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Title: Comparison of Results between discharge and LED lamps.

Document Ref J13351 – Summary Report

Date 26/6/2023

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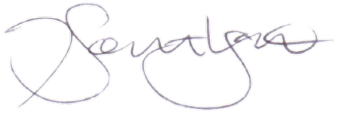
Signature Page / Lab Accreditation

LightLab is NATA accredited ISO 17025 (2017). Full scope available from the NATA website, here; https://nata.com.au/?post_type=site&s=lightlab&filter=&state=&status= .

	Lighting for roads and public spaces	Distribution of luminous intensity	Direct measurement by goniophotometer; Not applicable	AS/NZS 1158.1; AS/NZS 1158.2; AS/NZS 1158.3; CIE 121; IES LM-79	Streetlight luminaires for road lighting with maximum light emitting dimensions not exceeding 1550 mm and rated supply power up to 2 kW; angle; relative luminous intensity over the range from 10 to 100000 cd/1000 lamp lm; luminous intensity from 0.1 to 200 kcd; light output ratio in the range 1% to 125%; luminous efficacy in the range from 10 lm/W to 250 lm/W
	Lighting for roads and public spaces; Traffic signalling and warning signs	Illuminance	Direct measurement by goniophotometer; Direct measurement using a reference meter	AS/NZS 1158; AS/NZS 2144	in the range 0.1 to 1000 lux
		Lumen depreciation; Lumen maintenance; Temperature - In-situ	Direct measurement using a reference meter	AS 2293.3 Appendix D1 AS/NZS 3100 and AS 3137 (Temperature of materials and components only) IES TM-21; IES LM-84-14 (Annex A)	

Prepared by:



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Terms and Abbreviations

Table 0-1 - Terms and Abbreviations

Term	Definition
AS/NZS	Australian Standards / New Zealand Standards
Cd	Candela – unit of luminous intensity in a particular direction
CIE	International Commission on Illumination - abbreviated as CIE from its French title Commission Internationale de l'Eclairage
DGI	Discomfort Glare Index
IES	Illuminating Engineering Society. IES files (usually a . ies file) stores directional intensity information of a light source.
LED	Light emitting diode
lm	Lumen – unit of luminous flux (total light emitted from a source)
MH	Metal halide – type of lamp
MV	Mercury vapour – type of lamp
PF	Power Factor
UWLR	Upward Waste Light Ratio
SSL	Solid state lighting (a group of devices that embody p-n junctions that emit visible radiation when excited by an electric current. 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))
Tc	Temperature measurement point
W	Watt – scientific unit of power.

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1. Scope

The purpose of this report is to provide a comparison of the photometric properties of Western Power supplied LED lamps in comparison to the traditional discharge lamps (Mercury Vapour and Metal Halide lamps) they are replacing, within existing luminaires. This includes results of the Upward Light Ratio (UWLR), Luminous Intensity, Discomfort Glare Index (DGI) and temperature measurements of the LEDs within the luminaire enclosures.

Where applicable, comments are also provided against compliance with the respective AS/NZS 1158 road lighting standards.

The following lamp / luminaire combinations (Table 1-1) are included in the scope of the testing.

Table 1-1 - Lamp / luminaire combinations included for testing

Luminaire Housing Type	Traditional Discharge Lamp	Replacement LED Lamp
70W MH roadster type	70W Metal Halide	42W LED 3000K (Philips Trueforce LED Urban)
80W MV round type	80W Mercury Vapour	18W LED 3000K (Philips Trueforce Core Urban)
80W MV roadster type	80W Mercury Vapour	18W LED 3000K (Philips Trueforce Core Urban)
125W MV roadster type	125W Mercury Vapour	42W LED 3000K (Philips Trueforce LED Urban)

All luminaire housings, traditional discharge lamps and LED lamps tested were provided by Western Power.

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2. Test Equipment Setup

Photometry

- Czibula & Grundmann photocell
- YEW WT-210 wattmeter
- Keysight AC6804A power supply
- YEW 7563 thermometer
- LightLab R80 goniophometer

Sampling was not performed. This report is applicable only to the sample that was tested. Sample was tested in the condition it arrived. All luminaires showed various stages of weathering, and dirtiness.

The significance of the report is limited to the extent that the sample is representative of the population.

Testing was performed in a laboratory with suitable control of environmental conditions, stray light, electrical supply and stabilisation. The sample was maintained in a fixed orientation for the duration of testing.

The samples were mounted with the bottom surface (the lamp opening) horizontal face down. The test distance was 8m.

The photometric values contained in this report are absolute, they have not been scaled by the luminous flux emitted by the light source.

