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## RECORD OF AMENDMENTS

<table>
<thead>
<tr>
<th>Version</th>
<th>Summary</th>
<th>Date</th>
<th>Approved by</th>
</tr>
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<tr>
<td>R3452 Ed1 Rev0</td>
<td>Original specification R3452 titled “LED Traffic Signal Lanterns”</td>
<td>Oct 2003</td>
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<tr>
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<tr>
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<td>Remove dual voltage lantern option</td>
<td>Feb 2016</td>
<td></td>
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<tr>
<td>0.11 draft</td>
<td>Add limited access option</td>
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<tr>
<td>1.0</td>
<td>Convert to version 1 for publishing and release</td>
<td>Feb 2016</td>
<td>TSI mgr.</td>
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<tr>
<td>1.1</td>
<td>In item 6.4.2, modify dimming control wire signal “polarity” to align with the changed traffic controller dimming output described in amendment 4 of the traffic controller specification (TSC/4.) Also minor rephrasing within this item to improve clarity.</td>
<td>Jun 2016</td>
<td></td>
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<tr>
<td>1.2</td>
<td>In item A.4.2 add requirement to internally identify lantern as ELV, in place of option to externally colour an ELV lantern.</td>
<td>Jun 2016</td>
<td></td>
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<td>Convert to version 2 for publishing and release</td>
<td>4 Jul 2016</td>
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1 SCOPE

This specification details the requirements for the supply of vehicular and pedestrian signal lanterns used for control of road traffic in New South Wales.

2 REFERENCES AND APPLICABLE DOCUMENTS

Unless otherwise specified, the applicable issue of a reference document shall be the current one. The following documents are referenced by this specification:

2.1 Australian and International Standards

[2] AS 2276.1 – Cable for traffic signal installation
[3] AS 3808 – Insulating and sheathing materials for electric cables
[4] AS 2053 – Conduits and fittings for electrical installations

2.2 RMS Documents

[8] TS201 – Approval of ITS Field Equipment
[9] TSI-SP-064 – Pedestrian Countdown Timers
[10] TSC/4 – Control Equipment for Road Traffic Signals

2.3 RMS Drawings

[11] VM012-7 – Straps for mounting traffic single lanterns;
[12] VM012-14 – Tee-bar strap for dual 200mm lanterns;
[13] VM012-15 – Tee-bar strap for dual 300mm lanterns;
[14] VM206-13 – Target board mounting bracket for signal lanterns;
[15] VM206-14 – Target board details for 200mm signal lantern;
[16] VM206-21 – Target board details for 300mm signal lantern;
[17] VM208-29 – Closed visor type B for 200mm signal lantern;
[18] VM208-31 – Open visor type A for 200mm signal lantern;
[19] VM208-34 – Visor for pedestrian (Bicycle) lantern;
[20] VM208-39 – Blank-out disc for 200 and 300mm signal lanterns;
[21] VM208-43 – Closed visor type B for 300mm signal lantern;
[22] VM208-44 – Open visor type A for 300mm signal lantern.
2.4 Other Documents


3 DEFINITIONS AND GLOSSARY OF TERMS

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

- RMS - Roads and Maritime Services; a New South Wales Government Agency
- LV – Low voltage as defined in AS 3000 (For AC supply system, 50 – 1000 V<sub>rms</sub>)
- ELV – Extra Low Voltage as defined in AS 3000. (For AC supply system, below 50 V<sub>rms</sub>)

4 GENERAL REQUIREMENTS

4.1 Compatibility

The lanterns supplied shall be compatible with the traffic signal controllers approved in NSW. For recent controllers, the relevant controller specification is TSC/4 (refer [10]).

4.2 Safety

The equipment and installation shall comply with the requirements of the NSW Work Health and Safety Act.

4.3 Generic Compliance

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

4.4 Compliance with AS 2144

Traffic signal lanterns shall comply with all the requirements of AS 2144 [1], except as varied in subsequent items of this document.

Note: Where numbered item references are given in this document to help the user locate the relevant section of the standard AS 2144, they relate to the version AS 2144: 2014.

4.5 Pedestrian Countdown Option

If traffic signal lanterns are explicitly ordered with pedestrian countdown capability, refer to specification TSI-SP-064 [9] for the supplementary requirements.
4.6 Limited Access Option

If the limited access option is ordered, the requirements for individual doors to access each aspect do not apply. The entire assembly may potentially be essentially a sealed unit. It is expected that lanterns using such an approach be designed for intrinsic high reliability, backed up by an appropriate level of guarantee, noting the need to replace the whole if any element fails. Whole lifetime costs shall be considered. A lighter weight lantern is expected.

Further details are to be provided in subsequent issues of this document, defining more specifically which elements of AS 2144 may be varied.

4.7 Lightweight Class Option

Traffic signal lanterns that are lighter than the AS 2144 requirements and meet a defined mass formula are classed as “Lightweight”. Details are given in item 5.4. Lightweight class lanterns may be preferred for some activities and projects. Separate limits are also defined for the limited access option.

4.8 ELV Option

If the “ELV” option is specified for traffic signal lanterns, the applicable supplementary requirements and variations are given in Appendix A.

If ELV is not explicitly ordered, it shall be assumed the type required is LV. Dual voltage is not a permissible option.

Note that ELV Lanterns operate with a nominal 42V\textsubscript{rms} AC supply (min 32V to max 50V) from the traffic controller, whilst LV lanterns operate on a nominal 240V\textsubscript{rms} AC supply.

