Ironbark Sustainability

SSL Category P Street Lighting Design and Performance Guidelines - Victoria

CONFIDENTIAL

Prepared for
Victorian Distribution Network Service Providers

Version	Date	Description of changes
V1a-V1i	30/10/2013	Versions up to release as Public Specification
V2a	20/8/2014	Public release
V2b	3/9/2014	Expanded disclaimer
V2c	24/9/2014	Change to PE cell requirements
V2d	14/11/2014	Re-labelled 'Guidelines' rather than 'Specification' Reference to specific lense/visor materials removed. Remove duplicate reference to Cl 2.5.2 Inserted request for driver life data
V2e	19/3/2015	Included specific photometric test standards
V2f	7/4/2015	Removed P4 benchmark spacing requirement for 22m road reserve width and 5.5m mounting height
V2g	10/8/2015	Addition of Cl z), aa) and bb)
V2h	20/8/2015	Update to Cl x)
V2i	30/10/2015	Update to Scope and addition of Cl cc)

Prepared by
Ironbark Sustainability
Suite 8, 70-80 Wellington St
Collingwood 3066
ABN: 51 127 566 090
Ph. 1300 288 262
info@realaction.com.au
www.realaction.com.au

© October 30, 2015 Ironbark Group Pty. Ltd.
The information contained in this document produced by Ironbark Group Pty. Ltd is solely for the use of the Client identified on the cover sheet for the purpose for which it has been prepared and Ironbark Group Pty. Ltd undertakes no duty to or accepts any responsibility to any third party who may rely upon this document. All rights reserved. No section or element of this document may be removed from this document, reproduced, electronically stored or transmitted in any form without the written permission of Ironbark Group Pty. Ltd.

The requirements outlined in these Guidelines are not those of Ironbark, but those of the Victorian Distribution Network Service Providers who have contributed to the development of these Guidelines.

About Ironbark Sustainability

Ironbark Sustainability is a specialist consultancy that works with government and business around Australia by assisting them to reduce energy and water usage through sustainable asset and data management and on-the-ground implementation.

Ironbark has been operating since 2005 and brings together a wealth of technical and financial analysis, maintenance and implementation experience in the areas of building energy and water efficiency, public lighting and data management.

Ironbark provides public lighting support nationally around technology advice and approvals, business cases and projects. Ironbark delivers strategic and specific advice and support for the establishment of effective environmental management systems for government and business clients. We pride ourselves

CONFIDENTIAL

on supporting our clients to achieve real action regarding the sustainable management of their operations.

Our Mission

Ironbark's mission is to facilitate progressive sustainability outcomes through practical and realistic support for council's and their communities.

CONFIDENTIAL

Contents

Tables & Figures

Scope

These guidelines are designed to assist stakeholders to understand the technical requirements of SSL (solid state lighting, which includes LEDs) in Category P (residential) street lighting in Victoria, Australia. These guidelines include criteria which are common amongst the 5 Distribution Network Service Providers (DNSPs) in Victoria. Each DNSP will have additional requirements related to contractual issues such as contract timeframes, delivery, and legal requirements.

The intent of the document is to assist those designing and developing street light luminaires to have a common approach to meeting the needs of the Victorian community. These guidelines are designed to cover all technical requirements for SSL luminaires aiming to become Standard luminaires approved for use on the Victorian DNSP networks. This does not cover the requirements for luminaires that are non-standard, however for convenience, spacing benchmarks for non-standard (decorative) Category P luminaires have now been included.

These guidelines are likely to change over time as more knowledge about SSL technology comes to light.

Ironbark Sustainability facilitates the Public Lighting Approvals Network (PLAN) which aims to assist Local Governments, State Road Authorities and DNSPs in increasing the transparency and common understanding of technical issues associated with road lighting. As part of this role, these guidelines have been released by Ironbark following extensive consultation with the sector, and in particular, the five Victorian DNSPs:

- Citipower
- Jemena
- Powercor
- AusNet Services
- United Energy

Any questions, comment and feedback can be addressed to:

Ironbark Sustainability
info@realaction.com.au

CONFIDENTIAL

1 Definitions

Please refer to the definitions in AS/NZS 1158.0 with the addition of:

- *Solid state lighting (SSL)*
  A group of devices that embody p-n junctions that emit visible radiation when excited by an electric current. They can be further defined by the type of technology used, i.e. light-emitting diodes (LEDs), organic light-emitting diodes (OLEDs) or polymer light-emitting diodes (PLEDs).
- *Light-emitting diode (LED)*
  Solid state device embodying a p-n junction, emitting visible radiation when excited by an electric current.
- *LED chip*
  Sometimes called the LED die, this is the fundamental light source.
- *Light emitting array*
  A horizontal panel or module consisting of multiple SSLs.
- *Optics*
  Any optically transparent cover mounted over the SSL light source to allow escape of the visible light generated by the source.
- *Visor*
  The transparent, translucent or refracting cover of the optical chamber of a luminaire through which visible light is emitted. This includes any frame provided to facilitate access to the optical chamber.

