face to a square shape.  
- Clause 8.1 – Made reference to Appendix A for height and width dimensions of the sign enclosure.  
- Appendix A – Changed title to “ISLUS Dimensions and Display Layout”. Changed height dimensions to the same values as the width. | 1/04/2014 | A/Mgr, TSI  |
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No change to the intellectual content. Only | 1/04/2014 | A/Mgr, TSI  |
change is version renumbering for consistency with revised numbering practice.
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1. SCOPE

This specification covers requirements for integrated speed limit and lane use signs (ISLUS) that are used in permanent positions above or adjacent to roadways as appropriate for speed limit and/or lane use management in the State of New South Wales.

This specification includes requirements for the design, performance and quality assurance of integrated speed limit and lane use signs including their associated sign controllers.

NOTE: Version 3.x of this Specification are rewrites of Version 2 of TSI-SP-011 (which covered variable speed limit signs) with an expansion to the sign function and a reduction in scope. The sign can now be used both as a speed limit sign and a lane use sign, but the specification no longer covers requirements for sign installation and maintenance. The title of the specification has been changed accordingly.

This specification also makes reference to the Australian Standard for electronic speed limit signs AS 5156.
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2. REFERENCES AND APPLICABLE DOCUMENTS

2.1 Australian Standards

The following standards have been referred to in subsequent clauses of this Specification:

- AS/NZS 1170.2 – Structural design actions - Wind actions
- AS 2700 – Colour standards for general purposes
- AS/NZS 3000 – Electrical installations (known as the Australian/New Zealand Wiring Rules)
- AS/NZS 3080 – Telecommunications installations – Generic cabling for commercial premises
- AS/NZS 3100 – Approval and test specification – General requirements for electrical equipment
- AS 5156 – Electronic speed limit signs
- AS 60529 – Degrees of protection provided by enclosures for electrical equipment (IP Code)
- AS/NZS 60950.1 – Information technology equipment – Safety – General requirements
- AS/NZS ISO 9001 – Quality management system - Requirements

2.2 RMS Specifications and Documents

The following RMS specifications and documents have been referred to in subsequent clauses of this Specification:

- TSI-SP-003 – Communications Protocol for Roadside Devices
- TSI-SP-016 – General Requirements for Outdoor Electronic Equipment

2.3 Other Standards

The following standards have been referred to in subsequent clauses of this Specification:
ISO/IEC 8877 – Information technology - Telecommunications and information exchange between systems - Interface connector and contact assignments for ISDN Basic Access Interface located at reference points S and T

ISO 9001 – Quality management systems - Requirements

ISO 9660 – Information processing; volume and file structure of CD-ROM for information interchange

TIA-232 (formerly RS-232) – Interface between Data Terminal Equipment and Data Communications Equipment employing serial binary data interchange

TIA-485 (formerly RS-485) – Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

### 2.4 Compliance with Specifications

All equipment and materials, where not otherwise specified, shall be in accordance with Australian Standards/Specifications where such exist, and in their absence, with appropriate IEC or ISO Standards/Specifications.

The Sign (equipment) and its recommended installation method shall comply with the requirements of the NSW Work Health and Safety Act.

The equipment shall comply with the safety requirements of the National Electrical Codes AS/NZS 3000, AS/NZS 3100 and AS/NZS 60950.1.

Except where specifically stated otherwise in this Specification, the equipment shall comply with all relevant requirements of Specification TSI-SP-016 insofar as they are applicable.
3 DEFINITIONS AND GLOSSARY OF TERMS

For the purposes of this Specification, the following definitions and abbreviations shall apply:

8P8C – Eight position eight contact modular connector in accordance with ISO/IEC 8877

ACMA – Australian Communications and Media Authority

Auto-MDI/MDIX switchover – Automatic medium dependent interface/medium dependent interface crossover switchover

CMCS – The Central Management Computer System in the TMC

compiler – Means Sign controller unless the context dictates otherwise

DHCP – Dynamic Host Configuration Protocol

equipment – Means Sign(s) covered by this Specification unless the context dictates otherwise

frame – See definition in AS 5156

host control system – A remote computer system that communicates with the Sign to effect control of the Sign

IEC – International Electrotechnical Commission

IP – Internet Protocol

ISLUS, or integrated speed limit and lane use signs – Means integrated speed limit and lane use signs covered by this Specification

ISO – International Standards Organisation

LED – Light emitting diode

Luminance Ratio, or LR – See definition in AS 5156

luminous intensity half-angle – See definition in AS 5156

LUS – Lane Use Sign.

Lane use signs are also known as lane control signs (LCS)
LUS signal – Means a lane control signal displayed by an ISLUS.

Typical lane control signals include red cross, upward pointing arrow, up-left pointing arrow, up-right point arrow, down-left pointing arrow, down-right pointing arrow and downward pointing arrow.

MAC – Media Access Control
message – See definition in AS 5156
MTBF – Mean Time Between Failures
MTTR – Mean Time to Repair
NATA – National Association of Testing Authorities, Australia
NSW – New South Wales
OMCS – Operations Management and Control System in a motorway control centre or other dedicated traffic centre

Other displays, or Other displays – Means text or symbols, other than speed numerals, displayed by the Sign in normal operation, unless the context shows otherwise

PHCS – Product Host Control System
plan – See definition in AS 5156
Product Host Control System – See definition in AS 5156
RGB – Red-Green-Blue
RMS – Means Roads and Maritime Services, which is a New South Wales Government agency
RMS Representative – The person appointed by Roads and Maritime Services to carry responsibilities on behalf of Roads and Maritime Services for the execution of the contract under which the Sign is supplied.

A reference to the RMS Representative in this Specification shall be taken to include a reference to the representative(s) of the RMS Representative.
Sign or Signs – Integrated speed limit and lane use signs covered by this Specification.

A Sign comprises a Sign display unit and a Sign controller. The Sign controller may also control other Sign display units.

A reference to “Sign” or “Signs” in this Specification means the complete Sign(s) (i.e. Sign display unit and Sign controller) unless the context refers only to the Sign display unit(s).

Sign controller, or Sign controller – The control equipment that is a local, inseparable component of a Sign for operation of the Sign. Among other functions, the Sign controller communicates with a remote host control system (e.g. the CMCS in the TMC, or an OMCS), and switches, usually indirectly, individual display matrix pixels of the Sign displays in accordance with the received command.

The Sign controller may be a controller that controls a single Sign, or a group of Signs, or multiple groups of Signs. A Sign controller that is controlling more than one Sign is sometimes referred to as a group controller.

Sign display unit, or Sign display unit – The main assembly of a Sign, which contains the Sign display and other modules and components of the sign system that are not accommodated in the Sign controller.

Software – A generic reference to all computer programs and related data that are or may be required for the Sign regardless of what storage media the computer programs reside in or run from, unless the context shows otherwise.

This Specification – Means Specification TSI-SP-011

Suppliers – Means the supplier of sign(s) covered by this Specification.

Where the supply of sign(s) is under a contract, it means the contractor of the contract.

TIA – Telecommunications Industry Association

TMC – The NSW Transport Management Centre in Eveleigh
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4.  [ Not Used ]

[This Section is not used.]
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5. GENERAL REQUIREMENTS

5.1 Compliance with AS 5156

All Signs shall comply with AS 5156 for electronic speed limit signs, including all requirements therein related to matrix signs. For the purpose of this requirement, all requirements in AS 5156 shall be applicable to each Sign except those explicitly varied, supplemented, replaced or declared not applicable in this Specification.

5.2 Compliance with TSI-SP-016

The design, construction and manufacture of the Sign shall comply with RMS Specification TSI-SP-016.
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6. DISPLAY AND OPTICAL REQUIREMENTS

6.1 Display Requirements

6.1.1 Display Changes

In addition to the requirement in AS 5156 requiring all frames of a message to complete before the sign display is changed and the stated exception allowed therein (i.e. clause B2.1 of AS 5156-2010), a message or plan that was commenced shall run to completion even if a system reset has been invoked by way of the system reset command in the communications protocol referred to in Clause 7.5.1. For the purpose of this requirement, the following shall apply:

(a) For a message, the system reset shall be implemented after the transition time following the completion of the last frame of the message;

(b) For a plan, the system reset shall be implemented immediately if the plan is currently displaying a frame. If the plan is displaying a message, the system reset shall be implemented after the last frame and transition time of the message.

6.1.2 Display Changes due to Facility Switch Operation

The Sign's display shall operate in response to the position of the facility switch as defined for matrix signs in AS 5156.

6.1.3 Display Colours

The requirements for display colours in AS 5156 are replaced by the requirements in this clause.

The designated display colours shall be as follows on a matt black background:

(a) Speed numerals – white;

(b) Annulus – red;

(c) LUS cross – red;

(d) LUS arrows – white;

(e) Other displays – white.

Each of the required display colours shall be directly generated by LEDs for which the colour is their native output colour.
RGB or similar colour mixing system to create the required colours is not permitted.