4.9 Rotation Detector Option

If traffic signal lanterns are ordered as requiring a rotation detector, the applicable supplementary requirements are given in Appendix B.

4.10 Pre-installed Lantern Connector Option

In the default supply arrangement, lanterns are supplied with just a cable tail, and connections are made on bare wires via the standard RMS post top terminal assembly.

If the pre-installed connector option is selected, details shall be as given in the purchase order. The connectors shall provide appropriate mechanical robustness, electrical connection reliability, and weather resistance to suit their location. This is to permit the use of alternate termination arrangements for cables, such as may be required to support trials of in-post termination arrangements.

4.11 Accessories

The traffic signal lantern supplier shall ensure that its lanterns are compatible with the accessories shown in listed RMS Drawings (see items 2.3 and 6.6).

The supplier shall declare whether they are able to supply the accessory items listed in the drawings of item 2.3, and further detailed in item 6.6. The types and quantities required will be defined in purchase orders. Note that supply of these items is not considered mandatory to obtain Type Approval on a traffic lantern, but it is considered desirable.
5 MECHANICAL AND PHYSICAL PROPERTIES

5.1 Longevity of Materials
As part of the approval process, the manufacturer shall provide information to demonstrate that the materials used will meet the requirements of AS 2144 over the specified service life. Information provided shall include effects of:
   a) UV exposure.
   b) Temperature (including local effects of internal heat sources where applicable)
   c) Airborne pollution from motor vehicles and other foreseeable sources

5.2 Access to Optical System
In addition to the requirements for access to optical system described in item 4.1.3 of AS 2144, the following items are preferred, though not mandatory.
   a) Tool–free access to the interior of the lantern, to speed access when needed.
   b) Arrangement that permits an aspect's individual light source to be replaced whilst leaving all other aspect's light sources in situ.
   c) Access capable of being readily swapped in the field between left hinged and right hinged access, without the need for tools.

5.3 Lantern Bodies
The lantern body size and shape shall allow for the fitting of the following items without the need to disassemble the target board
   a) Single target board
   b) Dual target boards
   c) Target board mounting brackets

Note that the requirements for target boards themselves are given in AS 2144 and further in item 7.3 of this specification.

5.4 Mass of Lanterns
The mass of a lantern shall not exceed the requirements defined in item 4.2 of AS 2144
For a Lantern to be also classed “Lightweight”, its mass with any target boards, louvres and visors removed, and without attached cable, shall not exceed the following, where n is the number of aspects in the lantern:
   a) For 200mm aspects: Maximum mass (kg) = 2.25n + 1
   b) For 300mm aspects: Maximum mass (kg) = 3n + 1
   c) Limited access 200mm aspects: Maximum mass (kg) = 1.4n + 0.8
   d) Limited access 300mm aspects: Maximum mass (kg) = 2.3n + 0.8
Lanterns in the “Lightweight” class may potentially be ordered in preference, in some cases. To aid comprehension and comparison, a table of resulting values for common lanterns is given below:

<table>
<thead>
<tr>
<th>Aspects (number x diameter)</th>
<th>1 x 200</th>
<th>2 x 200</th>
<th>3 x 200</th>
<th>4 x 200</th>
<th>3 x 300</th>
<th>4 x 300</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 2144 max mass (kg)</td>
<td>3.5</td>
<td>7.0</td>
<td>10.5</td>
<td>14.0</td>
<td>15.0</td>
<td>-</td>
</tr>
<tr>
<td>Lightweight Class max (kg)</td>
<td>3.25</td>
<td>5.5</td>
<td>7.75</td>
<td>10.0*</td>
<td>10.0*</td>
<td>-</td>
</tr>
<tr>
<td>Limited Access Option (kg)</td>
<td>2.2</td>
<td>3.6</td>
<td>5.0*</td>
<td>6.4</td>
<td>7.7</td>
<td>10.0*</td>
</tr>
</tbody>
</table>

* = basis of target, to have indicated variant below this limit, with related items of different aspect count scaled, including an allowance for items independent of aspect count.

5.5 Thermal Design of Light Source

As part of the approval process, the manufacturer shall provide information to demonstrate that the light source’s thermal management is consistent with meeting the signal aspect optical output requirements of AS 2144 over the specified service life. This shall include modelling of the heat generated by the light source itself, as well as effects of thermal properties of housings, and external ambient air temperature. In particular, the information shall describe how LED junction temperature is managed and limited, so as to achieve the required service life.

5.6 Mounting Facilities

In addition to the requirements for mounting facilities in AS 2144, the following apply:

5.6.1 The width of 200mm lanterns shall permit side by side mounting using the dual lantern tee-bar straps detailed in RMS drawing VM012-14. This has a 260±1mm axis separation distance.

5.6.2 The width of 300mm lanterns shall permit side by side mounting using the dual lantern tee-bar straps detailed in RMS drawing VM012-15. This has a 350±1mm axis separation distance.

5.6.3 The M12 mounting studs, nuts and washers described in item 4.1.2 of AS 2144 shall be of 316 grade stainless steel.

5.6.4 The M12 mounting studs shall be locked to the lantern body such that the studs are prevented from turning, and the body is not damaged, when a torque of 25 Nm is applied externally.

5.6.5 The M12 mounting studs shall be sealed against the lantern body by an O ring or other means, such that the water ingress/sealing requirements of AS 2144 are met.

5.6.6 The length of the exposed thread outside of the lantern spacer at two aspect pedestrian and bicycle lanterns shall be minimum 30 mm and maximum 35 mm.

5.6.7 All two-aspect bicycle lanterns shall be supplied with the Size 7 lantern mounting straps in accordance with Figure 3 in RMS drawing VM012-7.