2 Requirements of SSL luminaires

a) All relevant requirements of the AS/NZS 1158.6:2010 shall be met (for the purposes of these Guidelines, SSL light sources are considered permissible luminaire sources when referring to AS/NZS 1158.6:2010)
b) The luminaire shall be fully sealed with a smooth, transparent visor in front of the light emitting array such that spiders and dirt cannot collect
c) The luminaire shall have an option for a luminaire which offers no upward light spill (e.g. aeroscreen)
d) Any transparent materials (including the SSL optics) between the light source (i.e. the LED chip) and the area to be lit, shall comply with the requirements of the materials and construction clauses of AS/NZS 1158.6:2010 (i.e. 2.5.2: Materials and construction)
e) The luminaire shall have no sharp edges
f) The luminaire shall be minimum IK06 (as per AS/NZS 1158.6:2010 Section 5.7)
g) The optical chamber shall be minimum IP65 (as per AS/NZS 1158.6:2010 Section 5.6)
h) The control gear chamber shall be minimum IP65 with the following exception: if the control gear is minimum IP65, the control gear chamber may be minimum IP24 (as per AS/NZS 1158.6:2010 Section 5.6)
i) Where the control gear chamber is less than IP65 then it must be designed such that any water that enters the control gear chamber will drain out naturally
j) The luminaire shall have no cable entry glands, washers, grommets or other device to restrict the cable entry in order to meet the minimum diameter of the cable entry hole required by clause 3.7(a) of AS/NZS 1158.6:2010
k) Vibration testing to AS/NZS 1158.6:2010 Section 5.5 required for all luminaires
l) Impulse voltage testing to AS/NZS 1158.6:2010 Section 5.8 required for all luminaires
m) Compliance with IEC 61000.3.2 (relevant component compliance is acceptable)
n) With relevance to the photoelectric (PE) cell:

CONFIDENTIAL

- The luminaire shall be designed such that the luminaire and the PE cell can operate when the ambient temperature (external to the luminaire) is 50˚C, and the luminaire must be suitable for all DNSP-approved PE cells
- The luminaire shall allow for tool-less removal/replacement of the PE cell

o) Standard side-entry Category P luminaires shall be able to accommodate 27mm to 34mm outer diameter spigots

p) All relevant requirements of the AS/NZS 1158 series shall be met, with the following variation:

a) In relation to glare, Table 2.10 of AS/NZS 1158.3.1 currently states that for:

a. Type 4 (residential or P-category) luminaires:

The intensity at any angle of azimuth shall be not more than –

1. *720 cd in total or 180 cd/1000 lamp lumens, whichever is the greater, at a vertical angle of 80°; and*
2. *300 cd in total or 80 cd/1000 lamp lumens, whichever is the greater, at a vertical angle of 90°*

The requirement for SSL luminaires will instead be:

The intensity at any angle of azimuth shall be not more than –

1. *720 cd in total or 180 cd/1000 lamp lumens, whichever is the greater, at **and above** a vertical angle of 80°; and*
2. *300 cd in total or 80 cd/1000 lamp lumens, whichever is the greater, at **and above** a vertical angle of 90°*

q) Correlated colour temperature (CCT) shall be 4000K ± 275K

r) The luminaire shall be RoHS compliant[1] (relevant component compliance is acceptable)

s) The luminaire shall have no moving parts in normal operation (e.g. fans)

t) Any area being lit shall have multiple chips lighting a particular zone, such that if one chip fails there will still be light provided for that particular zone

u) Luminaire suppliers shall provide a minimum five-year warranty covering maintained integrity and functionality of:

a. Any material over the light emitting source, including the optics and any other relevant material between the source and the area to be lit, shall comply with the requirements of the materials and construction clauses of AS/NZS 1158.6:2010 (i.e. 2.5.2: Materials and construction)
b. Luminaire housing, wiring, and connections
c. LED luminaire source(s)
Note - Negligible lumen output from more than 10 percent of the LED chips constitutes luminaire failure
d. LED driver(s)
e. Warranty period shall begin 90 days after date of invoice, or as negotiated by owner such as in the case of an auditable asset management system

v) Luminaire suppliers shall provide life/mortality data for the driver/control gear

w) Photometric testing of the luminaire shall be performed in accordance with one of the following protocols:

- IESNA LM-79-08
- CIE DIS-025

[1] As per The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive (2011/65/EU) the definition and aim of the RoHS directive is quite simple. The RoHS directive aims to restrict certain dangerous substances commonly used in electronic and electronic equipment. Any RoHS compliant component is tested for the presence of Lead (Pb), Cadmium (Cd), Mercury (Hg), Hexavalent chromium (Hex-Cr), Polybrominated biphenyls (PBB), and Polybrominated diphenyl ethers (PBDE). For Cadmium and Hexavalent chromium, there must be less than 0.01% of the substance by weight at raw homogeneous materials level. For Lead, PBB, and PBDE, there must be no more than 0.1% of the material, when calculated by weight at raw homogeneous materials. Any RoHS compliant component must have 100 ppm or less of mercury and the mercury must not have been intentionally added to the component.

CONFIDENTIAL

x) New standard Pedestrian Category street lighting products shall be designed so that their light output performs equal to or better than current Category P luminaires as indicated in Tables 1-4 below.

For **standard light output Category P luminaires** spacing performance must:

- meet or exceed ALL of the green highlighted parameters in Tables 1 and 2.
- be within 5% of ALL of the orange highlighted parameters in Tables 1 and 2.

P4	Road Reserve Width												
Mounting height	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m
5.5m	58.8	58.4	57.7	56.9	56.0	55.0	53.8	52.4	50.7	48.7	46.3	43.4	
6.5m	63.4	63.2	62.9	62.2	61.4	60.5	59.4	58.2	56.8	55.1	53.0	50.5	47.8

Table 1- P4 spacing requirements for standard light output Category P luminaires

P5	Road Reserve Width												
Mounting height	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m
6.5m	77.1	77.0	76.8	76.7	76.3	75.7	75.0	74.2	73.4	72.4	71.4	70.2	68.9
7.5m	82.4	82.3	82.2	82.0	81.8	81.5	80.8	80.1	79.3	78.5	77.5	76.4	75.3

Table 2 - P5 spacing requirements for standard light output Category P luminaires

For **high light output Category P luminaires** spacing performance must:

- meet or exceed ALL of the green highlighted parameters in Tables 3 and 4.
- be within 5% of ALL of the orange highlighted parameters in Tables 3 and 4.

High light output Category P luminaires are required where the spacing and light level performance of standard Category P luminaires is inadequate.

P4	Road Reserve Width												
Mounting height	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m
5.5m	65.2	65.0	64.8	64.6	64.4	64.1	63.8	61.7	59.7	57.8	56.1	47.7	
6.5m	70.3	70.1	69.9	69.7	69.4	69.2	68.9	68.7	67.9	66.7	65.5	64.1	62.7
7.5m	75.3	75.1	74.9	74.7	74.5	74.3	74.1	73.8	73.1	72.3	71.4	70.3	69.3

Table 3 - P4 spacing requirements for high light output Category P luminaires

P5	Road Reserve Width												
Mounting height	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m
6.5m	85.7	85.6	85.4	85.3	85.1	84.9	82.5	79.9	77.5	75.2	73.1	71.0	69.1
7.5m	91.4	91.3	91.1	91.0	90.8	90.6	90.4	90.2	90.0	89.8	89.6	88.9	86.6

Table 4 - P5 spacing requirements for high light output Category P luminaires

y) When performing spacing analysis, when assessing compliance with Tables 1-4, the following shall apply:

a) The Maintenance Factor (MF) used will be a factor (e.g. multiplied by each other) of the Luminaire maintenance factor (LMF) and the Lamp Lumen Maintenance factor (LLMF) (e.g. MF = LMF x LLMF)

b) The LMF used shall be 0.88[2]. This means the design assumes a clean at 10 yrs. In reality this clean would be as required and subject to testing to understand real life needs
c) LED lumen maintenance data shall be collected as per the requirements of IES LM-80-08 and extrapolated using the requirements of IES TM-21-11 to a minimum of 60,000 hours. The LLMF shall be calculated by further extrapolation to at least 88,000 hours (i.e. 20 years)[3]. Predicted failure rates shall also be calculated and communicated to at least 88,000 hours
d) An offset distance[4] of 1/4 of the road reserve width
e) A single-sided arrangement
f) An upcast angle of 5°