Prorating values for the use of other light source/driver combinations, or for use in different environmental conditions, may yield erroneous results.

This report is free of erasures and corrections.

Photometric intensity values are reported using the CIE Cgamma coordinate system as described in CIE Publication number 121.

The term "Total luminaire power" may appear in this report, it represents the total electrical power consumption of the device tested.

LightLab Procedure Test-B3130. Tested in accordance with the applicable sections of CIE Publication Numbers 121 and 34; with reference to Australian Standard AS/NZS 1680, Part 3.

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3. Assessment of results

3.1. Upward Waste Light Ratio (UWLR)

3.1.1. Comparative assessment and compliance to current standard

Upward waste light ratio (UWLR) is defined as the proportion of the luminous flux emitted by the luminaire above the horizontal, in the installed position. UWLR considers the total lumen and total upward lumen output for each luminaire. The calculation results listed in Table 3-1 below are based on the orientation they were photometered in. Calculations would need to be done on their final installed position. Generally, UWLR will increase with an upcast in the luminaire position.

Table 3-1 – Upward Waste Light Ratio – Comparative assessment and compliance to AS/NZS 1158.3.1:2020

Lamp (Luminaire)	Metric / Values	Comment
70W Metal Halide (Roadster Type)	0.03	UWLR for the luminaire with the LED installed is outside the limits as per AS/NZS 1158.3.1:2020:3.7.2: Table 3.10
42W LED (Roadster Type)	0.04	
80W Mercury Vapour (Round Type)	0.10	UWLR for the luminaire with the LED installed is outside the limits as per AS/NZS 1158.3.1:2020:3.7.2: Table 3.10
18W LED (Round Type)	0.19	
80W Mercury Vapour (Roadster Type)	0.04	UWLR for the luminaire with the LED installed is outside the limits as per AS/NZS 1158.3.1:2020:3.7.2: Table 3.10
18W LED (Roadster Type)	0.06	
125W Mercury Vapour (Roadster Type)	0.03	UWLR for the luminaire with the LED installed is outside the limits as per AS/NZS 1158.3.1:2020:3.7.2: Table 3.10
42W LED (Roadster Type)	0.04	

The calculations are done using the photometric data from the completed tests. The data used is contained in both the photometric reports and the associated IES files.

Reports;

70W Roadster – LL24643 & LL24644

80W Round – LL24633 & LL24636

80W Roadster – LL24640 & LL24641

125 W Roadster – LL24637 & LL24638A

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3.1.2. Compliance to previous standards

The UWLR metric is in both AS/NZS 1158.3.1: 1999 and 2005. It is calculated the same, but the tolerances were larger with the limits being 12% in 1999 and reducing to 10% in 2005.

With the relaxed limits the only luminaire and lamp combination that doesn't comply with either of the standards is the 80W Round Luminaire with the 18W LED lamp.

Table 3-2 – Upward Waste Light Ratio – Comparative assessment and compliance to AS/NZS 1158.3.1 20005 and 1999

Lamp (Luminaire)	Measured	AS/NZS 1158.3.1:2005 limit	AS/NZS 1158.3.1:1999 limit
70W Metal Halide (Roadster Type)	0.03	0.10	0.12
42W LED (Roadster Type)	0.04	0.10	0.12
80W Mercury Vapour (Round Type)	0.10	0.10	0.12
18W LED (Round Type)	**0.19**	0.10	0.12
80W Mercury Vapour (Roadster Type)	0.04	0.10	0.12
18W LED (Roadster Type)	0.06	0.10	0.12
125W Mercury Vapour (Roadster Type)	0.03	0.10	0.12
42W LED (Roadster Type)	0.04	0.10	0.12

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3.2. Discomfort Glare Index (DGI)

3.2.1. Comparative assessment and compliance to current standard

Discomfort glare is applicable to LED luminaires only, and comes about from the nature of LEDs. By the definitions in Appendix E of AS/NZS 1158.3.1-2020, the calculations are assuming an LED array is being used (so would typically be a whole new LED luminaire with a planar lens) whereas the tests have been done on luminaires where the existing lamp is being replaced with a LED lamp and they have dropped lenses/optics. The calculations done are therefore expanding upon the standard.

Refer to results in Table 3-3 below.

