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TfNSW is not under any duty to inform you of any errors in or changes to this Specification.
# RECORD OF AMENDMENTS

<table>
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<th>Issue</th>
<th>Summary</th>
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<th>Approved by</th>
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<tr>
<td>1.0</td>
<td>First Issue</td>
<td>18/03/2005</td>
<td>Mgr. TSI</td>
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<tr>
<td>2.0</td>
<td>Second Issue.</td>
<td>22/06/2010</td>
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<tr>
<td>3.0</td>
<td>Major revision, in particular covers integrated speed and lane use signs, not just speed limit signs.</td>
<td>25/02/2014</td>
<td>A/Mgr. TSI</td>
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<tr>
<td>3.1</td>
<td>Changed the sign face to a square shape, dimensions adjusted accordingly. Minor other changes</td>
<td>1/04/2014</td>
<td>A/Mgr. TSI</td>
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<td>4.0</td>
<td>Renumbered to whole issue number in line with normal issue practice, intellectual content unchanged.</td>
<td>1/04/2014</td>
<td>A/Mgr. TSI</td>
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<td>5.0</td>
<td>Multiple changes including:</td>
<td>17/2/2020</td>
<td>Mgr. TSI</td>
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<td></td>
<td>- Permits full matrix design</td>
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<td>- Permits higher resolutions</td>
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<td></td>
<td>- Extra ports including a dedicated output port for enforcement monitoring.</td>
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<tr>
<td></td>
<td>- Changed display dimensions including reduced numeral height, and reduced annulus width.</td>
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<tr>
<td></td>
<td>- Sign external dimensions less prescriptive, may be varied by project.</td>
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<td>- Text displays not required</td>
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<td></td>
<td>- Changed numeral shape base font.</td>
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<td></td>
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<tr>
<td></td>
<td>- Add “Swap Out Only” sign as maintenance option</td>
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<td></td>
<td>- Changes to enclosure colour, operating voltage, dimming transition time, certification, and power consumption.</td>
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<tr>
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<td>- Separate specs referenced for Manuals, Housings and communication interface details</td>
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<td>- Revised document layout</td>
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<td>- Multiple other minor changes and clarifications.</td>
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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 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.

ISLUS signs described here are dedicated to a single lane, to which the display applies.

The following are deemed out of scope of this sign:

- text display unless stored or delivered as a graphic frame

1.1 System description

The figure below shows an example ISLUS system with some of the main features and key terminology:

![Figure 1 – Example ISLUS system schematic](image)

Note 1: Display units may be assigned to groups in other combinations than those shown in the figure. A group may have one display unit in it, or many more. A group may include display units on several gantries. One gantry may have display units in different groups.

Note 2: The connecting lines between display units and group controller are intended as conceptual only. They do not constrain cabling methodology for communications and power supply.

For context of how this signage is typically used, the Austroads report AP-R341-09 [18] (section 9) contains information on typical usage on managed motorways, together with the TfNSW supplements 17.177 [15] and 17.168 [16].
2 REFERENCES AND APPLICABLE DOCUMENTS

2.1 Australian and International Standards

[1] AS 1170.2 – Structural design actions - Wind actions
[8] ISO 9001 – Quality management system - Requirements

2.2 TfNSW Documents

[9] TS201 – Approval of ITS Field Equipment
[10] TSI-SP-003 – Communications Protocol for Roadside Devices
[14] Drawing VM005-01 – Housing Facility Key drawing

2.3 Other Documents

[18] Austroads Report AP-R341-09: Freeway design parameters for fully managed operations

2.4 Generic Compliance

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.

2.5 Clause Referencing of AS 5156 [4]

There are many references to the document AS 5156 in the body of this specification. If a numbered clause reference is given in this specification to help the user locate the relevant clause of the standard AS 5156, then it refers to the version AS 5156:2010.
3 DEFINITIONS AND GLOSSARY OF TERMS

The definitions and abbreviations given in AS 5156 shall apply, unless varied by the listing below:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITS</td>
<td>Intelligent Transportation Systems</td>
</tr>
<tr>
<td>TfNSW</td>
<td>Transport for NSW, a New South Wales government agency</td>
</tr>
<tr>
<td>TSI</td>
<td>Traffic Systems Integration</td>
</tr>
<tr>
<td>ACMA</td>
<td>Australian Communications and Media Authority</td>
</tr>
<tr>
<td>Display unit</td>
<td>The display including its enclosure, as mounted over the lane it controls</td>
</tr>
<tr>
<td>Equipment</td>
<td>Sign(s) covered by this Specification unless context dictates otherwise</td>
</tr>
<tr>
<td>Host Control System</td>
<td>A remote computer system that communicates with the Sign to effect control of the Sign</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electro-technical Commission</td>
</tr>
<tr>
<td>ISLUS</td>
<td>Integrated speed limit and lane use signs</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standards Organisation</td>
</tr>
<tr>
<td>LED</td>
<td>Light emitting diode</td>
</tr>
<tr>
<td>LUS</td>
<td>Lane Use Sign.</td>
</tr>
<tr>
<td>MTBF</td>
<td>Mean Time Between Failures</td>
</tr>
<tr>
<td>MTTR</td>
<td>Mean Time to Repair</td>
</tr>
<tr>
<td>NATA</td>
<td>National Association of Testing Authorities, Australia</td>
</tr>
<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>TIA</td>
<td>Telecommunications Industry Association</td>
</tr>
</tbody>
</table>

Table 1 – Definitions and Glossary of Terms

4 GENERAL REQUIREMENTS

4.1 Compliance with AS 5156

Signs shall comply with AS 5156 [4] except where otherwise detailed in this specification.