6.1.4 Sign Dimming Control

For the purpose of automatic dimming control, the light-sensing device required by AS 5156 shall be provided on the Sign display unit.

The following changes to the requirements for Sign dimming control in AS 5156 shall apply:

(a) The number of dimming levels to be provided shall be 16;

(b) Monitoring of automatic dimming control shall be provided. Where a Sign cannot be dimmed in response to the scene illuminance, and the action described in paragraph (c) of this clause is not applicable, the Sign shall select a luminance value based on time of day or a fixed value in accordance with the requirements in the Australian Standard (AS 5156), based on the output of its dimming system fault-monitoring function.

The following addition to the requirements for Sign dimming control in AS 5156 shall apply:

(c) Where a Sign within a group cannot be dimmed in response to the scene illuminance, but one or more other signs within the group can, the Sign shall use the same or averaged target dimming level used by the latter as its own target dimming level. The Sign shall log the fault (in the fault log) that caused it to use the target dimming level of another sign(s) within the sign group, and also the resultant dimming level changes as an event (in the event log). The Sign shall clear the fault if the fault condition no longer exists.

6.1.5 Display Technology

The display technology for the message face shall be light emitting diode (LED).

For each Sign model, the Supplier shall submit the following information relating to the LED design currents for the approval of the RMS Representative:

(a) LED data sheets from LED manufacturer(s);

(b) Design drive currents for all light output levels;

(c) Method of modulation;
(d) General schematic for and description of the LED driver operation.

NOTE: Refer to Clause 11.2 for requirements to submit photometric and colorimetric test reports by a NATA test laboratory/laboratories.

6.1.6 Pixel Arrangement

6.1.6.1 Annulus Display

The requirements for red annulus pixel configuration in AS 5156 shall be replaced by those shown in Table 6.1.6.1.

Table 6.1.6.1 - Red Annulus Pixel Configuration

<table>
<thead>
<tr>
<th>Sign Size</th>
<th>Minimum Number of Pixel Rings</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>7</td>
</tr>
<tr>
<td>D</td>
<td>10</td>
</tr>
</tbody>
</table>

The number of innermost pixel rings for flashing shall be user programmable, and shall not be less than 50% of the total number of pixel rings in accordance with AS 5156. The default setting shall be the minimum number of rings that satisfies the stated ‘not less than 50%’ condition.

NOTE: Refer to AS 5156 for other requirements for flashing of the innermost pixel rings of the annulus display.

6.1.6.2 Matrix Display

The Sign shall use a matrix display for the display of speed numerals and other symbols and text specified to be displayed by this matrix display. The requirement for matrix displays in AS 5156 shall apply to the Sign.

In addition, the Sign shall be capable of generating and displaying the lane use sign bitmap display image definitions (LUS signals) in accordance with Appendix B.
6.1.7 Pixel Service Life

The requirements for pixel service life in AS 5156 shall apply with the following change:

(a) The rated minimum service life of each pixel of the Sign shall be not less than ten (10) years of continuous switching and operation.

6.2 Optical Requirements

6.2.1 General

The Sign shall pass all of the photometric and colorimetric tests covered in AS 5156 and this Specification.

The Sign shall pass all of the luminance and luminance ratio tests for display pixels for each of the output colours.

The Sign shall pass all of the luminous intensity half-angle tests for display pixels for each of the output colours.

6.2.2 Luminous Intensity Uniformity

6.2.2.1 General

In addition to the requirements for luminous intensity uniformity in AS 5156, the requirements in this section (Clause 6.2.2) shall apply.

6.2.2.2 Equalisation of Pixel Outputs

The Sign shall provide equalisation of the light outputs of all of its display pixels to eliminate perceivable intensity variations among the pixels. The equalisation shall be effective for all colours and output luminance levels (i.e. dimming levels) of the Sign display.

The pixel output equalisation shall be configured by means of an equalisation configuration facility available for sign maintenance. The facility shall allow adjustment to the equalisation levels of individual pixels/pixel chains or pixel panels as relevant to provide non-perceivable intensity variations. The facility shall also provide for permanent saving of not less than three (3) sets of settings for recall, including the default set of settings that was factory preset.

It is permissible to connect an external auxiliary device, such as a custom-built multi-sensor light meter, to the Sign to provide automatic or semi-automatic pixel output equalisation using the equalisation configuration facility. Notwithstanding, all functions of the
equalisation configuration facility shall be operational and available without any external auxiliary device.

For the purpose of this clause, it shall not be possible for any equalisation setting or action to cause the LED pixel drive currents to exceed the peak magnitudes of LED drive currents specified in AS 5156.

The Supplier shall perform pixel output equalisation on the Sign before pre-delivery acceptance test or delivery of the Sign, whichever occurs earlier.
7. OPERATION AND CONTROL

7.1 General

7.1.1 Host Control

In addition to the general requirements for local and remote control in AS 5156, the requirements in this clause shall apply.

For the purpose of the requirements for Product Host Control System in AS 5156, the Product Host Control System shall be designed to be operational under the Windows® XP¹ operating system and later Windows® operating systems.

7.1.2 Display Activation

The Sign's display shall be capable of being activated through any one of the methods listed as method for sign display activation in AS 5156, as follows:

(a) Command instruction from a host control centre (host control system for remote control);

(b) Command instruction from a remote site using the Sign manufacturer's control system (i.e. the PHCS);

(c) Command instruction from a portable computer locally;

(d) A pre-defined program schedule (plan) stored within the sign controller;

(e) Hardwire and external switch inputs;

(f) Facility switch.

The Sign shall not display corrupted displays. In the event of a corrupt and/or invalid display, the Sign shall blank its display immediately. For the purpose of this requirement, corrupt displays are deemed to be any display that is illegible, unintelligible or misleading to the observer.

¹ Windows is a registered trademark of Microsoft Corporation in the United States and/or other countries.
7.2 Local Control

In addition to the requirement for the provision of an RS-232 (current designation TIA-232) port for local control in AS 5156, the Sign shall be equipped also with an Ethernet port for local control.

For the purpose of this requirement, ground level access shall be provided to both this local RS-232/TIA-232 port and the local Ethernet port.

The Ethernet port for local control shall have a unique MAC address.

This Ethernet port shall provide Auto-MDI/MDIX switchover. The connector of this Ethernet port shall be an 8P8C jack compliant with ISO/IEC 8877. The connector wiring shall be compliant with the T568A wiring scheme in AS/NZS 3080.

This Ethernet port shall be user configurable to use a static IP address, or a dynamic IP address assigned by an external DHCP server. There is no requirement for this Ethernet port to provide DHCP server function.

7.3 Remote Control

In addition to the requirements for remote control in AS 5156, the following requirements shall apply:

(a) The Sign shall be capable of being operated remotely also via an IP-based telecommunications service to the Sign controller and a pair of appropriately configured and compatible IP network communications devices. For the purpose of this requirement, in addition to the configurable RS-232/RS-485 (current designations TIA-232/TIA-485) port specified in AS 5156 for remote control, the Sign shall be equipped with an Ethernet port for connection to a network communications device for remote control.

NOTE: The Ethernet port for remote control is a different port to the Ethernet port for local control referred to in Clause 7.2.

The Ethernet port for remote control shall have a unique MAC address.

This Ethernet port shall provide Auto-MDI/MDIX switchover. The connector of the Ethernet port shall be an 8P8C jack compliant with ISO/IEC 8877. The connector wiring shall be compliant with the T568A wiring scheme in AS/NZS 3080.

This Ethernet port shall be user configurable to use a static IP address, or a dynamic IP address assigned by an external DHCP server. There is no requirement for this Ethernet port to provide DHCP server function;
(b) The Supplier shall provide to the RMS Representative the necessary simulators, including simulators that emulate communications links, and necessary communications equipment (modems and/or terminal adaptors) that is compatible with existing equipment at the host control centre, for the purposes of checking the communications capabilities and functions of the Sign during pre-delivery acceptance tests;

(c) Where the Supplier is responsible for providing or organising a wireless communications service for the Sign, the informative or guidance requirements for wireless communications in AS 5156 shall apply.

7.4 Programming

7.4.1 General

The requirements related to programming of frames, messages and plans for matrix signs in AS 5156 shall be varied where there is an inconsistency with the communications protocol referred to in Clause 7.5, to support the use of the communications protocol.

For the purpose of this requirement, the following parameters shall support the full range of values provided by the communications protocol:

(a) Number of frames;

(b) Number of messages;

(c) Number of plans;

(d) Number of frames for a message;

(e) Number of message for a plan;

(f) Frame on times and transition times within a message;

(g) Number of messages within a plan;

(h) Other frame, message and plan related parameters.

7.4.2 Additional Requirements

7.4.2.1 Frames, Message and Plans

Frames and/or messages displayed by an enabled plan shall be overridden by a frame or message sent remotely from the host control centre. When the overriding frame or message is cleared (i.e. the Sign is blanked), the enabled plan shall reactivate.
Plans are set on a day-of-the-week basis. No enabled plan shall be allowed to overlap with another enabled plan.