Table 3-3 - Discomfort Glare Index - Comparative assessment and compliance to AS/NZS 1158.3.1:2020

Lamp / Luminaire	Metric / Values	Comment
70W Metal Halide (Roadster Type)	N/A	Clause 3.7.1.3 of AS/NZS 1158.3.1:2020 and Table 3.9 state a maximum DGI_P value of 40 000 for luminaire subcategories PR and PP at mounting heights of ≥ 6 m
42W LED (Roadster Type)	5932	
80W Mercury Vapour (Round Type)	N/A	Clause 3.7.1.3 of AS/NZS 1158.3.1:2020 and Table 3.9 state a maximum DGI_P value of 40 000 for luminaire subcategories PR and PP at mounting heights of ≥ 6 m
18W LED (Round Type)	2785	
80W Mercury Vapour (Roadster Type)	N/A	Clause 3.7.1.3 of AS/NZS 1158.3.1:2020 and Table 3.9 state a maximum DGI_P value of 40 000 for luminaire subcategories PR and PP at mounting heights of ≥ 6 m
18W LED (Roadster Type)	2659	
125W Mercury Vapour (Roadster Type)	N/A	Clause 3.7.1.3 of AS/NZS 1158.3.1:2020 and Table 3.9 state a maximum DGI_P value of 40 000 for luminaire subcategories PR and PP at mounting heights of ≥ 6 m
42W LED (Roadster Type)	6125	

The calculations are done using the photometric data from the completed tests. The data used is contained in both the photometric reports and the associated IES files.

Reports;

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80W Round – LL24633 & LL24636

80W Roadster – LL24640 & LL24641

125 W Roadster – LL24637 & LL24638A

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3.2.2. Compliance to previous standards

Compliance to previous standards was not assessed as the previous versions of the standard, specifically AS/NZS 1158.3.1:1999 and 2005, do not cover 'discomfort glare index'.

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3.3. Luminous Intensity

3.3.1. Comparative assessment and compliance to current standard

Refers to the maximum luminous intensity for a luminaire in the photometered position at any angle from 80° to less than 90°, and then at 90° as outlined in AS/NZS 1158.3.1-2020, clause 3.7.1.2 and Table 3.8.

There are different limits for luminaires below and above 4000 lm.

Refer to results in Table 3-4 below.

Table 3-4 - Luminous Intensity - Comparative assessment and compliance to AS/NZS 1158.3.1:2020

Lamp (Luminaire)	Measured Values (cd/cd)[1]	Maximum accepted luminous intensity (cd/cd)	Comment
70W Metal Halide (Roadster Type)	693.6/212.6	720 / 300	**From 80° to less than 90°** 70 W MH (Roadster Type) is compliant 42 W LED (Roadster Type) is **not** compliant **At 90°** 70 W MH (Roadster Type) is compliant 42 W LED (Roadster Type) is **not** compliant
42W LED (Roadster Type)	**796.7/360.1**	720 / 300	
80W Mercury Vapour (Round Type)	544.6/270.8	720 / 300	**From 80° to less than 90°** 80 W MV (Round Type) is compliant 18 W LED (Round Type) is compliant **At 90°** 80 W MV (Round Type) is compliant 18 W LED (Round Type) is **not** compliant
18W LED (Round Type)	515.5/**441.8**	720 / 300	
80W Mercury Vapour (Roadster Type)	517.9/217.5	720 / 300	**From 80° to less than 90°** 80 W MV (Roadster Type) is compliant 18 W LED (Roadster Type) is compliant **At 90°** 80 W MV (Roadster Type) is compliant 18 W LED (Roadster Type) is compliant
18W LED (Roadster Type)	409.5/211.5	720 / 300	
125W Mercury Vapour (Roadster Type)	**845.0/339.3**	749 / 333 *	**From 80° to less than 90°** 125 W MV (Roadster Type) is **not** compliant 42 W LED (Roadster Type) is compliant **At 90°** 125 W MV (Roadster Type) is **not** compliant 42 W LED (Roadster Type) is compliant
42W LED (Roadster Type)	707.7/250.6	720 / 300	

** luminaire > 4000 lumens*

[1] AS/NZS 1158.3.1:2020 Table 3.8 - ≤ 4000 lm: (80° to less than 90°) / (at 90°)

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The calculations are done using the photometric data from the completed tests. The data used is contained in both the photometric reports and the associated IES files.

Reports;

70W Roadster – LL24643 & LL24644

80W Round – LL24633 & LL24636

80W Roadster – LL24640 & LL24641

125 W Roadster – LL24637 & LL24638A

3.3.2. Compliance to previous standards

The previous versions of AS/NZS 1158.3.1:1999 and 2005 do not specifically cover 'Luminous Intensity' but rather have tables with limits for glare control, which is similar. The limits in the older standards are determined using a 'per 1000 lamp lumens' metric.