4.2 Work Health and Safety

The sign and its installation, including the Supplier’s instructions for installation, shall comply with the requirements of the NSW Work Health and Safety Act. [17]
5 GENERAL DESIGN AND ARRANGEMENT

5.1 Sign Display Enclosure

The requirements for sign display enclosure in AS 5156 [4] apply except as varied or supplemented below:

5.1.1 The colour of the front face of the sign shall be matt black. Other external surfaces should be a lighter colour, preferably matt grey, to minimise rise of internal temperature in direct sunlight, to prolong life of electrical items;

5.1.2 Dust and other airborne contaminants shall be prevented from reaching or accumulating in internal areas or components of the sign in a manner that may cause an adverse impact on the specified functional requirements, including sign light output and electrical items. This clause replaces clause 4.1.2(e) of AS 5156 [4].

5.1.3 The sign shall prevent moisture and condensation from accumulating in a manner that may cause adverse impact on the specified functional requirements, including sign light output and electrical items. It shall be assumed that high humidity air will enter the sign during service activity. Consideration shall be given to whether wind induced flex of panels may affect seals and permit additional water entry. This clause replaces clause 4.1.2(f) of AS 5156 [4].

5.1.4 Means shall be provided to access all replaceable components of the signs for maintenance.

5.2 Display Unit Mounting Facilities

5.2.1 The mounting points on the sign display unit, and other mechanical attributes of the sign, shall meet the structural requirements as specified in AS 5156 [4] and elsewhere as relevant, including capability to withstand wind loading.

5.2.2 The sign display with its mounts shall be certified as able to meet the structural requirements when supported as detailed in clause 5.2.6.

5.2.3 The sign display unit shall have appropriate structural integrity and features to enable it to be lifted into position without being damaged. If use of a lifting beam is required, this shall be described.

5.2.4 Sign display units declared as “swap out only” (see clause 12.1.3) shall have a “drop and lock” type attachment arrangement that permits a rapid exchange of sign displays, and preserving the set sign alignment.

5.2.5 The supplier shall provide drawings as part of approval submissions, to show how the sign display units can be attached to a support structure to meet the required structural and alignment outcomes.

5.2.6 Sign support structures are not considered part of the sign itself, so are not directly subject to approvals process TS201 [9]. However, where a project requires provision of a sign support structure, the relevant processes and standards shall be used.
5.3 Group Controller Housing

5.3.1 A weatherproof housing shall be provided for the Sign Group Controller.

5.3.2 The control housing shall be suitable for both post-mounting and ground mounting but shall be accessible by a technician standing at ground level.

5.3.3 The group controller housing shall comply with TSI-SP-012 [11]. This replaces the requirements of clause 4.1.4.1 of AS 5156 [4].

5.3.4 The group controller and housing shall be capable of supporting a minimum of 4 sign groups including the associated facility switches and wiring.

5.3.5 Signs shall be equipped for 2 sign groups by default, unless otherwise specified by a project.

5.3.6 The Supplier shall supply drawings of the control housing showing the following:
   (a) Mechanical design of the housing including dimensions;
   (b) General arrangement of modules, interfaces, cable terminals and main switchboard in the housing;
   (c) Provisions for installation including dimensions;
   (d) Provisions for passage and installation of cables into and out of the housing.

5.3.7 The Group controller shall provide a set of three inputs per sign group, for interfacing with external devices. (A sign equipped for 2 sign groups will accordingly require 6 inputs). Each set of three inputs shall be as described in clause B2.3 of AS5156 [4]. This requirement replaces clause 4.1.4.3 (g) of AS 5156 [4].

5.3.8 Markings shall be provided as defined in AS 5156 [4], except that the C tick compliance label referred to in clause 4.7(g) of AS 5156 [4] is replaced by the label for RCM compliance.

5.4 Facility Switches

5.4.1 Facility switches shall be provided on the exterior of the Group controller housing for local (on-site) control of the message display mode.

5.4.2 For each sign group that the sign is required to support, one facility switch shall be provided. Accordingly, for the default (see clause 5.3.5), two switches shall be provided.

5.4.3 The switches shall be operable by means of a key complying with Drawing VM005-1 [14]. Details of this key will be provided to the prospective suppliers by request. Operation of switches shall not require opening of the group controller housing door.

5.4.4 Each facility switch shall be provisioned with means to place labels, such that it can be clearly identified as to which sign group it controls.

5.4.5 Each facility switch shall provide for the Sign group 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.

5.4.6 Auto shall be the normal operation mode.

5.4.7 It shall be possible to configure displays for the two MESSAGE switch positions. The default state of MESSAGE 1 and MESSAGE 2 shall be a BLANK display.
5.4.8 The display units in the group shall blank if the facility switch is set to the blank position. It shall result in the actual removal of power from the sign display units within the group, such that they will blank regardless of the nature of fault with any of the sign display units, including an unresponsive processor in the sign display unit or group controller. This takes precedence over any competing commands from the host control system.