Frames, messages and plans shall reside in the Sign controller. A copy of the frames, messages and plans is also kept at the host control centre. A checksum for all frames, messages and plans shall be used to ensure that the stored data within the Sign controller is identical to that at the host control centre. Execution of any display shall be via the local “display” library. The remote Product Host Control System shall be able to store an identical “display” library for each Sign in the system. It should be noted that each local Sign “display” library may differ between each Sign.

7.4.2.2 Control of Multiple Signs

Each Sign controller shall be capable of supporting up to twelve Signs (sign display units) comprising up to twelve sign groups.

NOTE: A Sign group may consist of one to twelve Signs, but the total number of Signs (sign display units) a controller can support is twelve.

Signs within the same group shall be controlled as a single entity, but monitored on an individual basis. This shall include both fault and display monitoring. Refer to Clause 7.4.2.3 for conflict monitoring and response.

The Signs shall be capable of being programmed, monitored and controlled from both a local and remote location. All Signs and the Sign controller shall be individually addressable.

Signs within the same group face the same way on a roadway shall change their displays simultaneously. In the event that the Sign controller determines that there is a critical fault on one or more Signs, the Sign controller shall force all other Signs within the same group to blank.

Signs within the same group shall display one of the following combinations of displays:

(a) All signs displaying the same speed limit; or

(b) Some signs displaying the same speed limit, and other signs displaying lane use signals.

NOTE: Refer to Clause 7.5.1 for requirements for provision of an additional communications protocol command for operating signs in the manner described in paragraph (b).

NOTE: Refer to Clause 7.4.2.3 for requirements for display conflict monitoring and response.
7.4.2.3 Conflict Checking, Monitoring and Response

The Sign controller shall check all incoming commands that attempt to set up frames for display or to display stored frame(s), for the conflicting displays or conditions specified in this clause. The Sign controller shall reject all such commands where any specified conflicting display or condition is detected.

In addition, the Sign controller shall monitor the sign displays at all times to detect conflicting displays or conditions.

The Sign controller shall respond to the following conflicting displays and conditions:

(a) A Sign display unit not responding to the control signals from the Sign controller;

(b) One or more Sign display units within a group is displaying a blank display due to abnormal conditions;

(c) A Sign display unit within a group attempting to display or is displaying a different speed limit display to other sign display units of the group;

(d) A Sign display unit within a group attempting to display or is displaying a lane use signal that directs traffic to merge with an adjacent lane that does not exist or is closed.

NOTE: The lane use signals for lane merge are the Down-Left LUS Arrow and Down-Right LUS Arrow. Refer to Appendix B (Clause B.6.2) for bitmap definitions for these merge arrows.

NOTE: An adjacent lane may not exist if the lane controlled by the lane use signal is the left-most or right-most lane.

NOTE: An adjacent lane is closed if the lane use signal of that lane is displaying a lane closed signal, e.g. a red cross;

(e) A Sign display unit within a group attempting to display or is displaying a lane closed signal, e.g. a red cross, whereas a Sign display unit of an immediately adjacent lane is directing traffic (i.e. displaying a merge arrow) on to the closing/closed lane;

(f) Sign display units within a group on adjacent lanes attempting to display lane use signals that direct traffic toward each other;

(g) A Sign display unit on a lane that is not the furthest left lane of the road attempting to display or is displaying a lane use signal that directs traffic to exit the road from its left, but the left adjacent lane is not an exit lane.

NOTE: The lane use signals for exit are the Up-Left LUS Arrow and Up-Right LUS Arrow. Refer to Appendix B
(Clause B.6.2) for bitmap definitions for these exit arrows;

(h) A Sign display unit on a lane that is not the furthest right lane of the road attempting to display or is displaying a lane use signal that directs traffic to exit the road from its right, but the right adjacent lane is not an exit lane.

The Sign controller shall detect any of the above conflicting displays and conditions within 0.3 second of one occurring and immediately respond to such a condition by blanking the displays of all sign display units within the same group.

For the purpose of this clause, the Sign controller shall provide a configuration facility for the user to define the relative locations and orientations of all signs, entry lanes, exit lanes and road kerbs.

7.5 Communications

7.5.1 Communications Protocol

The Sign shall incorporate the communications protocol specified in RMS Specification TSI-SP-003 (“Communications Protocol for Roadside Devices”) for communication with the host control system and the Product Host Control System. For the purpose of this requirement, Specification TSI-SP-003 shall be considered as a part of this Specification.

The communications protocol shall be implemented in its entirety.

For the purpose of operating signs within the same group as described in paragraph (b) of Clause 7.4.2.2, the Sign and the Product Host Control System shall incorporate an additional communications protocol command for instructing individual signs within a group to display either a speed limit or a lane use signal. The Supplier shall submit details of the proposed command for approval by the RMS Representative before implementation.

NOTE: The RMS Representative may prescribe the details of the command for implementation by the Supplier, to ensure compatibility with existing or new control systems.

7.5.2 Initiation of Communication Connections

The Sign shall not initiate communication connection with the host control system.
7.5.3 **Machine-initiated Communications**

The Sign shall not initiate transmission of unsolicited messages to the host control system.

7.6 **Configuration Mode**

The Sign shall provide a configuration mode to allow for changes to be made to configuration values and settings of the Sign. Changes to configuration values and settings of the Sign shall be possible only when the Sign is in the configuration mode.

The normal operation of the Sign display shall not be affected while in configuration mode.

7.7 **Fall-Back Operation**

In addition to the requirements for fall-back operation in AS 5156, the requirements in this clause shall apply.

The Sign shall incorporate the ability to automatically fall-back to a pre-defined operation mode when a major system failure occurs, such as when a critical fault is detected.

Such fall-back modes shall include the following responses:

(a) When mains power is lost – maintain normal sign operation (except for pixel lighting) on battery back-up. On power restoration, the Sign shall resume the current plan sequence and/or frame or message display commanded prior to or during the mains failure;

(b) When communication is lost or adversely affected – maintain normal sign operation, continuing to operate from local control and current plan sequence. Where communication has been established, the Sign shall end the session and hang-up any communications device on detection of a communications failure;

(c) Where the processor is affected – completely blank the display area (by default);

(d) Where display drivers are affected to the extent that the resultant displays may be confusing to the public – completely blank the display area immediately;

(e) Where one or more Signs in the same sign group experiences a fault causing it to blank – blank and maintain blanked all other signs in the group until all critical faults are rectified (i.e. cleared).
In each case, the Sign shall correctly report and log the fault, as well as report the currently active display (in most cases blank). Upon clearance of the fault, the Sign shall correctly report and log the clearance, and resume the previous display, unless commanded to another display during the period the fault was present. If the previous active display has been modified (via a set command), but not activated, the display shall remain blank, or revert to the current plan sequence.

NOTE: Communications faults (see paragraph (b) above) cannot be reported as they occur, but should be logged as specified in this clause. Clearance of communications faults is to be reported and logged as specified above.

For messages, the Sign display shall resume from the first frame of the sequence.

In any case, where communication is available, the remote operator shall be able to override the local control and blank the Sign. For the purpose of this requirement, the Sign Controller shall support the “Power ON/OFF” command in Specification TSI-SP-003 for turning ON or OFF the power for the specified groups of sign display units.

NOTE: Turning OFF the power for a group shall result in the complete blanking of all sign display units within the group, regardless of whether there is a fault with any of the sign displays or sign display units.

Where communication is lost after expiry of a predefined time, the Sign shall end the session (i.e., go “offline”). For Sign controllers on dial-up links, in addition to performing a virtual end session and logging a communications time-out, the Sign controller shall ensure that the modem is returned to the on-hook state whether online or not. The communications time-out fault shall be cleared on the next successful communications message. The predefined time shall be configurable ranging from 0 (infinite) to 65535 seconds, and shall depend on the type of communications link. A nominal value of 120 seconds for dial up links and 30 seconds for direct links shall be preset.

Where communication has not been received within a predefined time, the Sign shall blank and log a display time-out. The predefined time shall be configurable ranging from 0 (infinite) to 10080 minutes, and shall depend on the type of communications link. The display time-out fault shall be cleared on the next successful communications message. A default value of 0 minute (infinite) shall be pre-set.

NOTE: A “0” minute configuration value allows the Sign to remain at the last known speed setting, unless a critical fault has occurred.
8. GENERAL DESIGN AND ARRANGEMENT

8.1 Sign Enclosure

In addition to the requirements for sign enclosure in AS 5156, the following requirements shall apply:

(a) The height and width dimensions of the sign shall be in accordance with Appendix A;

(b) The Supplier shall fully describe the surface treatment and finishes in the drawings of the sign design;

(c) The colour of the rear face of the Sign shall be Cloud Grey (Colour No. N22), Neutral Grey (Colour No. N23), Silver Grey (Colour No. N24) or Light Grey (Colour No. N35) in accordance with AS 2700;

(d) Locking left or right-hinged rear door(s) shall be provided for access to all internal components of the Sign for installation, inspection and maintenance purposes. Accordingly, all requirements in AS 5156 for such access through lockable doors (i.e. Clause 4.1.2(d) in AS 5156:2010) shall apply.