Lamp lumens are the total lumens emitted from the lamp when tested on their own. The lamps are still run from the drivers from the luminaire, but are operated externally from the luminaire. This required additional photometric testing. Once the lamp lumens are obtained, the glare control limits can then be determined.

The lamp lumen data is listed in Summary Table 4-2 and Table 4-3.

The 80W Round Luminaire with 18W LED combination is the only one that fails to comply with either the 1999 or 2005 standard.

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3.4. Photometric Properties

3.4.1. Luminaire Lumen Output

Total lumen output (total lumens emitted from the luminaire) as measured during the corresponding photometric test.

Refer to results in Table 3-5 below.

Table 3-5 - Lumen Output - Comparison

Lamp / Luminaire	Metric / Values	Comment
70W Metal Halide (Roadster Type)	3402 lm	~ 6% increase in total output for the LED lamp compared to the discharge lamp.
42W LED (Roadster Type)	3609 lm	
80W Mercury Vapour (Round Type)	2450 lm	~ 16% decrease in total output for the LED lamp compared to the discharge lamp
18W LED (Round Type)	2044 lm	
80W Mercury Vapour (Roadster Type)	2299 lm	~ 16% decrease in total output for the LED lamp compared to the discharge lamp
18W LED (Roadster Type)	1943 lm	
125W Mercury Vapour (Roadster Type)	4162 lm	~11% decrease in total output for the LED lamp compared to the discharge lamp.
42W LED (Roadster Type)	3705 lm	

Reports;

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80W Round – LL24633 & LL24636

80W Roadster – LL24640 & LL24641

125 W Roadster – LL24637 & LL24638A

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3.4.2. Candela Display

The below plots are comparing a single plane of horizontal data through the C90/C270. This is a just a snapshot of the overall distribution and intensities. Programs such as Photometric Toolbox offer the ability to do 3D comparison.

70 W Roadster Luminaire – 70 W MH vs 42 W LED

The overall shape of the distribution is similar, with the 42W LED is lamp providing a bit more lumen output. The peaks are less pronounced with the LED lamp.

Refer to Figure 3-1 below.