5.4.9 Means shall be provided (e.g., an electrical marshalling board) such that if sign display units are re-assigned to another group in the group controller configuration, a technician can change the connections such that the facility switch responses match the changed assignments.

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

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

5.4.12 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.

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

5.4.14 The key access for the Facility Switches shall be suitably weatherproofed.

5.4.15 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.

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

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

5.4.18 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.
5.5 Operating Voltage

The sign shall comply with clause 4.2.2 of AS 5156 [4], except that the ranges for operating correctly and reliably shall be 205 V to 264 V r.m.s, and 48 Hz to 52 Hz.

5.6 Battery Backup

5.6.1 A battery backup system shall be provided with the sign. This system shall comply with requirements in AS 5156 [4] for battery backup except as varied below.

5.6.2 The backup system shall 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.

5.6.3 The type of battery used for backup is not required to be a deep discharge gel type. However, the battery shall be maintenance free and leak free, with a design service life of at least 4 years.

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

    NOTE: Refer to Clause 5.9.2 for requirements for the dedicated battery backup system for the real-time clock.

5.7 Surge Protection

In addition to the requirements for surge protection in AS 5156 [4], surge protection shall be provided both at the control cabinet and display for power cables and for communication lines where copper based.

5.8 Design Life

The designed operating life of the Sign 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 display enclosure - not less than 20 years;
(d) For group controller housing - not less than 20 years;
(e) For the fixed sign mounting, support and access structures - not less than 50 years (informative).

    NOTE: Clauses (a) and (b) contain different values to those in AS 5156.
    NOTE: Refer to Clause 7.5 for rated minimum service life for pixels.
    NOTE: Clause (e) is applicable only if these parts are supplied by the Supplier.
5.9 Real-Time Clock

5.9.1 General

In addition to the requirements for real-time clock in AS 5156 [4], the requirements in this section (Clause 5.9) shall apply.

5.9.2 Dedicated Power Backup

The dedicated power backup system specified in AS 5156 [4] shall be a battery that provides extended power backup beyond the Sign’s battery backup system (clause 0) 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 (clause 0).

5.9.3 Logging of Time Updates and Changes

The Sign shall log all time updates and changes.

5.10 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.

5.11 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.
6 DISPLAY REQUIREMENTS

6.1 Display Dimensions

Figure 2 – Display Dimensions

Note: the colours above are not indicative of the required display colour.
6.2 Table of Dimensions

<table>
<thead>
<tr>
<th>Parameter (all values in mm)</th>
<th>Label</th>
<th>Limit type</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
<th>Type D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annulus outer diameter</td>
<td>a</td>
<td>Minimum</td>
<td>450</td>
<td>600</td>
<td>900</td>
<td>1200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum</td>
<td>405</td>
<td>540</td>
<td>810</td>
<td>1080</td>
</tr>
<tr>
<td>Annulus inner diameter</td>
<td>b</td>
<td>Maximum</td>
<td>378</td>
<td>504</td>
<td>756</td>
<td>1008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>378</td>
<td>504</td>
<td>756</td>
<td>1008</td>
</tr>
<tr>
<td>LUS region edge length</td>
<td>s</td>
<td>Minimum</td>
<td>315</td>
<td>420</td>
<td>630</td>
<td>840</td>
</tr>
<tr>
<td>Numeral height</td>
<td>h</td>
<td>Maximum</td>
<td>171</td>
<td>228</td>
<td>342</td>
<td>456</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>162</td>
<td>216</td>
<td>324</td>
<td>432</td>
</tr>
<tr>
<td>Sign Width*</td>
<td>c</td>
<td>Maximum</td>
<td>580</td>
<td>730</td>
<td>1030</td>
<td>1310</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>560</td>
<td>710</td>
<td>1010</td>
<td>1330</td>
</tr>
<tr>
<td>Sign Height*</td>
<td>d</td>
<td>Maximum</td>
<td>580</td>
<td>730</td>
<td>1030</td>
<td>1310</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>560</td>
<td>710</td>
<td>1010</td>
<td>1330</td>
</tr>
</tbody>
</table>

Note 1: *Sign width and height may be re-defined by a project as described in clause 6.3

Note 2: The annulus is to be centred between sign edges unless otherwise defined by a project.

Table 2 – Sign Dimensions

6.3 Sign External Dimensions

The Sign Width c and Sign Height d specified given in Table 2 may optionally be re-defined by a project to suit site locations and space constraints, to improve visibility for backlit signs by enlarging the border, or for other purposes. The following guidance is provided for projects seeking to follow this path:

6.3.1 The limits for sign width c and height d given in Table 2 fit the assumption that annulus outer diameter is 10mm more than the minimum, plus a default sign border width of 55 ± 5 mm.

6.3.2 Optionally a project may reduce the minimum sign width c and minimum sign height d for signs that will be minimally backlit and so have no need for borders, such as in tunnels.

6.3.3 Optionally a project may reduce the maximum sign height or width for sign locations with physical constraints such as narrow sites, or limited headroom.