8.2 Sign Mounting Facilities

The Sign shall provide the following mounting facilities:

(a) Mounting brackets for rear mounting of the Sign, including means for adjusting the angle of the mounted Sign during installation and commissioning to ensure correct aiming of the Sign display;

(b) Provision for the attachment of rails, brackets or other relevant parts on the left, right and bottom side faces of the Sign display unit for engagement with the support channels or slots of a Sign mounting structure;

NOTE: The purpose of this provision is to provide a “drop-in and lock” sign mounting arrangement;

(c) Provision of lifting brackets on the top side face of the Sign display unit for hoisting of the unit.

Provisions (a) and (b) shall be independent of each other, and each shall be adequate to support the Sign under the wind loading conditions and other environmental conditions specified in this Specification and AS 5156.
For the purpose of provision (a), the mounting brackets shall provide the following angular adjustment ranges to the Sign display for sign installation:

(a) Not less than 15° both left and right from the nominal forward direction;

(b) Not less than 6° both up and down from the nominal forward direction.

8.3 Control Housing

8.3.1 General

A weatherproof control housing shall be provided for each Sign.

The control housing shall be suitable for both post-mounting and ground mounting.

The control housing shall comply with all requirements in Specification TSI-SP-016 for roadside equipment housing and in AS 5156 for control housing.

The Supplier shall supply drawings of the control housing showing the following:

(a) Mechanical design of the housing including all key mechanical dimensions;

(b) General arrangement of modules, interfaces, cable terminals and main switchboard in the housing;

(c) Provisions for installation including all related dimensions;

(d) Provisions for passage and installation of cables into and out of the housing.

8.3.2 Power and Communications Equipment

The requirements in AS 5156 for provision of three external inputs in the control housing for interfacing with external devices (i.e. item (g) in clause 4.1.4.3 of AS 5156-2010) shall be changed to the following:

(a) For each Sign group controlled by the Sign controller, the control housing shall provide three inputs for interfacing with external devices.
The requirements in AS 5156 for provision of a facility switch in the control housing (i.e. item (h) in clause 4.1.4.3 of AS 5156-2010) shall be changed to the following:

(b) Refer to Clause 8.3.5.1 for the quantity of facility switches to be provided.

8.3.3 Housing Identification

Each control housing shall have on the outside an identification label in accordance with APPENDIX C. The Sign identification number shall have the format “Smnop” (the character S followed by 4 numeric characters) and need only to identify the Sign groups.

The label shall contain as many Sign identification numbers as there are sign groups under the control of the Sign controller.

**NOTE:** The example label in Appendix C shows the layout of a controller with two sign groups.

The actual ID number of the Sign will be confirmed by the RMS Representative after the issue of the supply contract.

A sample of the material (see APPENDIX C) with a sample black legend shall be submitted to the RMS Representative for approval.

8.3.4 Housing Nameplate

A metal nameplate shall be affixed in a permanent manner to the exterior of the control housing.

The nameplate shall be made from aluminium. Adhesive labels shall not be used.

A high quality process (such as photo engraving, anodising, etc) shall be used to produce the legends on the nameplate. The legends shall be clearly legible, indelible, and non-fading.

The nameplate shall provide the following information about the Sign:

(a) Product/model name or brief description of the Sign;

(b) Manufacturer's name;

(c) Manufacturer's type number;

(d) A unique serial number.
8.3.5 Facility Switch

8.3.5.1 General

Facility switches shall be provided on the control housing for local (on-site) control of the message display mode by means of a key complying with Drawing VM005-1. Details of this key will be provided to the prospective suppliers by request.

Unless otherwise specified, two facility switches and with space for another two facility switches shall be provided on the control housing.

Each facility switch shall be clearly identified as to which sign or sign group it controls.

Each facility switch shall provide for the Sign display to be switched to four (4) different display modes. The four display modes shall be, in the clockwise direction, BLANK, AUTO, MESSAGE 1 and MESSAGE 2.

NOTE: The default state of MESSAGE 1 and MESSAGE 2 should be a BLANK display.

Key access shall be provided from the exterior of the control housing, without the need to open the housing access door.

8.3.5.2 Type and Rating

The facility switch shall be an industrial grade switch suitable for use in outdoor equipment.

The facility switch shall not be used to switch Low Voltage.

The facility switch contacts shall be rated for switching Extra-Low Voltage control signals, operating at voltages of nominally 12 V d.c., and currents of 1 to 10 mA.

The contact material and rating for the contacts shall be suitably chosen to provide reliable operation for the life of the equipment.

8.3.5.3 Mounting

The facility switch shall be mounted inside the control housing.

The key actuator of the facility switch shall be recessed inside a metal ferrule, such that the head of the actuator is recessed 10 mm to 12 mm from the outside surface of the control housing.

The method of mounting the facility switch shall be such that the switch can be readily replaced in the field. Special tools shall not be required to replace the facility switch.

The facility switch shall be mounted within 250 mm of the top of the housing, on either the left or right side of the housing. The facility
switch shall not be mounted on the rear side of the housing or the housing door.

The key access for the Facility Switch shall be suitably weatherproofed.

8.3.5.4 Marking

The switch positions shall be indelibly and durably marked on the outside of the housing for each facility switch.

8.3.5.5 Resistance to Vandalism

The actuator mechanism for the facility switch shall provide sufficient spring tension such that the switch position cannot be changed without the use of the specified key. That is, it shall not be possible to change the switch position with simple tools or implements, such as screwdrivers, pliers, etc.

8.3.6 Lifting Brackets

A lifting bracket shall be permanently fixed on each side wall of the control housing for attachment of flat web slings for lifting the control housing.

The lifting brackets shall comply with the following requirements:

(a) Be constructed from the same material and treated with the same external surface finish and coating as specified in AS 5156 for the control housing;

(b) Have a minimum material thickness of not less than 3.0 mm;

(c) Have all top and bottom edges rounded at a radius of not smaller than 1.5 mm;

(d) Protrude not more than 10.0 mm from the side wall of the control housing;

(e) Be located at the top of each side wall at a suitable position close to the roof cap of the control housing;

(f) Be suitable for use with 40 mm wide 2000 kg capacity flat polyester web slings.

The lifting brackets installed on the control housing shall have adequate strength and safety margins to support the control housing in its fully laden state.
8.4 Battery Backup

A battery backup system shall be provided with the Sign. This system shall comply with requirements in AS 5156 for battery backup, and have the capacity to maintain normal sign operation, except for Sign pixel display, for a period of 12 (twelve) continuous hours including any communication services.

This system shall also provide backup for the real-time clock.

NOTE: Refer to Clause 8.8.3 for requirements for the dedicated battery backup system for the real-time clock.

8.5 Surge Protection

In addition to the requirements for surge protection in AS 5156, the Sign shall provide protection against electrical surges and transients on the mains supply and telecommunication lines.

NOTE: Refer to Specification TSI-SP-016 for requirements for immunity to surges and electromagnetic radiation.

8.6 Design Life

The designed operating life of the Sign and its support structure shall be as follows:

(a) For the electrical system - not less than 15 years;
(b) For the optoelectronic system - not less than 10 years;
(c) For the sign enclosure - not less than 20 years;
(d) For controller housing - not less than 20 years;
(e) For the fixed sign mounting, support and access structures - not less than 50 years.

NOTE: Items (a) and (b) contain different values to those in AS 5156.

NOTE: Refer to Clause 6.1.7 for rated minimum service life for pixels.

NOTE: Item (e) is applicable only if these parts are supplied by the Supplier.
8.7 Communications Equipment

A communication link will be provided for communication between each Sign (via the Sign controller) and the host control system (in the TMC or other traffic centre). For direct links using modems, the Supplier shall recommend and, if requested, supply modems that are compatible with those used at the host end.

8.8 Real-Time Clock

8.8.1 General

In addition to the requirements for real-time clock in AS 5156, the requirements in this section (Clause 8.8) shall apply.

8.8.2 Corrupt Time

The Sign shall check its real-time clock for correct operation. In the event that the real-time clock has not been initialized or is corrupt, the Sign shall default to a pre-defined date and time, being the first of January of the year the firmware was released.

8.8.3 Dedicated Power Backup

The dedicated power backup system specified in AS 5156 shall be a battery that provides extended power backup over the Sign’s battery backup system to the real-time clock.

This battery shall supply only the real-time clock and it shall have the following characteristics:

(a) Is maintenance-free;

(b) Is rated for operation over an extended range of ambient temperatures up to 70°C;

(c) Has a service life of not less than five (5) years under normal operation.