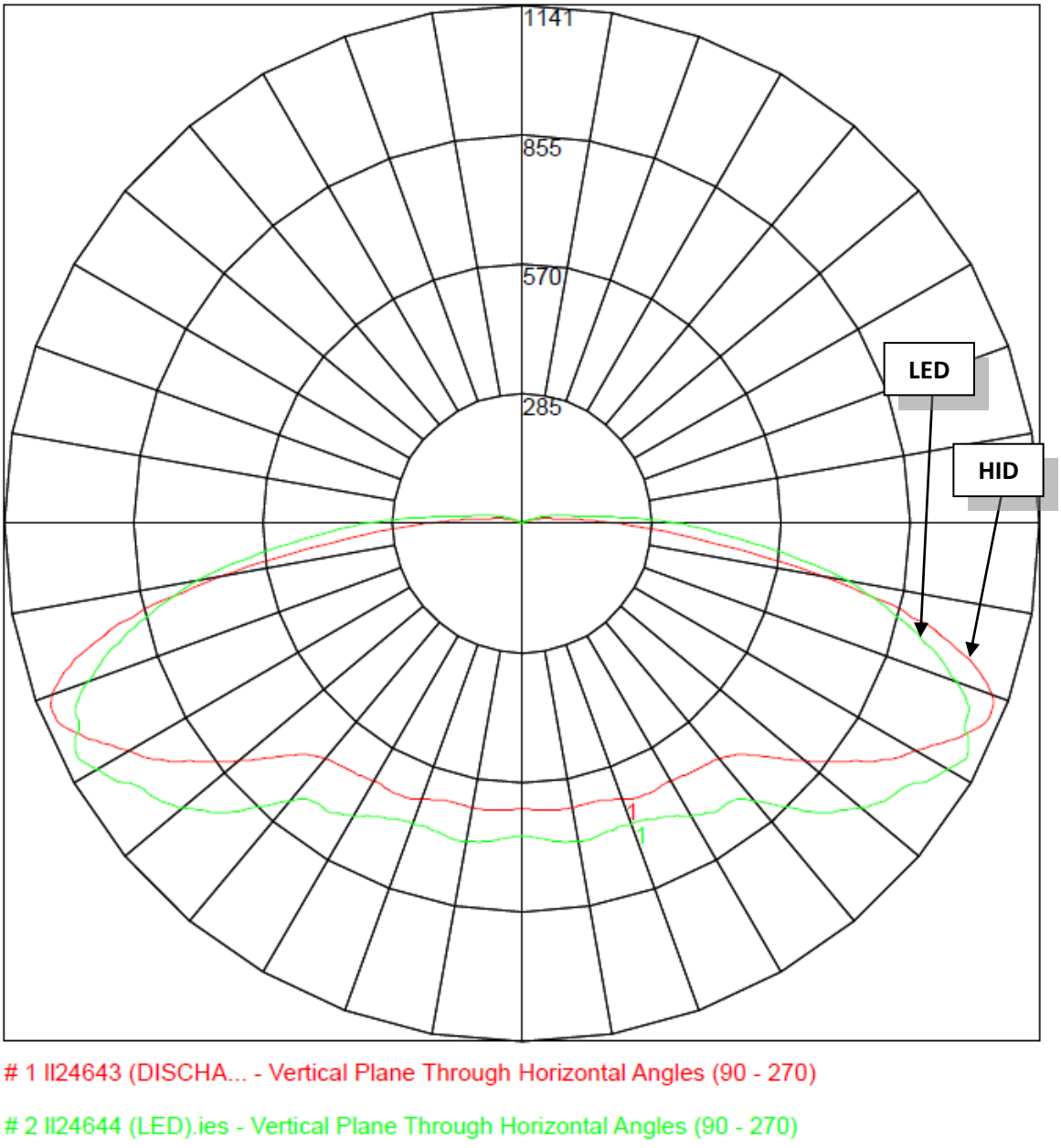

Figure 3-1 - Candela Display - Roadster Type - 70 W MH (red) vs. 42 W LED (green)

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80 W Round Luminaire – 80 W MV vs 18 W LED

The general shape to the distributions is similar however the LED lamp produces noticeably less lumen output. The LED lamp is less peaky, however it does throw more lumens up past the horizontal which is noticeable in the ULWR shown in Summary Table 4-1.

Refer to Figure 3-2 below.