6.3.4 If changed by a project, minimum sign width and height shall be specified at least 10mm larger than the minimum outer annulus diameter given in Table 2. (to preserve a practical margin)

6.3.5 Dimensions c and d need not be equal; the sign may be rectangular.

6.3.6 Optionally a project may increase the sign borders to improve legibility for signs expected to become back-lit by low sun as viewed by a driver at the site of use. For such placements it is suggested a minimum border width of 20% of the annulus outer diameter be used in at least one plane (side borders or top/bottom borders, or both). If this option is taken, sign width c and height d should be re-defined accordingly to achieve the desired border dimensions.

6.3.7 Optionally a project may change limits for sign width c and sign height d for other reasons, such as to enable use of a common mounting frame for ISLUS.
6.4 Display Colours

The 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.

6.5 LUS Region

The Lane Usage Sign (LUS) display area shall be a square region. It shall be capable of displaying white over its full area and red over sufficient area to display the LUS cross.

6.6 Numeral Region

The area used for display of numerals shall enable display of white numeral shapes including spacing as defined in AS 1744 [2], scaled to the character height, subject to the constraints of LED resolution.

6.6.1 The display “100” shall use AS 1744 [2] series C numerals and the associated scaled inter-character spacing, matching within the constraints of the sign’s pixel resolution.

6.6.2 The numeral region’s width shall provide at least the horizontal pixel count needed to deliver the character width pixel count and character spacing to deliver the numeral “100”, as defined in 6.6.1.

6.6.3 Display of “110” and speed displays using 2 numerals shall use AS 1744 [2] series D numerals and the associated scaled inter-character spacing, matching within the constraints of the sign’s pixel resolution.

6.6.4 An example of such matching of the illuminated pixels to the shape of numerals is given in the figure below, with the AS 1744 [2] character shape shown shaded behind the bit map, and number of pixels spacing between characters selected for closest match with the distance given in AS 1744 [2]:

![Character shape matching to AS 1744 [2]](image)

Note 1: Resolutions may vary provided they meet the requirements of clause 6.10. Higher resolutions are preferable in terms of numeral shaping.

Note 2: The bitmap numeral images given in Appendix B4.5 of AS 5156:2010 shall not be used, as they do not comply with the above requirements in shape or spacing.

6.7 Sign Face Shape

The sign face shall be square or rectangular
6.8 **Shape of Lane Usage Arrows and Crosses**

6.8.1 The arrow and cross shapes shall be nominally as per the variant options shown below, subject to the constraints of LED resolution:

![Figure 4 – Arrow and Cross shape variants](image)

Note these are based on selected variants of table 3.3 of AS 1742.14

6.8.2 The proportions of arrows and cross shall be based on the figure below:

![Figure 5 – Arrow and Cross dimension labels](image)

6.8.3 The arrow head width “t” shall be between 75% and 85% of arrow shaft length ‘L’

6.8.4 Stroke widths “w1” and “w2” shall be between 10% and 20% of distance “s”.

6.8.5 Arrow head arms shall be perpendicular to each other.
6.9 **Annulus Pixel Arrangement**

6.9.1 The annulus pixels may be arranged either as a matrix display, or as a set of concentric rings. Examples are given below:

![Matrix Annulus and Concentric Ring Annulus](image)

*Figure 6 – Matrix Annulus and Concentric Ring Annulus*

Note. These signs use different numeral pixel resolutions; 28 on the left, and 20 on the right. This is not intended to constrain, but is given to illustrate higher resolution usage.

6.9.2 If the annulus is arranged as a matrix display, its resolution shall be that of the numeral region, and the whole sign shall have a uniform resolution.

6.9.3 The pixel interspersion requirements described in AS 5156 do not apply to matrix displays.

6.9.4 The requirement in clause 2.1.2.2 of AS 5156:2010 for pixel spacing of the annulus is replaced by the following: For concentric ring annulus, within each ring, the distance between the edges of adjacent LED lenses (or equivalent light sources) shall not exceed 12.5mm.

6.9.5 If the annulus is arranged as concentric pixel rings, the requirements for minimum number of rings in AS 5156 [4] shall be replaced by those shown below:

<table>
<thead>
<tr>
<th>Sign Size</th>
<th>Minimum Number of Pixel Rings</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
</tr>
</tbody>
</table>

*Table 3 – Red Annulus Pixel Configuration*

6.9.6 An outer ring or set of pixels of the annulus shall remain illuminated during flashing operation of the annulus.

6.9.7 During flashing operation of an annulus in a ring arrangement, the number of inner rings flashing shall be from 50% to 75% of the total number of pixel rings.
6.9.8 During flashing operation of an annulus in a matrix arrangement, the number of inner pixels flashing shall be from 50% to 75% of the total number of pixels in the annulus.

6.9.9 If the annulus is arranged as a matrix display, the whole display shall be addressable as a single matrix, and shall support graphic frame display via the protocol TSI-SP-003 [10], for alternate displays if required

6.10 Numerals and LUS region pixel arrangement

6.10.1 The sign shall use a matrix display for the Numerals region and LUS region

6.10.2 Numerals shall have a minimum resolution of 18 pixels high. This replaces the requirement in AS 5156 [4].

6.10.3 The distance between the edges of LED lenses or equivalent light sources, in the horizontal or vertical axes of the matrix, shall not exceed 12.5mm.