The dedicated power backup battery shall provide not less than 60 days of support to the real-time clock after the depletion of the Sign’s battery backup system.

8.8.4 Time Updates

The Sign shall update its real-time clock when an update time message is received from the host control system.
8.8.5 Daylight-Saving Time Changes

The Sign shall provide automatic updates to the real-time clock for daylight-saving related time changes.

For the purpose of this requirement, the Sign shall provide user configurable settings for the dates and times to change from standard time to daylight saving time and vice versa. The default settings shall be as follows:

(a) Start of daylight saving time - At 0200 hr on the first Sunday in October;

(b) End of daylight saving time - At 0300 hr on the first Sunday in April.

8.8.6 Logging of Time Updates and Changes

The Sign shall log all time updates and changes.

8.9 Non-Volatile Memory

The Sign shall provide non-volatile memory for all of its configuration settings, logs, and other data and information that needs to be preserved when power to the Sign is off or lost.

8.10 Fault, Alarm and Event Logs

Sufficient memory not less than the following shall be provided for the fault log, alarm log and event log of the Sign:

(a) For fault log, not less than 50 entries or usage for 12 months, whichever is more;

(b) For alarm log, not less than 500 entries or usage for 12 months, whichever is more;

(c) For event log, not less than 1000 entries or usage for 12 months, whichever is more.

The fault log, alarm log and event log shall operate using the first-in first-out method in the event the above allocated memory is insufficient.
8.11 Reliability

All Signs shall have a mean-time-between-failure of not less than 45,000 hours in operation.

8.12 Maintainability

The Supplier shall state the following to assist the RMS Representative in assessing maintainability:

(a) Mean Time Between Failures (MTBF) for the Sign;
(b) Mean Time Between Failures (MTBF) for the sign display system;
(c) Mean Time to Repair (MTTR) for the Sign;
(d) Mean Time to Repair (MTTR) for the sign display system.
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9 ENVIRONMENTAL REQUIREMENTS

9.1 Temperature and Humidity

In addition to the requirements for temperature and humidity in AS 5156, the Sign shall operate within the required specifications with a relative humidity up to 90% within the temperature range 5°C to 50°C. For the purpose of this requirement, the conditions of relative humidity shall be additive to the ambient air temperature and insolation requirements specified in AS 5156.

9.2 Enclosure Protection

In addition to the requirements for enclosure protection in AS 5156, appropriate protection rating in accordance with AS 60529, and not less than IP45, shall apply to all components and modules (e.g. facility switch) that are exposed external of the equipment.

9.3 Wind Loading

The requirements for wind loading in AS 5156 are replaced by the requirements in this clause.

The Sign shall be designed with due consideration to wind loading in the field after installation. For the purpose of this requirement, the complete equipment, including mounting brackets and provisions, shall have adequate strength and rigidity for the wind loading conditions set down in AS/NZS 1170.2 for Terrain Category 1.5, Region B.

The Supplier shall provide certified calculations by a qualified structural engineer as proof of compliance with the requirements in this clause.

9.4 Environmental Tests

9.4.1 General

The Sign shall withstand and pass the environmental tests described in this section (Clause 9.4).

Environmental tests shall be performed by a NATA registered laboratory or approved test organisation. If the test facilities are not NATA registered for the types of test to be performed, the Supplier shall furnish a full description of the test facilities and technical expertise of the testing organisation(s) the Supplier intends to use, for approval by the RMS Representative before commencement of these tests.
9.4.2 **Temperature and Humidity Test**

The equipment, while in operation, shall withstand continuously for 72 hours at an ambient temperature of 50°C, and with 90% relative humidity, and with 1 kW/m² insolation applied to the maximum exposed surface, without any adverse effect to its operation.

*NOTE: It is acceptable to substitute insolation with a 10°C rise in ambient temperature.*

9.4.3 **Enclosure Protection Tests**

The complete sign enclosure and the control housing shall each be tested for compliance with the level of enclosure protection specified in AS 5156 and where applicable Clause 9.2.

9.4.4 **Shock Test**

The complete Sign shall be tested in accordance with the requirements for shock in AS 5156.

9.4.5 **Vibration Test**

The complete Sign shall be tested in accordance with the requirements for vibration in AS 5156.

9.4.6 **Electromagnetic Compatibility Tests**

The complete Sign shall be tested in accordance with the requirements for immunity and electromagnetic emissions in AS 5156.
10 QUALITY ASSURANCE

10.1 General
The Supplier and the manufacturer of the Sign shall operate a quality management system complying with AS/NZS ISO 9001 or ISO 9001. This quality management system shall be certified by a quality management system certification body either accredited under the criteria laid down in the Joint Accreditation System of Australia and New Zealand (JAS-ANZ), or listed in the International Standards Organisation ISO Directory of ISO 9000 and ISO 14000 Accreditation and Certification Bodies.

10.2 Traceability
Each Sign shall be marked with a batch code, serial number, or other marking to provide traceability under the Sign manufacturer’s quality management system to all key manufacturing, inspection and test processes, including batch identifications of key components (e.g. sign display LEDs).
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11 DOCUMENTATION

11.1 General

11.1.1 Supply of Documentation

The Supplier shall submit the following documentation for the Signs on order to the RMS Representative for approval:

(a) Quality plan, general drawings, reports and certifications (refer to Clause 11.2);

(b) Sign manuals (refer to Clause 11.3):
   (i) Operations manual;
   (ii) Maintenance manual;
   (iii) Installation manual;
   (iv) Reference drawings.

Unless stated otherwise, each submission of documentation shall be provided in the following forms:

(a) Two (2) sets in A4 prints. Drawings in A3 prints folded to A4 size are permitted. Drawings in their original size are required where explicitly specified;

(b) An electronic copy on an ISO 9660 compliant CD-ROM, or a common portable storage media acceptable to the RMS Representative and compatible with computers running the Windows® XP operating system or a later Windows® operating system. For the purpose of this requirement, all documentation other than software and firmware shall be in the ‘portable document file’ (pdf) format.

NOTE: Refer to Clause 11.3.3.2(f) for additional requirements for software and firmware.

NOTE: Refer to Clause 11.3.5 for additional requirements for reference drawings.

All documentation shall be clearly legible.

11.1.2 Structure of Manuals

Manuals shall have the following structure:

2 Windows is a registered trademark of Microsoft Corporation in the United States and/or other countries.
(a) Preliminary pages, comprising the title page, safety notice, warning page and amendment notice;

(b) A table of contents, and a list of figures and tables;

(c) Subject text divided into sections, and chapters as applicable, and separated by tabbed (reinforced) interleaves;

(d) A glossary of terms (if applicable);

(e) A list of abbreviations (if applicable);

(f) An alphabetical subject index.

11.2 Quality Plan, General Drawings, Reports and Certifications

The Supplier shall provide the following documentation as part of the equipment documentation (refer to Clause 11.1.1) not later than twenty-one (21) days before the commencement of pre-delivery acceptance test:

(a) A quality plan for the Sign including details of all tests and checks to be performed before, during and at the end of the manufacturing process;

(b) Drawings of the Sign, including drawings of the control housing, showing important features and including mechanical, constructional and structural data, key dimensions, weights, and other important mechanical parameters;

(c) The following NATA test reports for the Sign:

   (i) Photometric and colorimetric tests on luminance, luminance ratio, luminous intensity uniformity, luminous intensity half-angle, and chromaticity coordinates; (refer to AS 5156);

   (ii) Temperature and humidity tests (refer to Clause 9.4.2);

   (iii) Enclosure protection tests for the complete sign enclosure and control housing (refer Clause 9.4.3 and AS 5156);

   (iv) Shock test (refer to Clause 9.4.4 and AS 5156);

   (v) Vibration test (refer to Clause 9.4.5 and AS 5156);

(d) Certificates of Suitability issued by the NSW Office of Fair Trading;

(e) Documentary evidence of C-tick compliance (i.e. electromagnetic compatibility) (refer to Clause 9.4.6 and AS 5156);
(f) Documentary evidence of ACMA approval for telecommunications device, if applicable;

(g) Radiocommunications compliance certification, if applicable.

11.3 Sign Manuals

11.3.1 General

The Supplier shall submit draft versions of the sign manuals not later than twenty-one (21) days before the commencement of pre-delivery acceptance test for review by the RMS Representative, and revised versions updated in accordance with review comments for approval by the RMS Representative.

The Supplier shall deliver the approved sign manuals to the RMS Representative as soon as possible and not later than the scheduled delivery date(s) for the Sign(s) under order.

Each set of sign manuals shall comprise the following documents:

(a) Operations Manual (Clause 11.3.2);
(b) Maintenance Manual (Clause 11.3.3);
(c) Installation Manual (Clause 11.3.4);
(d) Reference Drawings (Clause 11.3.5).

11.3.2 Operations Manual

11.3.2.1 General

The Operations Manual shall detail the operation of the Signs supplied.

The Operations Manual shall have the manual structure specified in Clause 11.1.2.

