



Transport
**Roads & Maritime
Services**

ROADS AND MARITIME SERVICES

ROAD NETWORK OPERATIONS

SPECIFICATION NO. TSI-SP-041

LUMINAIRES FOR ROAD LIGHTING

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RECORD OF AMENDMENTS

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SPECIFICATION No. TSI-SP-041**LUMINAIRES FOR ROAD LIGHTING****1 SCOPE**

This specification covers requirements for luminaires (complete with light source) for Category V road lighting.

This specification does not cover luminaires for tunnel lighting.

NOTE: See Section 3 for definition for 'luminaire' and 'equipment'.

This specification includes requirements for assessing light output from luminaires (see Appendix B).

2 REFERENCES AND APPLICABLE DOCUMENTS

2.1 Australian Standards

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

- | | | |
|------------------|---|--|
| AS/NZS 1158.0 | – | Lighting for roads and public spaces, Part 0: Introduction |
| AS/NZS 1158.1.1 | – | Lighting for roads and public spaces, Part 1.1: Vehicular traffic (Category V) lighting – Performance and design requirements |
| AS/NZS 1158.1.2 | – | Lighting for roads and public spaces, Part 1.2: Vehicular traffic (Category V) lighting—Guide to design, installation |
| AS/NZS 1158.2 | – | Lighting for roads and public spaces, Part 2: Computer procedures for the calculation of light technical parameters for Category V and Category P lighting |
| SA/SNZ TS 1158.6 | – | Lighting for roads and public spaces, Part 6: Luminaires - Performance |
| AS/NZS 1170.2 | – | Structural design actions - Wind actions |
| AS/NZS 3000 | – | Electrical installations (known as the Australian/New Zealand Wiring Rules) |
| AS/NZS 3100 | – | Approval and test specification - General requirements for electrical equipment |
| AS/NZS ISO 9001 | – | Quality management systems - Requirements |
| AS 60068.2.6 | – | Environmental testing - Tests - Test Fc: Vibration (sinusoidal) |
| AS 60068.2.29 | – | Environmental testing - Tests - Test Eb and guidance: Bump |
| AS/NZS 60598.1 | – | Luminaires - General requirements and tests (IEC 60598-1, Ed. 7.0 (2008) MOD) |
| AS/NZS 61000.6.1 | – | Electromagnetic compatibility (EMC) - Generic standards - Immunity for residential, commercial and light-industrial environments |

2.2 RMS Specifications and Documents

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

- QA Specification R151 – Street Lighting
- QA Specification TS201 – Approval of ITS Field Equipment

2.3 Other Standards

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

- IES LM-79-08 – Electrical and Photometric Measurements of Solid-State Lighting Products
- IES LM-80-08 – Measuring Lumen Maintenance of LED Light Sources
- IES LM-84-14 – Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines, and Luminaires
- IES TM-21-11 – Projecting Long Term Lumen Maintenance of LED Light Sources
- IES TM-28-14 – Projecting Long-Term Luminous Flux Maintenance of LED Lamps and Luminaries

2.4 Compliance with Specifications

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

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

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

2.5 Precedence of Specifications

In the event of conflicting requirements between documents, the order of precedence shall be as follows:

- (a) Statutory requirements;
- (b) This Specification;
- (c) Other RMS specifications, where provided by RMS;
- (d) Australian Standards; and then
- (e) International Standards.

3 DEFINITIONS AND GLOSSARY OF TERMS

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

Colour rendering index (CRI)	–	As defined in AS/NZS 1158.0
control gear	–	As used in SA/SNZ TS 1158.6, the electronics that drives, and if equipped with a microcontroller, controls, monitors and manages the road lighting equipment
equipment	–	Luminaire covered by this Specification
IES	–	Illuminating Engineering Society of North America
LED	–	Light emitting diode
light source	–	As used in SA/SNZ TS 1158.6
light technical parameters	–	As defined in AS/NZS 1158.0
luminaire	–	As defined in AS/NZS 1158.0 but also includes the light source required for operation, unless explicitly stated otherwise.
		Note that luminaire is also referred to as 'equipment' in this Specification. See definition above for 'equipment'.
Manufacturer	–	The manufacturer of road lighting equipment covered by this Specification.
MTBF	–	Mean time between failures
MTTR	–	Mean time to repair
RMS	–	Roads and Maritime Services, which is a New South Wales government agency
RMS Technical Representative	–	The person appointed by RMS to carry responsibilities on behalf of RMS for technical matters relating to the equipment covered by this Specification
this Specification	–	Specification TSI-SP-041
Supplier	–	The supplier of road lighting equipment covered by this Specification

4 EQUIPMENT APPROVAL

4.1 General

Equipment approval in accordance with QA Specification TS201 is required prior to deployment of luminaires.