5.6.8 Arrangements for locking lantern aim direction shall not rely on friction alone, but shall have some degree of positive keying, or equivalent, to prevent the lantern rotating into an inappropriate direction under moderate forces such as wind action.

5.6.9 Other provisions required in applicable RMS drawings.
5.7 Provision for Adjustment

In addition to the requirements for positional adjustment in item 4.1.4 of AS 2144, the following requirement shall be met:

The vertical adjustment method shall nominally centralise the lantern between the lantern mounting straps. The method shall provide sufficient vertical adjustment capability to align/fit the lantern body within the aperture in the target board, taking account of variance due to tolerances and other installation factors.

A typical approach uses keyed spacers, but other approaches are potentially permissible provided they meet the above requirements, positively lock to prevent unwanted movement, and are compatible with the accessory hardware and mounting facilities.

5.8 Environmental Tests

Where item 4.8 of AS 2144 refers to operational test, this shall be taken to include confirmation of chromaticity characteristics at raised ambient temperature.
6 ELECTRICAL AND OPTICAL REQUIREMENTS

In addition to the electrical and optical requirements in AS 2144, the following apply:

6.1 Controller Compatibility

The lanterns shall be assessed for controller compatibility as per Appendix C in this specification, and meet the requirements therein.

6.2 Maximum Power Consumption

At nominal 100% supply voltage, the maximum power consumed shall not exceed the values tabled below:

<table>
<thead>
<tr>
<th>Max Wattage</th>
<th>Red and Green</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>200mm Aspect</td>
<td>10W</td>
<td>15W</td>
</tr>
<tr>
<td>300mm Aspect</td>
<td>15W</td>
<td>20W</td>
</tr>
</tbody>
</table>

6.3 Supply Conductors

In addition to the requirements of item 5.3.1 of AS 2144, if an additional red signal active function is required, the colour of the additional conductor shall be Pink.

6.4 Dimming

In addition to the electrical requirements in item 5.5.5. of AS 2144, the following apply:

6.4.1 Dimming Method

The traffic signal controllers approved in NSW are capable of supporting dimming by control wire, magnitude or phase-cut dimming. Manufacturers may select any of these methods to meet the specified criteria.

6.4.2 Dimming by Control Wire

Lanterns using the method of dimming by control wire method shall comply with the following requirements:

6.4.2.1 Each lantern aspect shall provide an input terminal for interfacing with the dimming control wire and be responsive to control signals on the wire. The input terminal shall present a load of not more than 2 mA at rated supply voltage of lantern to the electrical signal on the wire.

6.4.2.2 The input terminal interface with the dimming control wire shall be able to withstand a connection of a low voltage supply up to 280 V AC. without damage.

6.4.2.3 The control signal for dimming will be the presence of 50% of the rated lamp supply voltage on the control wire which shall cause signal aspects to operate in the dimmed state.

6.4.2.4 Note: The rated lamp supply voltage is 180V to 280V for LV, or for ELV 32V to 50V, therefore 50% of lamp supply voltage is 90V to 140V for LV, or for ELV 16V to 25V, inclusive. The presence of the rated lamp supply voltage on the control wire, or voltage other than 50% of the rated lamp supply voltage, shall cause signal aspects to operate in the undimmed state.
6.4.2.5 For a lantern which is already on, the transition from undimmed to dimmed operation shall be gradual over a period of 2-4 seconds.

6.4.2.6 For a lantern which is already on, the transition from dimmed to undimmed shall be less than 4 seconds, and should preferably be gradual over a period of 2-4 seconds.

6.4.2.7 The lantern display shall be protected from, or immune to, signal interference from the dimming control wire, so that brightness does not vary in an inappropriate manner.

6.4.2.8 The brightness in the dimmed and un-dimmed states shall be as in Clause 6.5 and Appendix G of AS 2144.

6.4.2.9 Dimmed and undimmed operation shall comply with the signal switching response times, from ‘Off’ to ‘On’, as in item 6.3 of AS 2144.

6.5 Longevity of LED Light Sources

The following requirements apply.

6.5.1 LED Light Source

As part of the approval process, the manufacturer shall provide information on their proposed LED light sources from laboratories accredited for the respective tests, to demonstrate the following requirements will be met:

6.5.1.1 Design service life of at least 10 calendar years, meeting minimum brightness requirements defined in AS 2144. For the purpose of this determination, it shall be assumed that Yellow aspects are active for 10% of time, and Red and Green aspects are each active for 50% of time, irrespective of type of aspect.

6.5.1.2 Chromaticity coordinate values of the light sources do not shift beyond the chromaticity coordinate tolerance as defined in AS 2144, over the service life;

The information to be provided to demonstrate the requirements have been met shall include the following:

6.5.1.3 LM-80 test results (Refer [23])
6.5.1.4 TM-21 extrapolation report (Refer [24])
6.5.1.5 Design service life analysis

6.5.2 Drive Current and LED Case Temperature

The drive current for the LED light source shall be regulated at a level that, while the LED aspects are being continuously operated at ambient temperature up to 55°C as specified in Clause 4.7 of AS 2144, the highest in situ measured case temperatures of the LED light source shall be lower than the maximum case temperatures applied in the LM-80 tests and TM-21 extrapolation report.

The manufacturer or supplier of the signal aspects shall provide information including an in situ temperature measurement report, to demonstrate the requirements specified above have been met.