11.3.2.2 Subject Text

The subject text of the Operations Manual shall be divided into the following sections:

(a) Section 1 “General Description” – This shall be a non-technical section which provides a brief overall description of the Sign;
(b) Section 2 “Operations Theory” – This shall contain a description of the Sign architecture and configuration, the functions of individual modules making up the Sign and their interaction, interfacing with other external devices, systems and host control systems, and the theory of Sign operations covering all operation and other modes available;

(c) Section 3 “System Operations” – This section shall contain a description of the operational and functional elements of the Sign. This shall include, but not be limited to, the following as applicable:

(i) Software functions;

(ii) Configuration settings;

(iii) Operation programming;

(iv) Communications with external control systems;

(v) Fault and error monitoring, logging and reporting;

(vi) Fall back systems;

(vii) Storage of operational data;

(viii) Data integrity verification;

(ix) Operator access and access level management;

(x) Backup power;

(xi) Battery backed up real time clock;

(xii) Display dimming;

(xiii) External switch input operation;

(xiv) Other application system operations;

(d) Section 4 “Operator’s Instructions” – This section shall contain a concise set of procedures and instructions, and guidance, for operating the system. The procedures and instructions shall cover, but not be limited to, the following as applicable:

(i) Starting up and shutting down the system;

(ii) Changing from one operation mode to another;

(iii) Aborting a mode change;

(iv) Changing configuration settings;

(v) Dwelling the system in a particular operation mode;

(vi) Setting up local control;
(vii) Setting up of operational data;
(viii) Running test programs;
(ix) Handling of various incidents.
(x) Simple fault diagnosis;
(xi) Work health and safety instructions in connection with the operation of equipment of the system.

NOTE: Electrical safety and laser safety (if applicable) are two of the issues that need to be covered by such work health and safety instructions.

11.3.3 Maintenance Manual

11.3.3.1 General

The Maintenance Manual shall contain all information required for maintenance of the equipment, including the functional and technical details of the Signs supplied.

The Maintenance Manual shall have the manual structure specified in Clause 11.1.2.

11.3.3.2 Subject Text

The subject text of the Maintenance Manual shall be divided into the following sections:

(a) Section 1 “General Description” – This shall be a non-technical section which provides the following:

(i) A brief overall description of the Sign;
(ii) Details, including contact addresses and telephone and facsimile numbers of the Supplier, and manufacturer of the Sign;

(b) Section 2 “System Architecture, Operation and Maintenance” – This section shall cover the following:

(i) All areas required to be covered in Section 2 of the Operations Manual (refer to paragraph (b) of Clause 11.3.2.2 above) but in greater technical depths and details than therein;
(ii) Descriptions of the following items, with reference to the relevant drawings referred to in paragraph (e) of this clause:
    - external features and dimensions of the Sign enclosure, and provisions for installation;
external features and dimensions of the control housing, and provisions for installation;

- general physical locations of individual modules, electrical protection devices and switches and electrical interconnections within the Sign enclosure;

- general physical locations of individual modules, electrical protection devices and switches and electrical interconnections within the control housing;

- wiring schematics of all modules within the Sign enclosure and control housing, and also between the two at module level;

- wiring schematics of the main switchboard;

(iii) Procedures to be followed for diagnosis of system level faults (i.e. faults related to system functions and operations, such as system black-out, failure to implement an operation mode, failure to implement dimming, and operator access problems) in the form of a chart with headings “fault”, “possible cause” and “remedy” (trouble shooting guide);

(iv) Details of routine and planned maintenance procedures for checking system integrity;

(v) Details of configuration data (both default values and settable ranges) for the Sign and Product Host Control System software, and other modules (e.g. modems) that use configuration data;

(c) Section 3 “Guarantees and Warranties” – Details of all equipment guarantees and warranties shall be included in this section, together with the procedure to be followed in the event of a guarantee or warranty claim;

(d) Section 4 “Maintenance” – This section shall contain guidelines and recommendations for preventive (routine) maintenance and fault (remedial or corrective) maintenance.

NOTE This section may be separately provided as a field maintenance handbook.

This section shall cover the following:

(i) Warnings wherever the public or maintenance personnel could be exposed to hazardous conditions. Where maintenance procedures could generate conditions that are potentially dangerous to the general public or the maintenance personnel, this condition shall be highlighted in the procedure;

(ii) Recommended preventive maintenance procedures and time schedules. These procedures shall be structured to forestall equipment failure due to wear out of consumable
parts, e.g. electromagnetic relays, ventilation filters, incandescent lamps and indicators, etc., and to correct the effects of drift in operating levels due to changes in component characteristics, and so reduce risk of catastrophic failures which may precipitate hazardous conditions.

Detail steps shall be included for making adjustments to address component drift and wear out. The information shall be presented in a manner similar to a test procedure. The text shall contain a minimum of explanation and shall be supported by diagrams and photographs showing the location and method of adjustment.

Recommended inspection periods shall be nominated with inspection levels, e.g. monthly, yearly;

(iii) Recommended fault maintenance procedures. These procedures shall be structured to guide maintenance personnel in the diagnosis of a fault and the restoration of service with the least possible delay.

Detail steps shall be included to provide a series of checks or tests which will isolate firstly the general region of the fault and then the faulty module. It is preferred that this should be presented in the form of a “fault tree” or pyramid diagram which comprises a range of identifiable faults at the top level with a series of logical steps based on observation, tests or measurements which lead to the faulty module.

Instructions shall be given for the connection of test equipment with reference to relevant block diagram or drawing.

The text shall be supported by diagrams in which level of details applies specifically to the diagnostic procedures. Modules or parts for which the internal construction is irrelevant shall be presented in outline only but full particulars of interconnection, cable routing, mechanical fixings and method of access and external monitoring points shall be provided;

(e) Section 5 “Reference Drawings” – This section shall contain the following drawings:

(i) The drawings, including electrical wiring schematics, referred to in paragraph (b)(ii) of this clause above;

(ii) Enlarged views of mechanical components and assemblies;

(iii) Circuit related information as follows:
  - Electronic system block diagrams;
- Power supply system schematics;
- Electronic circuit schematics;
- Component layout on printed circuit boards;
- Terminal block layouts;

(f) Section 6 “Software Information” – This section shall contain detail information on all items of software/firmware used in or by the Signs, as follows:

(i) Version references of the software and firmware installed;
(ii) Overview of the purpose and functions of each software and firmware;
(iii) Change logs of each software and firmware;
(iv) Guidelines for the update of each software and firmware.

An electronic copy of each of the installed software and firmware suitable for installation on the Sign or an intended device, including guidelines for the update procedure, shall be provided on the documentation CD or common portable storage media referred to in Clause 11.1, and a second copy provided on a separate ISO 9660 compliant CD-ROM or common portable storage media. For the purpose of this requirement, the software and firmware shall be in a file format suitable for the intended update installation.

11.3.3.3 Requirements for Diagrams and Drawings

Diagrams for inclusion in the Maintenance Manual shall be drawn on paper having vertical and horizontal grid margins (actual grid lines being omitted), preferably marked alphabetically in one direction and numerically in the other. All inter-relation of separate diagram sheets shall be shown on all relevant sheets.

Control diagrams shall be clearly drawn showing the operation of the equipment in simple functional form, on “tramline” or “schematic” type diagrams and separately on “connection” type diagrams, the latter showing the location and connection of components and cable forms in their relative positions within the enclosures. All control diagrams shall contain, or refer to, a comprehensive legend to identify components and contacts, showing their locations on the diagram by grid reference, indicating special features, e.g. current rating, coil voltage, adjustment settings, etc., and relating relay contacts to operating coils and particular functions.

Diagrams showing connections between equipment, i.e. transferred from one sheet to another or identifying interconnection cables, shall clearly show the reference on the associated diagrams and the identity and size of cores of the interconnecting cables.
Drawings of equipment layouts shall carry the same identification keys as the diagrams and shall be drawn so that all items are easily identified by location and type.

11.3.4 Installation Manual

11.3.4.1 General

The Installation Manual shall contain all information required for the installation of the equipment. It shall be tailored to suit the needs of installation personnel. It shall not depend on the presence of any other (separately bound) part of the sign manuals and shall present the information in a manner and sequence that is relevant to the installation procedure.

Illustrations shall be used wherever practical. Annotated photographs may be used provided that they are clearly labelled.

The Installation Manual shall have the manual structure specified in Clause 11.1.2.

Prior to any step in the installation that could be hazardous, a clear warning shall be included in the instructions with particulars of precautions to be taken or checks to be made before proceeding.

11.3.4.2 Subject Text

The subject text of the Installation Manual shall be divided into the following sections:

(a) Section 1 “Equipment Type” – This shall contain a full definition of equipment type and model to which the Installation Manual applies. The information shall be sufficient to allow installation personnel to unambiguously confirm that the Installation Manual applies to the equipment to be installed.