4.2 Documentation

The Supplier shall furnish the following documentation to RMS for the purpose of equipment approval:

- (a) A clause-by-clause compliance statement addressing each requirement in this Specification, including information on how and why compliance is achieved, referencing supporting documentation where applicable;
- (b) Test reports by an independent NATA-registered laboratory to demonstrate compliance with Clauses 5.2.1, 5.2.2, 5.3, 5.4.2, 5.5.1, 5.5.2, 5.7.3.2, 6.1, 6.2, 6.3, 6.4 and 6.5;
- (c) Where LED light source is used, test reports on the LED light source, including the following:
 - (i) IES LM-80-08 and IES TM-21-11 test reports, indicating make and part number of light source;
 - (ii) IES LM-84-14 and IES TM-28-14 test reports indicating make and part number of light source and make and model number of luminaire;
 - (iii) IES LM-79-08 and in-situ temperature measurement test (ISTMT) reports, indicating make and part number of light source and make and model number of luminaire;
- (d) Datasheet for light source, including supporting information on luminous efficacy, life and lumen depreciation;
- (e) Datasheet for luminaire;
- (f) Datasheets and/or other supporting information to demonstrate compliance with requirement in Clause 5.2.1 for optical components not to exhibit noticeable change to their required optical properties;
- (g) Thermal management calculations/report and results for luminaire, including LED junction temperature performance for LED light source within luminaire, showing luminaire model for the ambient conditions stated in Clause 6.1;

- (h) Test report with calculations by an independent certified structural engineer to demonstrate compliance with Clauses 5.2.3, 5.2.4, 5.2.5;
- (i) Spacing table and isolux diagram as required in Clause 5.2.8;
- (j) Test report by an independent certified engineer to demonstrate compliance with corrosion resistance requirements in Clause 6.6;
- (k) Datasheets and/or calculations to demonstrate compliance with Clauses 5.2.2, 5.2.6, 5.2.7, 5.4, 5.7.1 and 5.7.2.1;
- (l) RCM (Regulatory Compliance Mark) from the Australian Communication and Media Authority to demonstrate compliance with Clause 6.5.2;
- (m) A copy of the current Certificate of Suitability from NSW Fair Trading to demonstrate compliance with Clause 4.4;
- (n) Outline diagrams showing the general presentation and overall dimensions of the complete equipment;
- (o) Detailed information on the material used and protective treatment of the various components of the equipment;
- (p) Detailed circuit schematic diagrams (block-level acceptable) and descriptions of operation;
- (q) A copy of the Certification of the Manufacturer's and Supplier's Quality Management System to demonstrate compliance with Clause 8; and
- (r) A copy of the inspection and test plan for the equipment.

The Supplier shall provide additional information where requested by RMS to assist assessment of the submission.

4.3 Sample Tests

RMS may conduct tests on the sample equipment. These tests may include, but not limited to, verification of compliance with this Specification and SA/SNZ TS 1158.6.

4.4 Certificate of Suitability

The Supplier shall obtain a Certificate of Suitability issued by NSW Fair Trading for the equipment as evidence that the equipment meets minimum electrical safety requirements.

It is the responsibility of the Supplier and Manufacturer to ensure that the equipment complies with any subsequent amendments to State

Regulations and Australian Standards and Specifications related to electrical safety.

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

Where a Certificate of Suitability or an equivalent document is issued in another State, the Supplier shall submit written evidence from NSW Fair Trading that such Certificate or document is regarded as fully equivalent to a Certificate of Suitability issued by NSW Fair Trading.

The approval number shown on the Certificate of Suitability shall be shown on the marking plate as required in accordance with SA/SNZ TS 1158.6.