The method and arrangement of conducting the in situ temperature measurement, the value of the LED drive current and datasheet of the LED shall be included in the report.
6.6 Light Output Fundamentals

The fundamental optical requirements of signal aspects for at least 10 years of service are given in AS 2144.

This specification and AS 2144 presume the method of supplying constant current to an LED over its life, such that the LED is typically 30% brighter than the minimum at start of life, and progressively decreases brightness over its life, but remains above the minimum brightness after 10 years.

Manufacturers may in principle use an alternate method of variable current supply, with initial current at start of life being lower than the current used after 10 years. This may in some cases extend LED life, by permitting a reduced drive current in the early part of life.

If manufacturers propose to use the method of variable current supply, as part of type approval full details shall be provided to detail how current is set and managed against time, light output, influence of ambient temperature, or similar, and demonstrating how this will reliably maintain the fundamental signal aspect output required.

7 SYSTEM COMPONENTS

In addition to the optical system component and ancillary components requirements in section 7 of AS 2144, the following apply:

7.1 Lenses

7.1.1 The design shall have features that ensure lenses and/or lens assemblies (as applicable) can only be fitted with the correct orientation. This may be done by means of a rim locating tab, or other means.

7.1.2 Lenses shall be coloured, according to the colour of the aspect

7.2 Visors

7.2.1 Visors shall follow the recommended dimensions given in item F2 of AS 2144

7.2.2 Visors shall comply with RMS drawings VM208-29, VM208-31, VM208-34, VM208-43 and VM208-44, as applicable.

7.2.3 All two-aspect pedestrian and bicycle lanterns shall be supplied assembled complete with visors conforming to RMS drawing VM208-34.

7.2.4 Three-aspect bicycle lanterns shall be supplied without visors. The corresponding holes in the rim on the lantern door shall be 3.2 mm diameter.

7.2.5 Lantern doors shall be designed to accommodate visors with thickness up to 2.0mm.

7.2.6 Each visor shall be supplied with the required number of fasteners plus one spare.

7.3 Target Boards

All vehicular target boards shall have a white border and shall comply with RMS drawings VM206-14 and VM206-21. The target board mounting brackets shall comply with RMS drawing VM206-13.
7.4 Supply Conductors

In addition to the requirements for supply conductors in item 5.3.1 of AS 2144, the following applies:

7.4.1 The flexible conduit described in AS 2144 shall enclose the supply conductors for a distance of 2.3m from the point of exit from the lantern body, and the conductors shall extend a minimum of 700 mm beyond the end of the flexible conduit.

7.4.2 The supply conductors from the aspects shall be secured by a suitable clamp inside the lantern body to prevent any strain on the terminals connected in the terminal block. The terminal block shall be located to allow for clear access for connection and test purposes and shall include an insulation plate under the terminal block.

7.5 Multi-core Cable in place of Supply Conductors

Certain lantern installation locations require cable tails longer than provisioned for in item 7.4 above. The applicable variations for such cases are detailed below:

7.5.1 Signal lanterns planned to be mounted on outreach arms (of mast arms) shall be provided with a default 15m length of multi-core cable, unless a greater length is specified in the purchase order (to suit especially long outreach arms).

7.5.2 Signal lanterns planned to be column mounted on multi-function poles shall be provided with a default 4.5m length of multi-core cable, unless a different length is specified in the purchase order.

7.5.3 The multi-core cable is used in place of the individual supply conductors described in item 7.4 above. The multi-core cable shall be enclosed in flexible conduit as per AS 2053 for a distance of 2.3m from the point of exit from the lantern body.

7.5.4 The multicore cable shall be secured by a suitable clamp inside the lantern body on its external sheath to provide strain relief.

7.5.5 The multi-core connection cable, be rated at 0.6/1 kV in accordance with AS 2276.1 or equivalent, and have HTV-90 PVC insulation and sheath or equivalent, compliant with AS 3808. These typically require 6 or 7 cores, depending on the type of lanterns ordered.

7.5.6 The supplier shall provide details of the multicore cable used, as part of type approval.

7.6 Blanking-out Discs

All two-aspect vehicle lanterns shall be housed in a three-aspect body with the use of a blanking-out disc in accordance with RMS drawing VM208-39. The lantern shall be supplied with the blanking-out disc fitted in the required position.

7.7 In-line Connector for Aspects

In-line plug/socket connections for the aspects shall meet the requirements of item 5.3.2 in AS 2144 [1]. Additionally, such connectors shall provide:

7.7.1 appropriate current and voltage capability and insulation;

7.7.2 appropriately secure mechanical support both for cable and connector elements such that unwanted detachment does not occur;

7.7.3 capability of making multiple connect and disconnect operations without loss of connection function, as may be needed for maintenance activity.
7.7.4 connection of the “dimming” control wire, where lanterns contain such a control wire (refer item 6.4.2.)

7.8 Certificate of Suitability

The equipment manufacturer or Supplier shall obtain a NSW Certificate of Suitability for the complete lantern to ensure that the equipment meets minimum electrical safety requirements. Once a Certificate of Suitability is issued, it is the manufacturer’s and Supplier’s responsibility to ensure that the lantern complies with any subsequent amendments to State Regulations and Australian Standard Specifications relative to electrical safety.

Where a Certificate of Suitability or an equivalent document is issued in another state, the Supplier shall obtain written evidence from the appropriate NSW government office that such Certificate or document is regarded as fully equivalent to a Certificate of Suitability issued by the NSW government office.

The approval number shown on the Certificate of Suitability shall be shown on the marking plate required under Clause 1.4 of AS 2144. This shall be displayed on the marking plate alongside the Regulatory Compliance Mark (RCM), in accordance with AS4417.1 (Ref. [6]).