6.10.4 The LUS region shall have the same pixel resolution as the numerals region.

6.10.5 The numeral and LUS regions shall be addressable and shall support graphic frame display via the protocol TSI-SP-003 [10].

6.11 Required Displays

6.11.1 The following speed numerals shall be available, pre-set in the sign: 10, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, and 110.

6.11.2 Clause B4.5 of AS 5156 [4] does not apply. The bit-maps used for numerals shall meet the requirements of clause 6.6, as best suits the sign’s resolution.

6.11.3 Speed numeral displays shall be displayed together with the speed annulus.

6.11.4 A flashing treatment shall be available for use with speed displays. Refer 6.9.7 and 6.9.8.

6.11.5 The following 7 pre-set arrow and cross symbols shall be available, pre-set in the sign, to be shown filling the LUS region:

![Figure 7 – Required Symbols]

6.11.6 When arrows and cross symbols are being displayed, the annulus shall not be lit.

6.11.7 Arrows combined with flashers such as those described in Table B3 of AS 5156 [4] (frame numbers 190, 191, 192, 193, 194, 195) are not required.

6.11.8 Text displays, such as those described in Table B3 of AS 5156 (frame numbers 186, 187, 188, 196, 197, 198, 200, 201, 202, 203, 204, 205, and 207) are not required.
6.11.9 Multi-lane symbol displays without flashers and without annulus as described in Table B3 of AS 5156 (frame numbers 220, 221, 222, 223, 224, 225, 226, 227, 240, 241, 242, 243) shall be available, pre-set in the sign. They shall be delivered with shapes nominally as shown in Table B3, adjusted to the display resolution and at a size as large as practical within the available display width whilst retaining the proportions given in Table B3.

6.11.10 Multi-lane symbol displays with flashers as described in Table B3 of AS 5156 [4] (frame numbers 230, 231, 232, 233, 234, 235, 236, 237) are not required.

6.11.11 The matrix sign test displays listed in Table B3 of AS 5156 [4] (frame numbers 250, 251, and 252) shall be delivered as follows:
   a) Frame 250: Light all pixels White that are capable of delivering White.
   b) Frame 251: Light all pixels Red that are capable of delivering Red.
   c) Frame 252: Light just the pixels comprising the Annulus.

6.12 Sign Dimming Control


6.12.2 Light sensors used for dimming shall be located on the sign display unit.
   
   Note 1: More than one light sensor oriented in different directions may be required for effective dimming control.

   Note 2: It is permitted for other light sensors in the group facing in similar directions, or an average of such sensor input values, to be configured to be used as back-up inputs for auto-dimming, in the event of a failure of light sensors on the sign, if the group controller has the capability to do so. This capability is desirable but not mandated.

6.12.3 16 dimming levels shall be provided

6.12.4 Automatic dimming control shall be provided

6.12.5 The requirement given in AS 5156 [4] for the dimming light control algorithm to be user configurable does not apply.

6.12.6 The sign shall take a minimum of 5 s and a maximum of 15 s to transition from one dimming level to the next in either direction.

6.12.7 For automated dimming, the following preferred sequence of fall-back shall occur in the event of a sensor fault
   
   (a) Primary light sensors on sign or integrated back-ups
   
   (b) Alternate valid light sensors on other signs in group, individuals or average, where the optional capability exists in the group controller to configure and use these.

   (c) Time of day dimming.

   (d) Fixed dimming control.
7 OPTICAL REQUIREMENTS

7.1 Luminance and Luminance Ratio

The Sign shall meet the luminance and luminance ratio requirements in AS 5156 [4].

7.2 Luminance intensity Uniformity

7.2.1 The sign shall meet the luminous intensity uniformity requirements of AS 5156 [4].

7.2.2 Where both red and white colours are displayed simultaneously, they should appear with similar brightness. To achieve this, the luminance of white is suggested to need to be approximately four times the luminance of red.

7.3 Luminance Upwards

Light is not required to be emitted above the horizontal axis of the sign.

7.4 Colours

The sign shall meet the colour requirements of AS 5156 [4], as defined for the display colours red and white.

7.5 Pixel Service Life

The requirements for pixel service life in AS 5156 [4] are replaced by the following requirement.

The optical performance shall remain within the requirements of clauses 7.1, 7.2, 7.3 and 7.4 for a minimum of 10 years.
8  OPERATION AND CONTROL

8.1  General

8.1.1  Host Control

8.1.1.1  In addition to the requirements for host control in AS 5156 [4], the requirements in this clause shall apply.

8.1.1.2  The Product Host Control System shall be usable under Windows® operating systems, or through a web interface/internet browser.

8.1.2  Display Activation

8.1.2.1  The Sign’s display shall be capable of being activated through all of the methods listed as method for sign display activation in AS 5156 [4].

8.2  Local Control

The sign’s ground level control housing shall be equipped with, as a minimum, the following communication ports for in situ control, operation, configuration and diagnosis of the system:

8.2.1  TIA-232 port
8.2.2  TIA-485 port
8.2.3  Ethernet port

These ports shall meet the requirements of specification TSI-SP-071 [13]

8.3  Remote Control

In addition to the communication ports provided for local control, the control housing shall be equipped with, as a minimum, the following ports for remote operation and control:

8.3.1  TIA-232 port
8.3.2  TIA-485 port
8.3.3  Two x Ethernet port

These ports shall meet the requirements of specification TSI-SP-071 [13]

8.4  Monitoring Port

8.4.1  A TIA-485 monitoring port shall be additionally provided to permit the status of displays to be verified by enforcement camera systems.