5 TECHNICAL REQUIREMENTS

5.1 General

The road lighting equipment shall comprise all items necessary for the intended use. As a minimum, the following items shall be provided:

- (a) A lighting unit comprising the following (see Clause 5.2):
 - (i) A housing including covers, lenses, reflectors and provisions for accommodation and connection of the light source;
 - (ii) Light source (unless explicitly excluded in the supplies contract);

NOTE: Refer to Clause 5.4 for additional requirements for thermal management.

- (b) Control gear including dimming unit and power supply (see Clause 5.3);
- (c) Provisions for thermal management (see Clause 5.4);
- (d) Other accessories such as connectors, cables and seals.

The equipment shall meet all relevant requirements for Category V lighting in SA/SNZ TS 1158.6 and AS/NZS 1158.1.1, in addition to this Specification.

5.2 Lighting Unit

5.2.1 General

The output of the lighting unit shall be not less than 10,000 lm.

NOTE: Refer to Clause 5.2.2 for requirements for luminous efficacy.

All optical components of the lighting unit, excluding the light source, shall be manufactured of materials that do not exhibit noticeable change to those optical properties required by each of the optical components during the service life of the lighting unit.

5.2.2 Light Source

5.2.2.1 Non-LED Light Sources

Non-LED light sources shall be constructed of replaceable module(s).

NOTE: Refer to Clause 5.2.1 for requirement for output of the lighting unit.

The initial luminous efficacy (or normalised efficiency) of each light source shall be not less than 100 lm/W, in accordance with the following equation:

$$\text{Efficacy (or normalised Efficiency) lm/W} = \text{Luminous flux output} / \text{Power input}$$

Unless otherwise specified in the supplies contract, each light source shall conform to a colour temperature within 4000 K and 4500 K, and a colour rendering index (CRI) of not less than 70 Ra.

Each non-LED light source shall provide a service life of not less than ten (10) years of on-off operation, and with a lumen depreciation of not exceeding 30% of its initial value during its full service life, when operated under the environmental conditions stated in Clause 6.1.

5.2.2.2 LED Light Sources

NOTE: Refer to Clause 5.2.1 for requirement for output of the lighting unit.

Each LED light source shall have an initial luminous efficacy (or normalised efficiency) of not less than 100 lm/W, in accordance with the following equation:

$$\text{Efficacy (or normalised Efficiency) lm/W} = \text{Luminous flux output} / \text{Power input}$$

Unless otherwise specified in the supplies contract, each light source shall conform to a colour temperature within 4000 K and 4500 K, and a colour rendering index (CRI) of not less than 70 Ra.

Each LED light source shall provide a service life of not less than 100,000 hours of powered-on operation and with a lumen depreciation not exceeding 30% of its initial value during its full service life, when operated under the environmental conditions stated in Clause 6.1.

The lumen depreciation of each light source at 10,000 hours of powered-on operation shall not exceed 4.0% of its initial lumen output.

When operating in any combination of the ambient conditions specified in Clause 6.1, the maximum junction temperature of any LED shall not exceed 60°C or the safe operating temperature recommended by the LED manufacturer, whichever is lower.

5.2.3 Load Maxima

Where retrofitting to existing poles, the structural loads due to the lighting unit shall not exceed the maximum loads specified in Appendix A.

Where fitted to new poles, the structural load due to the lighting unit shall not exceed the maximum loads specified in SA/SNZ TS 1158.6.

Notwithstanding if installation is required to be on existing or new poles, the lighting unit shall be tested and provided with calculations and certification from an independent certified structural engineer, to ensure that the installation does not exhibit dynamic behavioural characteristics (e.g. wind loading) that can adversely affect the integrity of pole structures.

5.2.4 Wind Loading

The equipment shall be certified for wind loading conditions in AS/NZS 1170.2 for at least Terrain Category 2 Region B.

5.2.5 Attachment Points

Each lighting unit shall provide not less than two (2) separate spigot (primary) attachment points in accordance with spigot attachment point requirements of SA/SNZ TS 1158.6, with aperture size for Ø42 mm spigots.

In addition, each lighting unit shall provide a lanyard (secondary) attachment point with a load rating in accordance with lanyard attachment point requirements of SA/SNZ TS 1158.6.

5.2.6 Upward Light Reduction

Each lighting unit shall incorporate provisions to reduce light wastage through upward light in accordance AS/NZS 1158.1.2.