If the design of the equipment is changed, it is necessary for the manufacturer/Supplier to have the Certificate of Suitability endorsed accordingly.

7.9 Labelling

In addition to the labelling requirements of AS 2144, the supplier shall stamp or mark each lantern, and aspects if separately supplied to show the date of despatch to the signal service providers or RMS. This is to facilitate checking of warranty claims.

8 TYPE APPROVAL

To gain type approval of a Traffic Signal Lantern, the supplier shall follow the process defined in TS201 [8]

As per that process, the manufacturer or supplier shall self-assess their traffic signal lanterns and submit documentation detailing the self-assessment. To obtain any assistance the manufacturers or suppliers of the lanterns shall contact the ITS help desk (ITSHelpDesk@rms.nsw.gov.au.)

8.1 Submission Contents

In line with the requirements described in the self-assessment of TS201, the lantern manufacturer or supplier shall include the following support documentation when applying for approval of traffic signal lanterns:

8.1.1 A item-by-item statement of compliance, and associated evidence referenced to each compliance item, with this Specification and AS 2144;

8.1.2 A copy of the manufacturer's quality plan for the lanterns

8.1.3 Evidence of third party certification of the manufacturer's and Supplier's quality systems;

8.1.4 Test reports from NATA registered laboratories to demonstrate compliance with all applicable photometric, colorimetric and dimming output requirements in this Specification and AS 2144;
8.1.5 Data sheets, calculations, test reports from NATA registered laboratories, and other information as relevant to demonstrate compliance with all electrical, constructional, material and operational requirements in this specification and AS 2144;

8.1.6 Documentary evidence of compliance with statutory EMC (electromagnetic compatibility) arrangements;

8.1.7 A copy of the current Certificate of Suitability;

8.1.8 Outline diagrams showing the general presentation, interface dimensions and overall dimensions of the complete lantern, accessories and provisions for mounting, together with detailed information on the material used and protective treatment of the various components of the lantern assembly;

8.1.9 Detailed circuit diagrams and description of operation;

8.1.10 LM-80 test results and TM-21 extrapolation report

8.1.11 Document providing details of thermal design.

8.1.12 List showing which accessories from the supplier is able to provide, and which the supplier is not able to provide, from the RMS drawings list given in item 2.3.

The Supplier shall provide any additional information deemed necessary by RMS to enable RMS to conduct a comprehensive assessment of the type approval application.

8.2 Provision of Samples

RMS will typically require the supplier or manufacturer to submit sample(s) of each of the lantern(s) it intends to offer, together with accessories such as target boards and visors.

8.3 Changes

If a design, material or manufacturing method change is made to a type-approved lantern, the supplier shall notify the ITS help desk (ITSHelpDesk@rms.nsw.gov.au), and the requirements of TS201 (Ref. [8]) regarding changes shall be followed.
9 QUALITY ASSURANCE AND CONTROL

9.1 General

The supplier and the manufacturer shall operate a quality management system complying with ISO 9001.

9.2 Third Party Accreditation

The manufacturer’s quality system shall be certified by an approved independent organisation accredited for such purposes.

9.3 Quality Plan

The manufacturer shall document a quality plan appropriate to the item detailing the quality control tests and assessments the manufacturer will conduct during manufacture prior to release. This shall include sampling plans and test frequency, and a description of the records to be made, as relevant.

A copy of this quality plan shall be provided to RMS as part of the approval process. Acceptance of this quality plan by RMS is a prerequisite to gaining overall approval.

9.4 Quality Audits

RMS reserves the right to examine the Manufacturer’s quality records pertaining to any order for Traffic Signal Lanterns. RMS also reserves the right to arrange for an independent quality audit concerning Traffic Signal Lanterns in contract.

9.5 Pre-delivery Inspection

If RMS is not the direct purchaser, any pre-delivery inspection arrangements and requirements shall be as defined in the purchase order and related contractual documentation.

The following applies when RMS is the direct purchaser:

9.5.1 The supplier shall give RMS at least two working days’ notice of the availability of the goods for pre-delivery inspection. Requests for pre-delivery inspection are to be arranged with RMS inspectors directly.

9.5.2 The supplier shall provide RMS with copies of quality control release records prior to the date of the proposed pre-delivery inspection (eg by email). These quality control release records shall be according to the agreed manufacturer’s quality plan and associated sampling plans (item 9.3). It shall provide results of tests conducted, and outcomes, in addition to an overall compliance statement.

9.5.3 RMS reserves the right to subject lanterns to an inspection at the supplier’s or manufacturer’s premises in the Sydney metropolitan area prior to delivery. Such inspections may include an examination of the lantern’s performance (electrical and photometric) and a check of the manufacturer’s quality records.

9.5.4 The RMS inspector will issue the supplier with documentation to confirm that the goods:

(a) Have been accepted and are cleared for delivery; or
(b) Have been rejected for stated reason(s); or
(c) Are subject to further verification for stated reason(s).
If the inspection has been at the suppliers premises, this documentation will be issued before the inspector leaves those premises.

10 WARRANTY

10.1 Warranty Period

All lanterns and aspects supplied under this specification shall be subject to warranty periods as follows from the date of despatch:

10.1.1 Five (5) years for electrical and optical components; and
10.1.2 Ten (10) years for the lantern body and all mechanical components.

10.2 Warranty Return/Replacement

Any equipment failed in service, or found to be defective within the warranty period will be returned to the supplier, who shall make good the defect and return/replace the equipment at no charge to RMS or its service providers of traffic signals. Unless otherwise agreed, the supplier shall process the returned equipment and return or replace it within 30 calendar days from the date of receipt.