Basic physical parameters of dimension, weight and if relevant, colour as well as the location of equipment markings, name plates and any other identification marks shall be included;

(b) Section 2 “Packing” – This shall contain a description of packaging and method of handling both in transit and at the point of installation. Particulars shall be included of the following:

(i) Location of lifting lugs, handles;

(ii) Places to which slings and hooks may be attached;

(iii) Places that shall not be subject to external loads;

(iv) Parts that need to be provided with additional protection, support or fixing during transport;
(c) Section 3 “Preparatory Works” – This section shall cover details of any site works that must be completed before installation can take place, where relevant. This information shall be presented in the form of dimensioned mechanical drawings showing the location of mountings, access doors or panels, cable terminations, ducts and conduits. The drawings shall be supported by notes or explanatory text;

(d) Section 4 “Placement” – This section shall cover details of the placement and connection of the equipment in the form of a step by step procedure. It shall include the following:

(i) Precautions when unpacking;
(ii) Details of the hauling operation;
(iii) Details of fixing bolts or other types of fasteners;
(iv) Details of sign face alignment;
(v) Details of size and type of electrical connections, e.g. lug size, cable socket capacity, and type, minimum cable size, preferred routing for external cables etc.

NOTE: Refer to Clause 11.3.4.1 for requirements to include clear warnings and precautions for hazardous installation steps;

(e) Section 5 “Setting up for Operation” – This section shall include the procedure for turning on and the procedure for turning off or shutting down as a step-by-step procedure. Full information shall also be given of basic checks and setting-up adjustments to be made after installation and prior to full commissioning tests.

11.3.5 Reference Drawings

Reference drawings and diagrams referred to in Clause 11.3.3.2(e) in their original sizes on prints shall be provided separately, as a part of the sign manuals, in addition to those (A3 or A4 sized version) bound in the Maintenance Manual and on CD-ROMs or common portable storage media.
12 ROUTINE PRODUCTION TESTS AND PRE-DELIVERY ACCEPTANCE TEST

12.1 Routine Production Tests

Routine production tests shall be carried out by the Supplier on each and every Sign after completion of manufacturing and before pre-delivery acceptance test.

For the purpose of this requirement, all routine production tests specified in Specification TSI-SP-016 shall be applicable, with the equipment soak test (i.e. Sign burn-in test) conditions changed as follows:

(a) The equipment soak test temperature changed to room temperature;

(b) The equipment soak test duration changed to seven (7) days.

The RMS Representative may wish to witness the conduction of the Sign burn-in tests. For the purpose of this requirement, the Supplier shall provide advance notice of not less than two (2) working days to the RMS Representative of the conduction of each Sign burn-in test.

The Sign burn-in test shall comprise a controlled seven (7) day continuous burn-in program designed to operate each sign system including sign displays, pixels, monitoring and communications.

12.2 Pre-delivery Acceptance Tests

12.2.1 General

Where it is a requirement of the Sign supply contract, pre-delivery acceptance test shall be conducted in accordance with the contract. Where the contract does not specify the details for pre-delivery acceptance test, the requirements in this section (Clause 12.2) shall apply.

Pre-delivery acceptance test shall be required for each and every Sign including all associated software, unless otherwise stated in the sign supply contract. Testing shall be conducted at the Supplier’s or manufacturer’s premises in the Sydney metropolitan area prior to delivery.

A pre-requisite for the commencement of pre-delivery acceptance test is the completion of all routine production tests for each Sign (refer to Clause 12.1).

The Supplier shall schedule the pre-delivery acceptance test to allow adequate time for completion of all tests and delivery of the Sign(s) not later than the required Sign delivery time under the supply contract.
12.2.2 Test Plan

The Supplier shall submit to the RMS Representative a test plan, including time schedule, for pre-delivery acceptance test not less than two (2) weeks before the commencement of pre-delivery acceptance test. Testing shall not commence before the test plan is approved by the RMS Representative.

The test plan shall include forms to be used for the acceptance test, and will be used as a list to check compliance with this Specification and AS 5156. Space shall be provided in the test plan for the following data fields:

(a) Name of Supplier’s representative to each test and the name of the RMS test representative as relevant;

(b) Test status - original test or repeat due to a previous test failure; and date, time and location of the test;

(c) List of test and measuring equipment used including unique item reference numbers and statement of software and version number used;

(d) Reference to this Specification, AS 5156, Specification TSI-SP-003 and other contract specifications to identify compliance with a specification clause;

(e) Compliance field for each specification clause.

The duration and testing resources required for each test shall be stated in the test plan submission.

12.2.3 Facilities for Testing

The Supplier shall provide full communications facilities for testing. These facilities shall include live links (both dial-up and direct) to the NSW Transport Management Centre and/or to a nominated RMS office.

The Supplier shall note and make provision for any resources required for test purposes (e.g. a temporary power supply if a permanent supply is not already available).

The Supplier shall have available in their premises an area designated for the testing where the equipment to be tested shall be set up in a logical manner to allow ready communications between and visual observation by personnel engaged in the pre-delivery acceptance test. The environment shall be compatible with the types and functions of the equipment to be tested.
All items of test equipment and measuring instruments required for the pre-delivery acceptance test shall be provided by the Supplier and shall be available in the test area for the duration of the tests. The test equipment and measuring instruments shall be in serviceable condition and where necessary shall be calibrated. Calibration documentation shall be provided to the RMS Representative.

12.2.4 Conduction of Pre-delivery Acceptance Test

The pre-delivery acceptance test shall be carried out by the Supplier's representatives and witnessed and passed by the RMS test representative.

The pre-delivery acceptance test shall comprise all tests and inspections to confirm compliance with this Specification, AS 5156 and other applicable specifications. It is permissible that tests of functions provided by the Sign’s firmware be carried out on only the first unit of signs of the same type, make, model and hardware version that use the same firmware version and build, and with only limited firmware function testing conducted on other subsequent units supplied under the supply contract. The RMS test representative will determine which limited tests are to be conducted.

The testing and inspection shall be arranged such that the whole system including all equipment and software shall be available at the same time.

The Supplier shall allocate appropriate senior personnel to carry out the pre-delivery acceptance test, supported by necessary technical staff.

12.2.5 Completion of Pre-delivery Acceptance Test

On completion of the pre-delivery acceptance test, the original test report certified by the representatives of the Supplier and the RMS test representative, together with a brief narrative report by the Supplier detailing variations from the approved test schedule and procedure and the reasons therefor, shall be submitted to the RMS Representative.

Notwithstanding the execution of satisfactory pre-delivery acceptance test and the witnessing thereof by the RMS test representative, the Supplier shall accept full responsibility for the satisfactory performance of the Signs and all of their components after installation.

12.2.6 Delivery of Signs

No Sign shall be delivered until it has passed the pre-delivery acceptance test and delivery is authorised by the RMS Representative.
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13 PACKAGING

The Signs and any spare parts, tools and ancillary equipment shall be packed to protect them from damage during transport and handling. All fittings liable to damage during shipment shall be protected, or removed and packed separately. Where necessary, reusable transit bars or other forms of additional support shall be provided with the equipment.

Equipment must not be damaged and preset adjustments must not be affected when subjected to the shock and vibration of transport between the Supplier’s premises and the nominated delivery point. Unless otherwise directed, the Supplier shall select the means of transport and pack the equipment to ensure compliance with this clause.
APPENDIX A

ISLUS DIMENSIONS AND DISPLAY LAYOUT
APPENDIX A:  ISLUS DIMENSIONS AND DISPLAY LAYOUT
<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>j</th>
<th>k</th>
<th>r1</th>
<th>r2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISLUS-A</td>
<td>570</td>
<td>570</td>
<td>60</td>
<td>450</td>
<td>178</td>
<td>223</td>
</tr>
<tr>
<td>ISLUS-B</td>
<td>720</td>
<td>720</td>
<td>60</td>
<td>600</td>
<td>237</td>
<td>297</td>
</tr>
<tr>
<td>ISLUS-C</td>
<td>1020</td>
<td>1020</td>
<td>60</td>
<td>900</td>
<td>356</td>
<td>446</td>
</tr>
<tr>
<td>ISLUS-D</td>
<td>1320</td>
<td>1320</td>
<td>60</td>
<td>1200</td>
<td>474</td>
<td>594</td>
</tr>
</tbody>
</table>

Notes:
1. It is permissible for the display region outside of the central 20 x 34 (vertical x horizontal) region to be depopulated of pixels where pixels are not required for the sign images specified in this Specification;
2. See Clause B.6.2 for permissible offset for LUS signals.
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APPENDIX B

SIGN IMAGES
APPENDIX B

SIGN IMAGES

B.1 General

The bitmap display image definitions in this Specification are based on a display matrix of 20 x 34 (vertical x horizontal) pixels for speed numerals and other displays excluding LUS related displays. LUS related displays are based on a matrix size of 36 x 36 pixels.