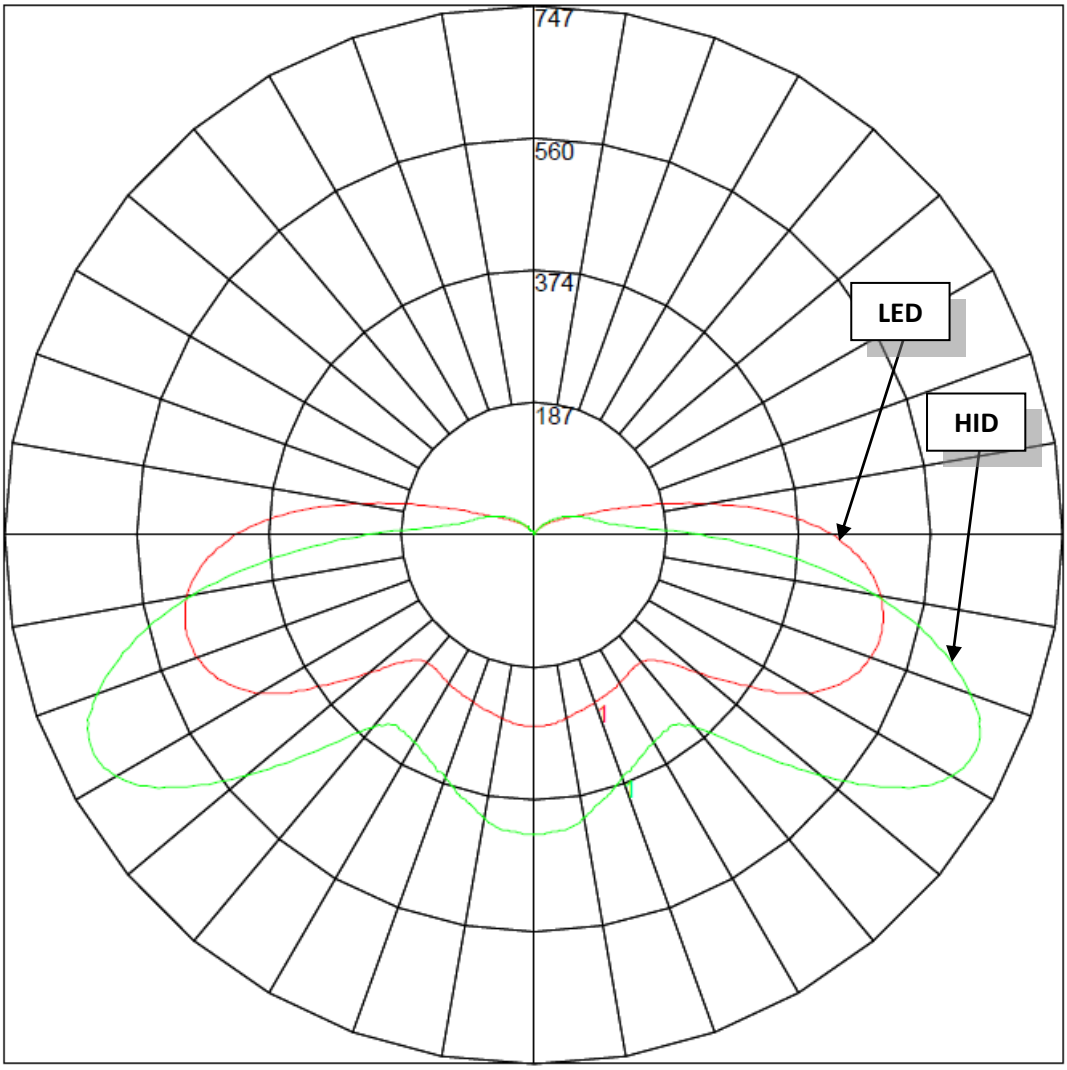

Figure 3-2 - Candela Display - Round Type - 80 W MV (green) vs. 18 W LED (red)

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80 W Roadster Luminaire – 80 W MV vs 18 W LED

The general shapes of the distributions are similar, however there is less lumen output from the LED. This more noticeable with the outward throw than directly beneath the luminaire.

Refer to Figure 3-3 below.