Any lantern or aspect failed as a result of a traffic accident, abuse or act of vandalism after delivery to RMS or the service providers shall not be covered by warranty provisions outlined above.
APPENDIX A - ELV

A.1 - General

If a traffic lantern is specified as “ELV”, the requirements relating to ELV defined in AS 2144 shall be met.

ELV Lanterns shall operate with a nominal $42V_{rms}$ AC supply (min 32V to max 50V) from the traffic controller.

The requirements that follow shall also be met.

A.2 - Protection device

Aspects shall have an electrical protection device fitted so that if LV voltage above 55 V is inadvertently applied to an ELV lantern or aspect, the protection device shall activate to achieve the following

A.2.1 Prevent permanent damage to the aspect
A.2.2 Aspect shall be prevented from illuminating
A.2.3 Provide visual indication that the protection device has operated. (either from externally, or with lantern doors open)

If the protection device has activated, and the inappropriate LV voltage has been removed, it shall be possible to re-set the protection device such that when the correct ELV voltage is applied, the aspect will operate. If the protection device operates by means of consumable fuses, storage shall be provided in the traffic lantern for two or more fuses per aspect. These fuses shall have a different fit to any other fuses in the lantern, such that it is obvious if an attempt is made to place the wrong fuse.

A.3 - Dimming

Lanterns operating at ELV levels shall use dimming by control wire methodology.

A.4 – Markings for ELV Lanterns

ELV voltage lanterns shall:

A.4.1 Bear a permanent and durable marking of “ELV” of dimensions and placement so it can be readily and read seen from ground level, both in the day and under typical night-time illumination conditions, when the lantern is installed on a pole in a typical manner.

A.4.2 Bear permanent and durable internal markings of “ELV” inside the lantern, placed and dimensioned to be readily visible to a maintenance technician when any of the lantern doors are open, to further distinguish the lantern as “ELV”.
APPENDIX B – Lantern Rotation Detector Option

B.1 - Purpose
The purpose of a lantern rotation detector is to mitigate risk if a traffic lantern is rotated by an incident such as a vehicle collision with the lantern edge, or other cause. Such rotation might potentially create traffic signals conflict, by causing the aspects to be visible to vehicles on a different approach to the one the lantern was set to service.

B.2 – Primary Functions
The lantern rotation detector shall perform the following primary functions;
B.2.1 Reliably detect that rotation of the lantern has occurred.
B.2.2 Determine when the extent and direction of rotation exceeds a threshold.
B.2.3 Turn off all aspects within the lantern display if the threshold rotation has been exceeded.
B.2.4 Maintain all aspects as off within the lantern until manual intervention/reset of the intervention device.

B.3 – Further Requirements.
To achieve the primary functions adequately, the following requirements shall also be met:
B.3.1 Detect rotation of the lantern, if the lantern rotates but the post does not.
B.3.2 Rotation is defined as about a vertical axis (even if the post is no longer vertical).
B.3.3 Detect rotation of the lantern, if the post rotates and the lantern rotates with the post (no movement on the post/lantern interface).
B.3.4 Detect rotation of the lantern, if the lantern rotates as a result of movement of any of the lantern’s mounting brackets relative to the post.
B.3.5 Detect rotation of the lantern, if the lantern rotates on its axis but neither the post or lantern mounting brackets rotate.
B.3.6 Rotation detectors shall in particular respond to rotation and movement such as may cause the lantern to point at the wrong approach. This shall include such movements as may be associated with bending and deformation of the support post such as due to vehicle collision.
B.3.7 Means shall be provided to set the rotation sensor’s reference position, when the lantern is correctly orientated, and confirm to the setter that the lantern is within ±2 degrees of the set reference position.
B.3.8 Provide separate left rotation threshold and right rotation threshold (providing a means to adjust to different intersection geometry).
B.3.9 Means shall be provided to set the threshold of left rotation and right rotation which triggers intervention, and confirm to the setter what values have been set.
B.3.10 Means shall be provided to limit false triggering of the rotation detector caused by malfunctions of hardware.
B.3.11 Shall not be false triggered by common events associated with normal displacement, such as posts swaying in wind, or passing traffic.
B.3.12 Other types of aspect movement shall not trigger the lantern to turn off, unless the rotational thresholds in the horizontal plane are exceeded.

B.3.13 Sufficiently low rate of false triggers that the risk to road users as a consequence of lights turning off when they should not is acceptable, and that the manpower required to address maintenance fixes for false detection is sustainable with existing resources.

B.3.14 Placement, mounting and other arrangements shall facilitate setting, maintenance, and/or replacement as appropriate.

B.3.15 It shall be possible to manually suppress/deactivate the rotation detection function from disabling the aspect displays (to provide a means to manage repeated false detection).

B.3.16 If multiple sensors are in use for validation purposes (e.g. a rotation sensor and an accelerometer), such that both are required to trigger for the rotation function to turn off the aspect display, provide local display of detection state of each, so it is possible to see if either are repeatedly triggering inappropriately.

B.3.17 If the system has the means to diagnose its own health, it shall act appropriately on this information, e.g. if aware of a sensor fault likely to cause a false trigger, system shall not turn off the lanterns based on this faulty input.

B.3.18 Ability to be installed on each lantern/aspect/element capable of rotating independently. Identification of where rotation may occur for this item shall consider possible clipping of an aspect by a passing vehicle in a manner that might cause rotation but leave the aspect operating.