Refer to Appendix A for the location of the display matrix on the sign face. All speed numerals and other displays, excluding LUS related displays, shall be shown within the central 20 x 34 (vertical x horizontal) pixel region of the display matrix. LUS related displays shall use the full 36 x 36 pixel region.

B.2 Frame Numbering and Bitmap Definitions for Speed Displays

The requirements for frame graphics and numbering for speed displays for matrix signs in AS 5156 (i.e. clause B4.1 of AS 5156-2010), including bitmap definitions for speed limits (clause B4.5 of AS 5156-2010), shall apply to the Sign.

For the purpose of this clause, where the annulus is required to be flashed, only the innermost pixel rings of the annulus that are configured to flash (see Clause 6.1.6.1) shall flash, and the remaining pixel rings shall remain on continuously.

B.3 Message Numbering for Speed Displays

The requirements for message numbering for speed displays for matrix signs in AS 5156 (i.e. clause B4.2 of AS 5156-2010) shall apply to the Sign.

B.4 Frame Numbering for Other Displays

The requirements for ‘frame numbering for other displays’ for matrix signs in AS 5156 (i.e. clause B4.3 of AS 5156-2010) shall apply to the Sign with the following defined usage and additions:

(a) Frame numbers 180 to 185 and 190 to 195 are to be used as LUS signals and are to be so identified. See also Clause B.6.2;
(b) New frame numbers 189 and 199 for use for display of a Red LUS Cross, as follows:

<table>
<thead>
<tr>
<th>Frame No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>189</td>
<td>Red LUS Cross With no Annulus and no Flashers</td>
</tr>
<tr>
<td>199</td>
<td>Red LUS Cross With no Annulus but with Up/Down Flashers</td>
</tr>
</tbody>
</table>

Refer to Clause B.6.2 for the revised and new bitmap display image definitions for these LUS signals.

**NOTE:** Appendix D provides a summary list of defined frame numbers for displays other than speed limits.

### B.5 Message Numbering for Other Displays

The requirements for ‘message numbering for other displays’ for matrix signs in AS 5156 (i.e. clause B4.4 of AS 5156-2010) shall apply to the Sign.

### B.6 Bitmap Definitions for Other Displays

#### B.6.1 General

The typical bitmap display image definitions for other displays for matrix signs in AS 5156 (i.e. clause B4.6 of AS 5156-2010), except for arrows (i.e. frame numbers 180 to 185 and 190 to 195), shall apply to the Sign.

In addition, the typical bitmap display image definitions in Clause B.6.2 for LUS signals (arrows and cross) shall apply to the Sign.

#### B.6.2 Bitmap Definitions for LUS Signals

It is permissible for LUS signals to be provided on the Sign display with an offset of up to 75% pixel pitch in each of the horizontal and vertical directions from the specified locations.

**NOTE:** While bitmap definitions for operation with flashers (i.e. flashing conspicuity devices) are defined in this clause, there is no requirement for flashers to be provided.
Upward LUS Arrow – Frame 180, and Frame 190 (with flashers)
Downward LUS Arrow – Frame 181, and Frame 191 (with flashers)
Up-Left LUS Arrow – Frame 182, and Frame 192 (with flashers)
Up-Right LUS Arrow – Frame 183, and Frame 193 (with flashers)
Down-Left LUS Arrow – Frame 184, and Frame 194 (with flashers)
Down-Right LUS Arrow – Frame 185, and Frame 195 (with flashers)
RED LUS Cross – Frame 189, and Frame 199 (with flashers)
APPENDIX C

CONTROL HOUSING LABEL
APPENDIX C: CONTROL HOUSING LABEL

Content: “Smmop” (Sign ID number)
Format: Series ‘C’ numerals as per AS1744 (80 mm, medium spacing, centred)

Content: “Srsr” (Sign ID number)
Format: Series ‘C’ numerals as per AS1744 (80 mm, medium spacing, centred)

Content: “TO REPORT VANDALISM OR MALFUNCTION PLEASE PHONE”
Format: Arial BOLD, 2 lines, 10 mm high characters, vertical spacing 7 mm, centred

Content: “131 700”
Format: Series ‘E’ numerals as per AS1744 (40 mm, medium spacing, centred)

Details

1) Label to be made from pressure sensitive non-reflective material such as “Fascal 400, Gloss Yellow” (made by Fasson P/L) or “Scotchcal Type 3652 Yellow” (made by 3M Australia P/L) or approved equivalent.

2) Lettering, logo and bordering to be black. Sign ID Number to be yellow with black background (See example).

3) Samples of the base material offered with a sample black legend shall be submitted to and approved by Roads and Maritime Services.

4) A written four year guarantee is required against any defect in colour or adhesion when applied to a vertical painted surface exposed to all weather conditions.
APPENDIX D

SUMMARY LIST OF FRAME NUMBERS
FOR OTHER DISPLAYS
(Informative)
APPENDIX D

SUMMARY LIST OF FRAME NUMBERS
FOR OTHER DISPLAYS
(Informative)

For reference purpose, a summary list of defined frame numbers for displays other than speed limits is provided in Table D.1.

Table D.1 - Frame Numbers for Displays other than Speed Limits

<table>
<thead>
<tr>
<th>Frame No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>Upward LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>181</td>
<td>Downward LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>182</td>
<td>Up-Left LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>183</td>
<td>Up-Right LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>184</td>
<td>Down-Left LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>185</td>
<td>Down-Right LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>186</td>
<td>‘NO’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>187</td>
<td>‘EXIT’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>188</td>
<td>‘ONLY’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>189</td>
<td>Red LUS Cross</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>190</td>
<td>Upward LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>191</td>
<td>Downward LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>192</td>
<td>Up-Left LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>193</td>
<td>Up-Right LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>194</td>
<td>Down-Left Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>195</td>
<td>Down-Right LUS Arrow</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>196</td>
<td>‘NO’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>197</td>
<td>‘EXIT’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>198</td>
<td>‘ONLY’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>199</td>
<td>Red LUS Cross</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>200</td>
<td>‘SLOW’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>201</td>
<td>‘SLOW’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>202</td>
<td>‘DOWN’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>203</td>
<td>‘DOWN’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>204</td>
<td>‘FOG’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>205</td>
<td>‘FOG’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>206</td>
<td>‘STOP’</td>
</tr>
<tr>
<td></td>
<td>With no Annulus but with Up/Down Flashers</td>
</tr>
<tr>
<td>207</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>For “24 HOURS” for other sign types</td>
</tr>
<tr>
<td>208</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>For “NOT IN OPERATION” for other sign types</td>
</tr>
<tr>
<td>209</td>
<td>All Lanes Closed (Road Closure)</td>
</tr>
<tr>
<td></td>
<td>With no Annulus and no Flashers</td>
</tr>
<tr>
<td>Frame No.</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>221</td>
<td>Lanes Closed / Closed / Open With no Annulus and no Flashers</td>
</tr>
<tr>
<td>222</td>
<td>Lanes Closed / Open / Closed With no Annulus and no Flashers</td>
</tr>
<tr>
<td>223</td>
<td>Lanes Closed / Open / Open With no Annulus and no Flashers</td>
</tr>
<tr>
<td>224</td>
<td>Lanes Open / Closed / Closed With no Annulus and no Flashers</td>
</tr>
<tr>
<td>225</td>
<td>Lanes Open / Closed / Open With no Annulus and no Flashers</td>
</tr>
<tr>
<td>226</td>
<td>Lanes Open / Open / Closed With no Annulus and no Flashers</td>
</tr>
<tr>
<td>227</td>
<td>All Lanes Open (Closure Restriction Eased) With no Annulus and no Flashers</td>
</tr>
<tr>
<td>228</td>
<td>Lanes Closed (Road Closure) With no Annulus but with Up/Down Flashers</td>
</tr>
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<td>229</td>
<td>Lanes Closed / Closed / Open With no Annulus but with Up/Down Flashers</td>
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<td>234</td>
<td>All Lanes Closed (Road Closure) With no Annulus and no Flashers</td>
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<td>Lanes Closed / Open / Closed With no Annulus and no Flashers</td>
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<td>236</td>
<td>Lanes Open / Closed / Closed With no Annulus and no Flashers</td>
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<tr>
<td>237</td>
<td>All Lanes Open (Closure Restriction Eased) With no Annulus and no Flashers</td>
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<tr>
<td>238</td>
<td>Matrix Sign Test With no Annulus and no Flashers</td>
</tr>
<tr>
<td>239</td>
<td>Matrix Sign Test With Annulus and no Flashers</td>
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<tr>
<td>240</td>
<td>Matrix Sign Test With Annulus and with Up/Down Flashers</td>
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<tr>
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<td>Matrix Sign Test With Annulus and with Up/Down Flashers</td>
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<td>242</td>
<td>Matrix Sign Test With Annulus and with Up/Down Flashers</td>
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<td>243</td>
<td>Matrix Sign Test With Annulus and no Flashers</td>
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<td>252</td>
<td>Matrix Sign Test With Annulus and with Up/Down Flashers</td>
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