8.4.2  The monitoring port shall bear the same outgoing data as the remote control port from group controller to host control system, except that it shall be converted into TIA-485 format, if not originally in that format.

Note: Date and time values are part of the data and so shall match the source message.

8.4.3  The monitoring port shall output within 0.5 seconds of the active remote control port’s output of the same data.

8.4.4  The sign shall not respond to incoming traffic on the monitoring port.

8.4.5  The monitoring port shall be labelled to distinguish it as a monitoring only port.
8.5 Programming

8.5.1 General

The requirements related to programming of frames, messages and plans for matrix signs in AS 5156 [4] shall be varied where there is an inconsistency with the communications protocol referred to in Clause 8.6, to support the use of the communications protocol.

For the purpose of this requirement, the following parameters shall support the following 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.

8.5.2 Frames, Message and Plans

8.5.2.1 A plan which is enabled by the host control centre shall override the plan currently enabled by the group controller.

8.5.2.2 When the overriding plan expires/completes, the group controller shall revert to the appropriate plan based on the previous plan, its schedule and any plans which are scheduled to activate.

8.5.2.3 The controller shall activate one plan at a time.

8.5.2.4 A plan shall be active until its completion, except where overridden (clause 8.5.2.1).

8.5.2.5 Prior to completion of a plan the group controller shall establish which plan will be activated next, to minimise delays. If no plan is available to be activated next, the sign shall blank on completion of the running plan.

8.5.2.6 Frames, messages and plans shall reside in the Sign controller.

8.5.2.7 Execution of any display shall be via the local “display” library. The remote Product Host Control System shall be able to store a “display” library that is identical to that stored in each Sign in the system.

Note: Local Sign “display” libraries may differ between each Sign.

8.5.3 Control of Multiple Signs

8.5.3.1 The group controller shall be capable of controlling twelve sign display units.

8.5.3.2 The displays signs shall be able to be grouped, for the purposes of control. The group controller shall be able to support four groups of displays.

8.5.3.3 The number of displays assigned to each group shall be configurable, from none up to twelve displays.
8.5.3.4 The sign group controller shall be able to support a poll rate of 1 heartbeat poll command per second, such that a sign status reply for all connected signs can be delivered in less than this interval, including when equipped 12 signs, however grouped.

Note: The heartbeat poll command and sign status reply are as defined in specification TSI-SP-003 [10] with MI codes respectively 05h and 06h.

8.5.3.5 Signs within the same group shall be controlled as a single entity and shall display the same message.

8.5.3.6 Signs in a group shall be monitored on an individual basis. This shall include both fault and display monitoring. Refer to Clause 8.5.4 for monitoring and response.

8.5.3.7 The Signs shall be capable of being programmed, monitored and controlled from both a local and remote location via the sign group controller.

8.5.3.8 All displays and the group controller shall be individually addressable.

8.5.3.9 Displays within the same group shall change their displays simultaneously in response to a demanded change.

8.5.3.10 In the event that the group controller determines that there is a critical fault on one or more displays, the group controller shall force all other displays within the same group to blank.

8.5.3.11 The group controller shall limit displays within the same group to one of the following combinations of displays:

(a) All displays showing the same speed limit; or
(b) Some displays showing the same speed limit, and other displays showing lane use signals
(c) Displays showing lane use signals

8.5.4 Monitoring and Response

8.5.4.1 The group controller shall check all incoming commands that attempt to display stored frame(s), for the conditions specified in this clause. The group controller shall reject all such commands where any of these conditions are detected.

8.5.4.2 In addition, the group controller shall monitor the displays at all times for these conditions.

8.5.4.3 Where sign displays are mounted above the lane to which they apply, the group controller shall respond to the following conditions:

(a) A Sign display unit not responding to the control signals from the group controller;
(b) One or more Sign display units within a group displaying a blank display when other sign display units in the group are not blank;
(c) A Sign display unit within a group displaying a different speed limit display to other display units of the group; Differential speeds shall not be shown on the same gantry for signs on facing the same carriageway and travel direction.
(d) A Sign display unit within a group 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. 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 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 displaying 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 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.

(h) A Sign display unit on a lane that is not the furthest right lane of the road 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.

8.5.4.4 The Sign group controller shall detect any of the above conditions and respond to such a condition by blanking the displays of all sign display units within the same group, within 0.3 seconds of the occurrence of that trigger condition.

8.5.4.5 For the purpose of this clause, the Sign group 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.

8.6 Communications

8.6.1 The Sign group controller shall incorporate the communications protocol specified in RMS Specification TSI-SP-003 [10] ("Communications Protocol for Roadside Devices") for communication with the host control system.

8.6.2 For the TSI-SP-003 protocol, the MI codes listed as applicable to ISLUS in the summary table (item 3.6.4 TSI-SP-003 [10]) shall be implemented, except for the message “Sign Set Text Frame” (MI code 0A), that the sign shall respond to with the reject response.