5.2.7 Glare Reduction

Each lighting unit shall incorporate provisions to reduce perceivable glare in accordance with AS/NZS 1158.1.2.

5.2.8 Spacing

For new installations, the prospective supplier shall provide a spacing table and isolux diagram in accordance with the lighting category determined by RMS.

NOTE: Refer to Appendix B for a calculation / measurement grid for testing, and AS/NZS 1158.2 for procedures for the calculation of light technical parameters.

For retrofitting to existing installations, the prospective supplier shall provide a spacing table and isolux diagram indicating that the lighting unit meet the illuminance equivalent to and suitable for the existing installations as used by RMS.

NOTE: The prospective supplier may contact the relevant project office for details relating to the existing installation.

5.3 Control Gear

The control gear may be incorporated into the lighting unit, or designed for installation in a road lighting control gear tray in accordance with the mounting requirements in RMS QA Specification R151.

The combined efficiency of the control gear and power-supply shall be not less than 90%, and the overall power factor not less than 0.95.

5.4 Thermal Management

5.4.1 Heat Removal

The equipment shall incorporate adequate and effective heat removal capability on the lighting unit, control gear and power-supply to maintain normal operational performance within the temperature range stated in Clause 6.1. For the purpose of this requirement, electro-mechanical parts such as ventilation fans shall not be used.

The Supplier shall supply heat removal calculations, circuit schematics and design drawings for the equipment indicating the sources, locations and magnitudes of heat generation, and the design heat removal mechanism and paths, to the RMS Technical Representative.

5.4.2 Thermal Endurance

The entire equipment shall be tested for compliance with thermal endurance requirements specified in SA/SNZ TS 1158.6.

5.5 Electrical Requirements

5.5.1 Operating voltage

The equipment shall operate correctly and reliably for mains supply voltages over the range 230 Vrms + 10%, - 6%, and variations in supply frequency in the range 50 Hz \pm 4%.

5.5.2 Surge Protection

The equipment shall have built-in surge protection in accordance with lightning surge and impulse voltage requirements in SA/SNZ TS 1158.6.

5.6 Fault Logging, Reporting

Where fault logging and/or reporting is provided, the prospective supplier shall provide details for assessment by RMS. All log and report events shall be time-stamped in real-time to a resolution of not coarser than deciseconds.

5.7 Reliability, Maintainability and Material Safety

5.7.1 Reliability

5.7.1.1 Mean Time Between Failures

The MTBF of the equipment, excluding light source failures, shall be not less than 50,000 hours in operation.

The supplier shall confirm the MTBF of the light source for the lighting unit under the operating conditions specified in Clause 5.2.2.

5.7.1.2 Service Life

The luminaire, excluding the light source, shall be designed to provide a service life of not less than twenty (20) years when operated under the environmental conditions stated in Clause 6.1.

The minimum service life of non-LED light sources shall be as specified in Clause 5.2.2.1. The minimum service life of LED light sources shall be as specified in Clause 5.2.2.2.

5.7.2 Maintainability

5.7.2.1 Mean Time to Repair

The Supplier shall provide RMS with the MTTR figures of the equipment.

5.7.2.2 Modular Design

The equipment, and parts thereof, shall be available in modular and backward compatible units (between older and newer parts). All parts used in the equipment shall be readily available from more than one (1) manufacturer.

The equipment design shall facilitate the following:

- (a) Replacement of luminaire and/or light source modules;
- (b) Replacement of control gear and/or power-supply;
- (c) Replacement of other individual parts;
- (d) Access to control gear and gear tray;
- (e) Access to power-supply;
- (f) Access to replaceable parts.

5.7.2.3 Retrofitting

Where used for retrofitting, all luminaires shall be compatible with the existing installation on the following:

- (a) Spigot attachment points and aperture size;
- (b) Lighting unit mass;
- (c) Wind loading;
- (d) Rated power, voltage and current;
- (e) Photometric requirements of the existing fittings or as specified in this Specification.

5.7.2.4 Labelling

All markings and labels shall be weather resistant and durable for the life of the equipment.

The front face of each lighting unit (facing downward when installed), shall have provisions to imprint a unique luminaire identification label issued by RMS.