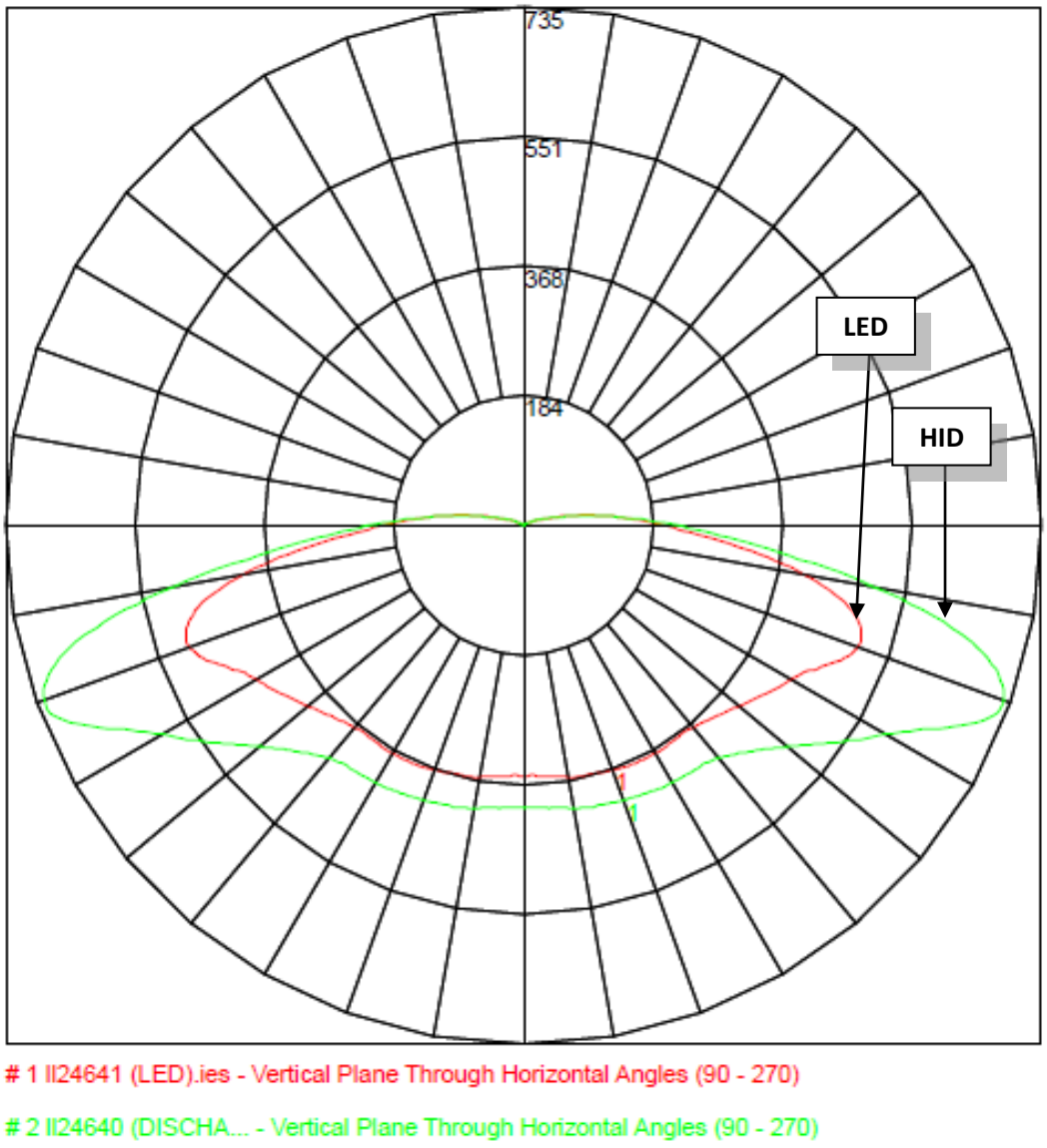

Figure 3-3 - Candela Display - Roadster Type - 80 W MV (green) vs. 18 W LED (red)

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125 W Roadster Luminaire – 125 W MV vs 42 W LED

The overall distributions here are quite similar. The LED lamp produces a bit less total lumens which shows directly beneath the luminaire and at the peaks. With the plots above, these are comparing the planes at which the peak intensities occur.

Refer to Figure 3-4 below.

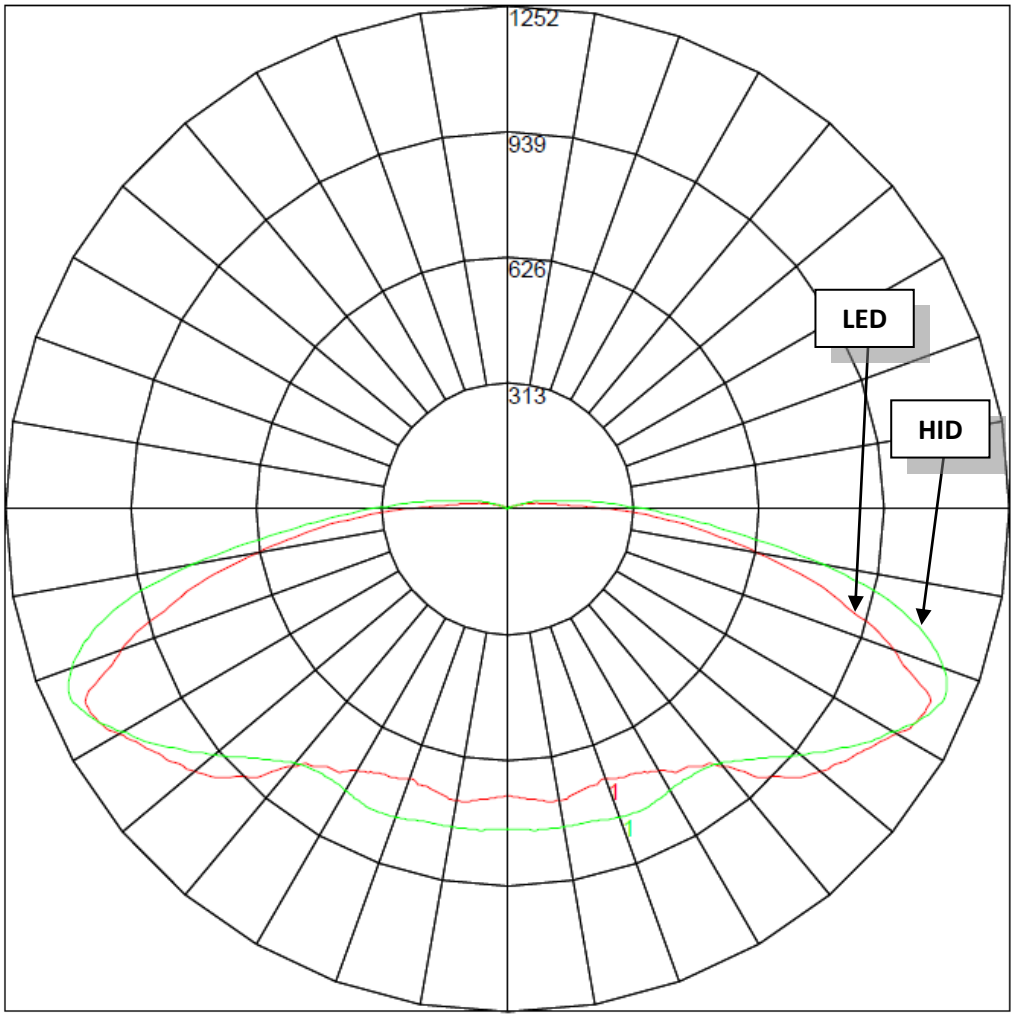

Figure 3-4 - Candela Display - Roadster Type - 125 W MV (green) vs. 42 W LED (red)

The plots are done using the photometric data from the completed tests. The data used is contained in both the photometric reports and the associated IES files.