B.3.19 Where multiple lanterns are mounted on a common post (e.g. on a T mount), and some lanterns are rotated past threshold limits, but not others, only turn off those lanterns that have passed their thresholds.

B.3.20 The supplier shall provide operating instructions for the rotation detector, as part of the approval process.

B.3.21 As part of the approval process, the supplier shall provide a description of how the device operates, and detail measures taken to deal with commonly known intrinsic technology issues relevant to the methodology used, that might cause false triggers, (e.g. drift on gyro's, changes of magnetic field if a steel clamp is later attached to support an item to the post).

B.4 Optional Desirable Requirements

B.4.1 Ability to retro-fit rotation detector to existing RMS lanterns that were not originally designed to support this function.

B.4.2 Provide local storage of detection events, so there is a record of when rotation and incident sensors were triggered, for use in maintenance and trouble-shooting in the event of false triggers.

B.4.3 Provide means for system to diagnose its own health (e.g. relating to problems with power supplies or sensors).

B.4.4 Generate and locally store record of rotation detector health status, alarms, and detector events, that can be accessed locally (e.g. text file in memory card).

B.4.5 Provide means to transmit a “health status” on a go/no-go basis to the controller as a contact closure output.

B.4.6 Output health status, alarm/event data to controller housing (e.g. by cable/other).
**APPENDIX C – Controller Compatibility Assessment**

**C.1 – Compatibility with Traffic Signal Controllers**

The LED lanterns shall be compatible with each type and model of traffic signal controller in use in New South Wales, for both dimmed and undimmed operation of the signals. Under normal operation the controller may or may not regulate the supply voltage to signal groups to 240 V rms, and in dimmed operation the controller reduces the supply voltage to signal groups to nominally 216V or 192V rms. The controller may achieve regulation and dimming of the supply voltage to the lanterns by either tap changing on a supply transformer integral with the controller, or by phase control of the supply voltage waveform.

The design of the LED lanterns shall meet the following compatibility requirements:

(a) Operation without flickering in both dimmed and undimmed operation;
(b) Correct and accurate detection of failed aspects on all signal groups by the traffic signal controller;
(c) Correct detection of loss of all Red signals on specified signal groups by the traffic signal controller;
(d) Compatibility with the conflict detection circuits of the traffic signal controller.

Compliance with these compatibility requirements shall be confirmed by the assessment procedures specified in Appendix A.3. The results of the compatibility tests shall be recorded in the forms specified in A.4.

**C.2 – Assessment Configuration**

**C.2.1 Configuration of Test Equipment**

<table>
<thead>
<tr>
<th>Controller hardware configuration</th>
<th>At least two output signal groups available on controller’s signal output module.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller personality configuration</td>
<td>At least two major phases (A &amp; B)</td>
</tr>
<tr>
<td>Phase A: at least one vehicle signal group, time settings are: MinGrn = 5 secs, MaxGrn = 20 secs, Yel = 4 secs, AllRed = 2 secs.</td>
<td></td>
</tr>
<tr>
<td>Phase B: at least one vehicle signal group as specified above or Pedestrian signal group (when Pedestrian signal lantern is submitted).</td>
<td></td>
</tr>
<tr>
<td>Time settings of pedestrian signal group are: Wlk = 8 secs, Clr1 = 10 secs, Clr2 = 6 secs.</td>
<td></td>
</tr>
</tbody>
</table>

| Loading on signal group(s) at Phase A | 3-aspect vehicle signal lanterns; |
| Loading on signal group(s) at Phase B | 3-aspect vehicle or 2-aspect Pedestrian signal lanterns |
| Cabling | All of assessed signal lanterns are connected to traffic signal controller via 29-core cable, at least 100 metres in length. |
C.2.2 Loading Configuration of Signal Groups

Loading on the vehicle signal group:

a) Each vehicle signal group shall have minimum four and maximum six vehicle signal lanterns connected;

b) Each signal group shall contain a maximum of three types of signal lantern, the number of each type of lantern shall be equal;

c) The default number of signal group in each phase is one, if more than three types of vehicle signal lanterns are submitted, the number of signal groups in each phase shall be increased accordingly;

d) The lanterns having the lowest or highest power consumption shall be grouped together;

e) 200mm and 300mm vehicle lanterns are allowed to be connected to the same signal group.

f) Each signal group shall be connected with lanterns supplied by the same manufacturer;

g) Loading on pedestrian signal group: Four Pedestrian signal lanterns or if Bicycle lantern is submitted 2 pairs of Pedestrian and Bicycle signal lanterns are connected together at same Pedestrian Signal Group
C.3 Assessment Procedure

1. Connect all of the hardware as described in A.1 & 2 and switch on power of controller.

2. Apply a short circuit to the pedestrian pushbutton input. (Note: The personality should apply a software arterial to A phase, the vehicle phase.)

3. Confirm that the controller cycles without the controller entering Fault mode.

4. Confirm that all lanterns operate correctly without any perceivable flicker.

5. Allow the controller to cycle continuously for at least one day or more.

6. Record the current wattage for each colour for each of the used signal groups.

7. Disconnect Red aspects from the vehicle signal group one by one in the sequence of their power consumption from low to high, recording the new wattage reading from controller after each disconnecting, confirming that a lamp fault is recorded in the controller error-log after disconnection of each aspect (Allow up to 30 minutes for controller to report a Lamp Fault (LF) in the controller error-log).