Note: Character font sets are not to be used for ISLUS. Any text representation, if required, is to be loaded and managed as a graphic frame.

8.6.3 The Sign shall not initiate communication connection with the host control system.

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

8.7 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.
8.8 Fall-Back Operation

8.8.1 In addition to the requirements for fall-back operation in AS 5156 [4], the requirements in this clause shall apply.

8.8.2 The sign display shall blank immediately if experiencing a critical fault.

Note: The relevant definition of a critical fault is given in clause 3.6 of AS 5156 [4].

8.8.3 When mains power is lost the group controller shall:

8.8.3.1 Maintain its operation and normal sign operation (except for pixel lighting) on battery back-up whilst stored power remains to do so,

8.8.3.2 If the group controller has been able to maintain operation during the mains power outage, then on mains power restoration, the group controller shall resume the current plan sequence and/or frame or message display commanded prior to or during the mains failure;

8.8.3.3 If the group controller has not been able to maintain operation during the mains power outage, then on resumption of mains power the group controller shall leave sign displays blank until it receives confirmation from the host control system of the latest required displays, and only then shall it begin display of those.

8.8.4 When communication is lost or adversely affected – maintain normal sign operation, continuing to operate from local control and current plan sequence. (but log a communications time-out).

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

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

8.8.7 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).

8.8.8 In each case, the Sign shall correctly report and log the fault, as well as report the currently active display.

8.8.9 Upon clearance of the fault, the Sign shall correctly report and log the clearance.

8.8.10 Upon clearance of the fault, the Sign shall establish the appropriate plan/message to display:

- Display an overriding plan/message which was activated while the sign was in fault
- Resume the previous display, plan/message, unless the plan has expired.
- Display the next appropriate plan/message

8.8.11 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 8.8.4 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.

8.8.12 In any case, where communication is available, the remote operator shall be able to blank the Sign, or group of signs. 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. If the
facility switch is in the Auto, Message 1 or Message 2 position, the sign (or group of signs) shall blank on receipt of this command.

NOTE: Turning OFF the power for a group shall result in the actual removal of power from the sign display units within the group, such that they will blank regardless of the nature of fault with any of the sign displays or sign display units, including an unresponsive processor in the sign display.

8.8.13 If communication between the sign controller and the host control system is lost and not resumed within a communications threshold time, the Sign controller shall end the communications session (i.e. go “offline”).

(a) The communications threshold time shall be configurable ranging from 0 (infinite) to 65535 seconds.

(b) A default communications threshold time of 30 seconds shall be pre-set.

(c) 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

(d) The communications time-out fault shall be cleared on the next successful communications message.

8.8.14 Where communication between the sign controller and the host control system is lost, and not resumed within a display threshold time, the Sign controller shall blank all signs it controls, and log a display time-out.

(a) The display threshold time shall be configurable ranging from 0 (infinite) to 10080 minutes.

(b) A default display threshold time of 2 minutes shall be pre-set.

(c) The display time-out fault shall be cleared on the next successful communications message.

9 ENVIRONMENTAL REQUIREMENTS

9.1 Temperature and Humidity

The sign shall meet the environmental requirements described in clause 5.1 of AS 5156 [4], consistent with use in the State of NSW.

9.2 Enclosure Protection

The sign enclosure shall provide at least protection level IP55, in accordance with AS60529 [5]. This clause replaces clause 5.2(a) of AS 5156 [4].

9.3 Wind Loading

The requirements for wind loading in AS 5156 [4] 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 [1] for Terrain Category 2, 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.

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 [4] and clause 9.2 as applicable.

9.4.4 Shock Test

The complete Sign shall be tested in accordance with the requirements for shock in AS 5156 [4].

9.4.5 Vibration Test

The complete Sign shall be tested in accordance with the requirements for vibration in AS 5156 [4].

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 [4].
10 MANUALS

In addition to the requirements of AS 5156 [4] for manuals, the following shall apply:

10.1 Sign Generic Manuals

10.1.1 The Supplier shall provide generic manuals compliant with TSI-SP-062 [12] as part of the approval process.

10.1.2 Manuals shall include a list of relevant spare parts for anticipated maintenance, and include instructions for related diagnosis for when spare parts should be used.

10.1.3 Maintenance manuals shall include arrangement drawings or photographs to illustrate activity required for replaceable items. This shall include pixel module replacement, as well as other replaceable items.

10.2 Project Specific Manuals

10.2.1 The Supplier may be required to provide project specific manuals; if so these shall be similar to approved generic manuals, with additional items, or approved variations, as appropriate to the project.

10.2.2 Project specific manuals are not required as part of the TS201 [9] approval process. Instead, they relate to the project, and shall be sent to the project’s RMS Representative for their review, prior to the delivery of the sign(s) under order.

11 CERTIFICATION

The following certification shall be obtained and provided as part of approvals submissions:

11.1 EMC Immunity

11.1.1 Declaration of Conformance of the sign to AS/NZS 61000.6.1 [6], and supporting evidence.

11.2 Mandatory Regulatory items

This item replaces clause 4.7(g) and clause 4.7(h) of AS 5156 [4]. Either all of 11.2.1 shall be supplied, or all of 11.2.2 shall be supplied.