The back face of each lighting unit (facing upward when installed), and the control gear, shall be marked with the following information as the minimum on an aluminium label by the manufacturer:

- (a) Name of manufacturer;
- (b) Model Number;
- (c) Serial Number;
- (d) Date of despatch to RMS.

Each new or replaced part of the equipment shall be dated with the respective delivery date and tagged with a label.

5.7.3 Safety

5.7.3.1 Safety Valves

Each lighting unit shall be equipped with one or more fast acting pressure release safety valves.

5.7.3.2 Fire Resistant Materials

All electrical insulation materials shall comply with the relevant insulation and fire resistance requirements in AS/NZS 3100 and AS/NZS 60598.1.

6 ENVIRONMENTAL REQUIREMENTS

6.1 Temperature and Humidity

The equipment shall be designed for operation in an environment with ambient temperatures ranging from -20°C to +50°C and relative humidity up to 90%.

6.2 Shock

All removable sub-assemblies, in an unpacked condition, shall withstand the bump test (Test Eb) to AS 60068.2.29. The severity shall be 1,000 bumps at an acceleration of 98 m/s² (10g) with a pulse duration of 16 ms.

The entire equipment, packaged for transport, shall be subjected to a bump test. This test shall be carried out in accordance with AS 60068.2.29. The severity shall be 4,000 bumps at an acceleration of 98 m/s² (10g) with a pulse duration of 16 ms.

6.3 Vibration

The entire equipment shall be subject to the vibration tests specified in this Clause. The test procedures shall be in accordance with AS 60068.2.6 for sinusoidal vibration. For all tests specified in this Clause, the amplitude shall be 0.75 mm up to the cross-over frequency, (approximately 8.2 Hz), where the acceleration is 0.2g, and for higher frequencies the acceleration shall be maintained constant at 0.2g.

The operation of the equipment shall be recorded during the tests and its overall performance summarised in the test report.

The tests shall be performed for three (3) mutually perpendicular axes with the equipment in the normal (installed) orientation.

For each axis of the tests, an investigative sweep cycle shall be performed on the test specimen over the frequency range 5-55 Hz with an amplitude of up to 0.75 mm to identify critical frequencies at which:

- (a) Equipment malfunctioning and/or deterioration of performance are exhibited which are dependent on vibration; and/or
- (b) Mechanical resonances and other response effects, such as chatter, occur.

The frequencies and the applied amplitudes at which these effects occur shall be noted, together with the behaviour of the test specimen at each critical frequency.

The equipment shall be tested for 10 minutes at each of the critical frequencies identified, with a vibration amplitude of 0.75 mm below the cross-over frequency, and 0.2g acceleration above the cross-over frequency.

For each axis of the tests, the entire equipment shall be tested with an endurance of 20 sweep cycles over the frequency range 5-55 Hz with an initial amplitude of 0.75 mm. The sweep rate shall be 1 octave per minute.

6.4 Ingress Protection

The luminaire, either in a single housing or multiple housings (e.g. separate control gear), shall be rated to a degree of enclosure protection not less than classification IP65, in accordance with AS 60598.1.

6.5 Electromagnetic Compatibility

6.5.1 Electromagnetic Immunity

The equipment shall comply with AS/NZS 61000.6.1, with immunity to the following

- (a) Radiated electromagnetic frequencies;
- (b) Conducted electromagnetic frequencies;
- (c) Electrostatic discharges;
- (d) Fast transients on the mains supply;
- (e) Surges on the mains supply.

6.5.2 Electromagnetic Emissions

The equipment shall comply with all statutory requirements, including RCM (Regulatory Compliance Mark) labelling requirements, for electromagnetic compatibility.

6.6 Corrosion Resistance

All constituent components of the equipment shall be inherently corrosion resistant or suitably treated to prevent corrosion over their service life. Compliance shall be confirmed in accordance with AS/NZS 60598.1.

6.7 Vermin Resistance

The equipment and its constituent components shall be adequately protected against the incursion of vermin, termites and insects.

The design and arrangement of the ventilation system shall be such as to minimise the ingress of vermin.

6.8 Resistance to Vandalism

The equipment shall be designed for maximum resistance to vandalism in accordance with SA/SNZ TS 1158.6.