8. Confirm that the controller enters Fault mode when the last Red aspect at the signal group is disconnected.

9. Reconnect all of disconnected Red aspects to controller and re-start the controller.

10. Repeat Step 7 above, but for the Yellow aspects rather than the Red aspects.

11. Confirm that the controller continues to operate normally after the last disconnection, and reconnect all of the disconnected yellow aspects back into the controller.

12. Repeat Step 7 above, but for the Green aspects rather than the Red aspects.

13. Confirm that the controller continues to operate normally, and reconnect all of the disconnected Green aspects back into the controller.

14. Set the controller to dimmed operation of the signals by adjusting the clock time and ignoring the light sensor. Allow the controller to cycle for one hour or more.

15. Repeat Steps 7 through 13, when the signal displays are dimmed at 216Vac and 192Vac respectively.

16. Repeat Steps 7 through 15, but for pedestrian or Bicycle signal lanterns (applying the procedures for Red and Green aspects only).
C.4 Forms for Results of the Assessment

C.4.1 Assessment of Vehicle Signal Lanterns

<table>
<thead>
<tr>
<th>LED lantern manufacturer:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical wattage of tested lanterns:</td>
<td></td>
</tr>
<tr>
<td>Type of lanterns</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Controller type and manufacturer:</td>
<td></td>
</tr>
<tr>
<td>Operating mode: [Un-Dim / Dim]</td>
<td></td>
</tr>
<tr>
<td>Group 1 – Vehicle roundel signals</td>
<td>Watts</td>
</tr>
<tr>
<td>Red</td>
<td>All aspects connected</td>
</tr>
<tr>
<td>Red</td>
<td>1st aspect disconnected</td>
</tr>
<tr>
<td>Red</td>
<td>2nd aspects disconnected</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Red</td>
<td>The last aspect disconnected</td>
</tr>
<tr>
<td>Red</td>
<td>Fault mode? [ Y / N ]</td>
</tr>
<tr>
<td>Yellow</td>
<td>All aspects connected</td>
</tr>
<tr>
<td>Yellow</td>
<td>1st aspect disconnected</td>
</tr>
<tr>
<td>Yellow</td>
<td>2nd aspects disconnected</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Yellow</td>
<td>The last aspect disconnected</td>
</tr>
<tr>
<td>Yellow</td>
<td>Fault mode? [ Y / N ]</td>
</tr>
<tr>
<td>Green</td>
<td>All aspects connected</td>
</tr>
<tr>
<td>Green</td>
<td>1st aspect disconnected</td>
</tr>
<tr>
<td>Green</td>
<td>2nd aspects disconnected</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Green</td>
<td>The last aspect disconnected</td>
</tr>
<tr>
<td>Green</td>
<td>Fault mode? [ Y / N ]</td>
</tr>
</tbody>
</table>

Notes:
### C.4.2 Assessment of Pedestrian (and/or Bicycle) Signal Lanterns:

<table>
<thead>
<tr>
<th>LED lantern manufacturer:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical wattage of tested lanterns:</td>
<td></td>
</tr>
<tr>
<td>Types of Signal Lanterns</td>
<td>Red</td>
</tr>
<tr>
<td>Pedestrian lantern</td>
<td></td>
</tr>
<tr>
<td>Bicycle lantern</td>
<td></td>
</tr>
<tr>
<td>Controller type and manufacturer:</td>
<td></td>
</tr>
<tr>
<td>Operating mode: [Un-Dim / Dim]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pedestrian signal group</th>
<th>Watts</th>
<th>Lamp faults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>All aspects connected</td>
<td>Any LF entry?</td>
</tr>
<tr>
<td>Red</td>
<td>1 aspect disconnected</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>2 aspects disconnected</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>3 aspects disconnected</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>4 aspects disconnected</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>Fault mode? [ Y / N ]</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>All aspects connected</td>
<td>Any LF entry?</td>
</tr>
<tr>
<td>Green</td>
<td>1 aspect disconnected</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>2 aspects disconnected</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>3 aspects disconnected</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>4 aspects disconnected</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>Fault mode? [ Y / N ]</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
APPENDIX D - FIELD TRIAL OF TRAFFIC SIGNAL LANTERNS

Field trial of submitted lanterns at traffic signal intersections shall be carried out if the results of indoor assessment of the submitted lanterns are satisfactory. The period of the field trial is typically 6 to 8 weeks (may be more if an uncontrollable event occurs).

D.1 Selection Criteria of Trial Sites

D.1.1 Two traffic signal sites are typically selected for a trial of lanterns, typically using different signal controller types relevant to anticipated deployment (e.g. TSC/4 and PSC).

D.1.2 Dimming operation shall be enabled at the trial site(s).

D.1.3 The longest signal cable from the signal controller to the most remotely installed lanterns shall be more than 100m; at least two lanterns shall be connected at the end of each cable.

D.1.4 Relatively close to RMS or its signal service providers’ depot.

D.2 Criteria of Acceptance

The following incidents shall not occur in the trial period:

D.2.1 A failure of the signal aspects under trial at the site(s);

D.2.2 Daily or frequent false reports of Lamp Failure.

D.3 Operation at the Trial Site(s)

D.3.1 If the incidents described in item D.2 have not occurred in the first two week period from the first day of the trial, the logic control module at the TSC/4 trial site may be changed over to another manufacturer’s. The change-over of the logic control module could be done every two weeks until each type-approved manufacturer’s module has been applied at the site.

D.3.2 All of the controller logic modules shall be installed with the latest approved software.

D.3.3 The trial shall be terminated if the incidents described in item D.2 occur, such that upgrading the lantern’s hardware or software is required. RMS may on receipt of the investigation report into the incident either reject the type approval application or reinitiate the trial.