11.2.1 Evidence of valid RCM compliance as defined in AS/NZS 4417.2 [3].

Note 1: Associated details are provided on the ACMA website, such as at https://www.acma.gov.au/Industry/Suppliers/Regulatory-arrangements/EMC-Electromagnetic-compatibility/device-compliance-levels.

Note 2: Further associated details are provided on the NSW fair trading website such as at https://www.fairtrading.nsw.gov.au/trades-and-businesses/business-essentials/selling-goods-and-services/electrical-articles/approval-of-electrical-articles. The sign is classed as a ‘non-declared article’.

11.2.2 Both of the items below

(a) Certificate of Suitability issued by the NSW Office of Fair Trading.

(b) Declaration of Conformance of the sign to AS/NZS 61000.6.3 [7] and supporting evidence
12 SUPPORTABILITY

12.1 Design for maintenance

12.1.1 The equipment design and construction shall take account of ergonomic factors relating to operation and maintenance safety (clause 4.2) irrespective of the maintenance strategy chosen (“in-situ” or “swap out”).

12.1.2 Where signs are required to be maintained in situ, doors shall be provided that give the access described in clause 5.1.4 when the sign is mounted on the expected support structure. Signs lacking this capability shall be declared by the supplier as “Swap out only”.

12.1.3 “Swap out only” signs shall provide facilities to be swapped out as the maintenance strategy. Such signs shall provide a means to access the internal components, but are not required to provide such access whilst the sign is mounted.

12.1.4 A modular approach should be used in designing the equipment to facilitate maintainability, ease of installation and commissioning.

12.1.5 Equipment layout within housings shall be designed for ease of access during operation, maintenance and service. Access to individual modules shall be provided for replacement of the module without the need for removing other components or wiring. The access to and replacement of modules shall not require the removal of fasteners that are not reusable. Preference shall be given to fasteners which are held captive when loosened.

12.1.6 Preference shall be given to only requiring standard tools for preventive and repair maintenance activities. A standard tool in this context is considered one that is readily available from common hardware retailers, as distinct from one that has very restricted supply sources, such as only available from the ISLUS manufacturer.

12.1.7 The Supplier shall provide the following information as part of approval submissions, to help evaluation of 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.

12.2 Reliability

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

12.2.1 A failure for the purpose of the above MTBF limit is defined as any defect (hardware or software) which causes the display to be blanked or the display to be stuck ‘ON’. It also includes failures where the actual display differs from the intended display to the extent that viewers are unlikely to comprehend the intended message.

12.2.2 As part of approval submissions, the supplier shall provide the MTBF of the sign display system, and information and calculations supporting the MTBF value provided.
12.3 Power consumption

As part of approval submissions, the supplier shall provide laboratory test reports for the sign's power consumption, as given below:

12.3.1 Measurements shall be obtained using calibrated test equipment, traceable to a national standard. Details shall be included in the reports.

12.3.2 For the purposes of comparing electrical running cost, and estimating typical consumption, results shall be provided for the condition that the group controller is connected to twelve (12) signs.

12.3.3 For the purposes of comparing electrical running cost, and estimating typical consumption, results shall be provided for the condition that the sign is displaying the speed sign 100 (km/hr) with annulus, as per Figure 6, at dimming level 1. If the sign has further variables that affect power consumption, such as when cooling devices are operating, then this shall be stated and data for both the low and high power demand states shall be included.

12.3.4 For determination of required rating of power supplies and cables, results showing:

(a) Sign peak power during start up.

(b) Maximum in-service power.

The conditions of test shall be given, including what items are connected and active, and display states.

12.4 Software

12.4.1 In addition to the requirements for software development monitoring in clause 3.8 of AS 5156 [4], the requirements in this item shall apply.

12.4.2 The sign manufacturer/Supplier shall control the issue of firmware/software versions for the group controller / sign according to their quality plan for this activity.

12.4.3 The supplier shall provide a local means to upgrade the group controller / sign’s software/firmware, should this be needed post deployment. Preferably, most activity of this type shall be achievable at ground level via the control housing. Details shall be described in maintenance manuals.

12.4.4 The group controller / sign shall revert to the previous version if the new version fails to validate or install correctly.

12.4.5 The group controller / sign shall not be rendered inoperable in the event of an interruption during the software/firmware upgrade process, for example a power failure.

12.4.6 The supplier shall provide a means to perform a remote firmware/software upgrade. The process shall be described in the manual. It shall be necessary to enter the device’s individual password to enact a remote access firmware upgrade. It shall be possible to disable the remote upgrade capability.
13 QUALITY ASSURANCE

13.1 Quality System

The Supplier and the manufacturer shall operate a quality management system complying with ISO 9001 [8] and certified by an accredited quality management system certification body.

13.2 Quality Plan

The manufacturer shall document a quality plan. A copy of this quality plan shall be provided to TfNSW as part of the TS201 [9] approval process. Acceptance of this quality plan by TfNSW is a prerequisite to gaining overall approval.

The quality plan shall include details of model numbers, traceability of key components, in process and release inspections and records, and control of software/firmware release associated with update/rework of deployed VMS.

13.3 Quality Audits

TfNSW reserves the right to examine the Manufacturer's quality records pertaining to an order. TfNSW also reserves the right to arrange for an independent quality audit concerning items in contract.