z) Compliance with AS/NZS CISPR 15
aa) The SSL module must be uniquely identifiable
bb) If polycarbonate is used as a chip lense material, then:
a) the polycarbonate must be UV-stabilised
b) an acrylic visor must be over the lense
c) data must be provided detailing the performance of the polycarbonate in relation to light transmittance and yellowness index in order to allow comparison with standard acrylic/PMMA
cc) New non-standard (or decorative) Pedestrian Category street lighting products intended for P4 (or URD) lighting schemes shall be designed so that their light output performs equal to or better than the spacing benchmarks as indicated in Table 5 below.

Spacing performance must:
- meet or exceed ALL of the green highlighted parameters in Tables 5.
- be within 5% of ALL of the orange highlighted parameters in Tables 5.

P4	Road Reserve Width													
Mounting height	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	17m	18m
5.5m	50.5	50.4	50.3	50.3	50.1	50.0	49.9	49.8	49.5	49.1	48.6	48.1	47.4	46.6
6.0m	52.3	52.2	52.1	52.0	51.9	51.8	51.7	51.6	51.3	50.9	50.4	49.9	49.3	48.6

Table 5 - Spacing requirements for non-standard Category P luminaires

End of Guidelines.

[2] 0.88 is based on data provided in Table B.1 of the British standards (BS5489 2012/13) and extrapolated out to 10 years.
[3] For example Cree offer the "TEMPO" testing service which can provide this information.
[4] The offset distance is the distance between the property boundary and the pole.

CONFIDENTIAL

3 Appendix A - Product Family Testing

LM-79 and In Situ Temperature Measurement Testing (ISTMT)

It is recognized that due to the time and cost required for product testing, it would not be realistic to expect manufacturers offering a multitude of unique luminaire configurations to test every possible configuration. Therefore, the "product families" method may be utilized for LM-79 and ISTMT, whereby manufacturers identify a set of representative products for which test data can be used to demonstrate the accuracy of interpolated or extrapolated performance of product configurations lacking test data. Precedent for this approach can be found in LM-80.

If the particular luminaire configuration submitted has not been tested, the performance may be conservatively represented by test data for another luminaire configuration having:

- The same intensity distribution (typically only applies to LM-79)
- The same or lower nominal CCT
- The same or higher nominal drive current
- The same or greater number of LED luminaire source(s)
- The same or lower percentage driver loading and efficiency
- The same or smaller size luminaire housing.

A more accurate estimate of performance can be obtained by linear interpolation between two or more tests differing in terms of the six parameters listed above. For example, consider a hypothetical luminaire offered in a single size housing, and having the following parameters:

- Three intensity distributions: IES Type II, III, or IV
- Three CCTs: 4000, 5000, and 6000K
- Three drive currents: 350, 525, and 700 mA
- Four LED quantities: 20, 40, 60, or 80 LEDs.

Table A.1 illustrates a set of tests which could allow for accurate interpolation between tested configurations, given a single luminaire housing size and essentially constant driver efficiency; these 10 tests may provide representative data for the 108 possible product configurations. Note that normalized intensity distribution must not be affected by the other three parameters.

Table A.1. Representative testing of a single luminaire housing size

Tests	Intensity distribution (IES Type)	CCT (K)	Drive current (mA)	# of LEDs
1, 2, 3	II, III, IV	4000	700	80
4, 5	IV	5000, 6000	700	80
6, 7	IV	4000	325, 525	80
8, 9, 10	IV	4000	700	20, 40, 60

For example, the manufacturer could detail interpolation as shown in Table A.2, applying the following multipliers to the base test #2 to model a configuration with Type III intensity distribution, 5000K CCT, 525 mA drive current, and 40 LEDs:

CONFIDENTIAL

- Ratio of test #4 lumens to test #3 lumens
- Ratio of test #7 lumens to test #3 lumens
- Ratio of test #9 lumens to test #3 lumens.