7 LONG-TERM PERFORMANCE AND WARRANTY

7.1 General

The equipment purchased under this Specification shall be subject to the long-term performance and warranty provisions in this Section.

7.2 Long-Term Performance

The lumen depreciation from initial value, of each luminaire, shall not exceed that specified in Clause 5.2.2 of this Specification for the applicable light source. In the event the light output falls below the above specified value from its initial value, the Supplier shall replace the luminaire.

Where software is provided, the Supplier shall provide software upgrades and bug fixes, as requested by the RMS Technical Representative.

The initial value and rate of depreciation of light output of each luminaire shall be matched with the sample that was measured by a NATA registered laboratory and submitted for RMS' equipment approval assessment. In addition for the same purpose, the Supplier shall provide an initial light output measurement of each luminaire taken with a light meter along with the make and model of the light meter clearly indicated with the reading results.

The RMS, from time-to-time, will conduct measurements on the light outputs of luminaire in the field using an in-house test meter. This in-house test meter measures the light output from the front of the luminaires, and its readings will be correlated with those of the approved sample. For the purpose of determining the degradation of light outputs from, and the long-term performance of, luminaires, the readings of this RMS in-house test meter shall be deemed sufficient. The RMS will make a determination from the readings of the meter as to whether the luminaire has passed or failed the long-term performance requirement in this clause. Where the Manufacturer or Supplier disagrees with the RMS's decision, the dispute will be resolved by sending the luminaire in question to a NATA registered laboratory for testing. The costs of such tests shall be borne by the party whose assertion is not supported by the test results.

7.3 Warranty

All luminaires purchased under this Specification shall be subject to warranty for at least the periods as specified in the Clause 5.7.1.2, from the date of receipt at RMS.

Software upgrades, where provided during the warranty period, shall include servicing and be free of charge to RMS.

8 QUALITY ASSURANCE

8.1 General

The Supplier and Manufacturer shall operate a quality management system complying with AS/NZS ISO 9001. This quality management system shall be certified by a quality management system certification body accredited for such purposes under the criteria defined in the Joint Accreditation System of Australia and New Zealand (JAS-ANZ).

8.2 Inspection and Test Plan

The Supplier shall submit an inspection and test plan for each batch of equipment as part of quality assurance requirements.

9 DOCUMENTATION

The following documentation shall be supplied by the Supplier:

- (a) Operations and maintenance manual, including:
 - (i) Full description of the luminaire, control gear and power supply;
 - (ii) Dimensional outline drawing of the luminaire;
 - (iii) Inspection and maintenance requirements;
 - (iv) Bill-of-materials;
 - (v) Part numbers for all of the major components;
 - (vi) Recommended spares;
- (b) Installation manual;
- (c) Field manual.

APPENDIX A – OUTREACH ARM LOAD MAXIMA FOR RETROFITTING TO EXISTING POLES

For retrofitting to existing poles, the luminaire shall be suitable for the intended application in accordance with the following table:

Table A.1 Outreach Arm “Dead” Load Maxima Based on Outreach Length and Wind Sail Area (Long Side)

Luminaire Wind Sail Area (Long Side Profile)	Maximum Mass of Luminaire (for Different Light Pole Outreach Arm Lengths)			
	Outreach Length 2.5 m	Outreach Length 3.0 m	Outreach Length 4.5 m	Outreach Length 6.0 m
Up to 0.080 m ²	14 kg	14 kg	13 kg	13 kg
Larger than 0.080 m ² and up to 0.132 m ²	14 kg	14 kg	10 kg	None

APPENDIX B – LUMINOUS FLUX OUTPUT CALCULATION/MEASUREMENT GRID FOR TESTING

The luminous flux output calculation/measurement grid for testing is shown in the figure below.

Using the calculation/measurement grid numbering convention shown:

- the first number denotes the row normal to the kerb line, and
- the latter two numbers denote the column longitudinal to the kerb line.

The calculation and/or measurement grid is 8 m × 60 m.
 A luminaire located above grid column 16 (centre) as shown, and grid row

- 1 is 1 m onto the kerb from the kerb line,
- 2 is 1 m onto the carriageway from the kerb line,
- 3 is 3 m onto the carriageway from the kerb line,
- 4 is 5 m onto the carriageway from the kerb line, and
- 5 is 7 m onto the carriageway from the kerb line.