Table A.2. Multipliers for Test #2 to yield: Type III , 5000K, 525mA, 40 LEDs

Test #	Intensity distribution (IES Type)	CCT (K)	Drive current (mA)	# of LEDs	Multiplier (lumens ratio)
2	III	4000	700	80	n/a
3	IV	4000	700	80	n/a
4	IV	5000	700	80	#4 / #3
7	IV	4000	525	80	#7 / #3
9	IV	4000	700	40	#9 / #3

Interpolation between minimal LM-79 and ISTMT data is more difficult if housing size increases with increasing wattage; it may not be clear whether the lowest-wattage configuration would be expected to "run cooler" than the highest-wattage configuration. In these circumstances, the adequacy of submitted data is subject to Owner approval.

At this time, the "successor" method cannot be used; luminaires tested must utilize the LED luminaire source(s) characterized by the submitted LM-80 report.

CONFIDENTIAL

4 Appendix B – Checklist

Complies	Requirement	Reference to supporting evidence
☐	All relevant requirements of AS/NZS 1158.6:2010 series are met	
☐	Luminaire is fully sealed with a smooth, transparent visor in front of the light emitting array such that spiders and dirt cannot collect	
☐	Has an option for a luminaire which offers no upward luminaire spill (e.g. aeroscreen)	
☐	Transparent materials (including SSL optics) between the light source and the area to be lit meet all relevant requirements of visors within AS/NZS 1158.6:2010 Section 2.5.2	
☐	No sharp edges	
☐	Minimum IK06 (as per AS/NZS 1158.6:2010 Section 5.7)	
☐	Optical chamber is minimum IP65 (as per AS/NZS 1158.6:2010 Section 5.6)	
☐	Control gear chamber is minimum IP65 OR control gear chamber is minimum IP24 and control gear is minimum IP65 (as per AS/NZS 1158.6:2010 Section 5.6)	
☐	Water can drain out of control gear chamber naturally (where control gear chamber is minimum IP24)	
☐	No cable entry glands, washers, grommets or other device to restrict the cable entry in order to meet the minimum diameter of the cable entry hole required by clause 3.7(a) of AS/NZS 1158.6:2010	
☐	Meets vibration testing to AS/NZS 1158.6:2010 Section 5.5	
	Meets impulse voltage testing to AS/NZS 1158.6:2010 Section 5.8	
☐	Complies with IEC 61000.3.2 (relevant component compliance is acceptable)	
☐	Luminaire and PE cell can operate when ambient temp external to luminaire is 50˚C (compliant with this requirement using all DNSP-approved PE cells)	
☐	Tool-less removal of PE cell	
☐	If a standard side-entry Category P luminaire, then is able to accommodate 27mm to 34mm outer diameter spigots	
☐	If a Category P luminaire, then meets the following requirements relating to glare: • The intensity at any angle of azimuth shall be not more than – ○ 720 cd in total or 180 cd/1000 lamp lumens, whichever is the greater, at and above a vertical angle of 80°; and 300 cd in total or 80 cd/1000 lamp lumens, whichever is the greater, at and above a vertical angle of 90°	

CONFIDENTIAL

☐	Any material over the light emitting source, including the optics and any other relevant material between the source and the area to be lit, complies with the requirements of the materials and construction clauses of AS/NZS 1158.6:2010 (i.e. 2.5.2: Materials and construction).	
☐	Correlated colour temperature (CCT) is 4000K ± 275K	
☐	Luminaire is RoHS compliant (relevant component compliance is acceptable)	
☐	Luminaire has no moving parts in normal operation (e.g. fans)	
☐	Luminaire utilises multiple chips to light a particular zone, such that if one chip fails there will still be light provided for that particular zone	
☐	Minimum five-year warranty provided covering maintained integrity and functionality of: • Luminaire housing, wiring, and connections • LED luminaire source(s) LED driver(s)	
☐	• Warranty period to begin 90 days after date of invoice, or as negotiated by owner such as in the case of an auditable asset management system	
☐	Life/mortality data for the driver/control gear provided	
☐	Photometric testing of the luminaire performed in accordance with one of the following protocols: o IESNA LM-79-08 o CIE DIS-025	
☐	Luminaire achieves relevant minimum spacing requirement as outlined in Section 2(x), using parameters outlined in 2(y)	
☐	Compliant with AS/NZS CISPR 15	
☐	SSL module is uniquely identifiable	
☐	If polycarbonate is used as a chip lense material, then: a) polycarbonate is UV-stabilised b) acrylic visor over the lense c) data provided detailing the performance of the polycarbonate in relation to light transmittance and yellowness index in order to allow comparison with standard acrylic/PMMA	

CONFIDENTIAL