Reports;

70W Roadster – LL24643 & LL24644

80W Round – LL24633 & LL24636

80W Roadster – LL24640 & LL24641

125 W Roadster – LL24637 & LL24638A

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3.5. Temperature Measurement Tests

Table of results from the temperature tests, report numbers included, are provided below.

70W Roadster with 42W LED

The manufacturer's Tc Max is 90°C. The measured Lamp Tc is within the manufacturer's specifications.

Refer to Table 3-6 below.

Table 3-6 - 70 W Roadster Luminaire with 42 W LED Lamp

Test Report Number LL2313001A-I			
Electrical & environment		Temperatures (1)	
Supply Voltage (ac)	240 V	Ballast surface (TC #11)	36.2 °C
Supply Power	38.6 W	Ballast surface (TC #12)	36.1 °C
Supply Current (ac)	281 mA	Lamp Tc (TC #13)	87.6 °C
Supply Frequency	50 Hz	Prismatic bowl (TC #14)	49.7 °C
Power Factor	0.57		
Measured Ambient Temperature	25.8 °C		
Stabilisation time *	19.75 hours		
Test duration *	0.5 hours		

Measurements Table

80W Round with 18W LED

The manufacturer's Tc Max is 70°C. The measured Lamp Tc is within the manufacturer's specifications.

Refer to Table 3-7 below.

Table 3-7 - 80 W Round Luminaire with 18 W LED Lamp

Test Report Number LL2312501A-I-R01			
Electrical & environment		Temperatures (1)	
Supply Voltage (ac)	240 V	Driver Tc point (TC #1)	30.5 °C
Supply Power	18.4 W	LED Tc (TC #3)	62.5 °C
Supply Current (ac)	260 mA	Lamp chamber T (TC #4)	34.5 °C
Supply Frequency	50 Hz		
Power Factor	0.30		
Measured Ambient Temperature	25.5 °C		
Stabilisation time *	17.5 hours		
Test duration *	0.5 hours		

Measurements Table

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80W Roadster with 18W LED

The manufacturer's Tc Max is 70°C. The measured Lamp Tc is within the manufacturer's specifications.

Refer to Table 3-8 below.

Table 3-8 - 80 W Roadster Luminaire with 18 W LED Lamp

Test Report Number LL2312901A-I			
Electrical & environment		Temperatures (1)	
Supply Voltage (ac)	240 V	Driver Tc point (TC #7)	31.9 °C
Supply Power	21.5 W	Driver Tc point (TC #8)	31.8 °C
Supply Current (ac)	108 mA	LED Tc (TC #9)	58.8 °C
Supply Frequency	50 Hz	Lamp chamber T (TC #10)	37.7 °C
Power Factor	0.83		
Measured Ambient Temperature	25.6 °C		
Stabilisation time *	21.75 hours		
Test duration *	0.25 hours		

Measurements Table

125W Roadster with 42W LED

The manufacturer's Tc Max is 90°C. The measured Lamp Tc is within the manufacturer's specifications.

Refer to Table 3-9 below.

Table 3-9 – 125 W Roadster Luminaire with 42 W LED Lamp

Test Report Number LL2312801A-I			
Electrical & environment		Temperatures (1)	
Supply Voltage (ac)	240 V	Driver Tc point (TC #1)	86.8 °C
Supply Power	38.4 W	Driver Tc point (TC #2)	34.6 °C
Supply Current (ac)	460 mA	LED Tc (TC #3)	34.8 °C
Supply Frequency	50 Hz	Lamp chamber T (TC #4)	45.7 °C
Power Factor	0.35		
Measured Ambient Temperature	24.8 °C		
Stabilisation time *	20.5 hours		
Test duration *	0.5 hours		

Measurements Table

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4. Summary and Conclusion

4.1. Comparative assessment and compliance with AS/NZS 1158.3.1:2020

A summary of results is provided in Table 4-1.

UWLR

The UWLR calculated is for the luminaires in the photometered position. While the results give you an idea, AS/NZS 1158.3.1-2020:3.7.2 provides limitations for the luminaire "in the attitude in which it is installed" so would need to be calculated in a lighting design with the luminaire in its final position.

The calculations have been done using Photometric Toolbox which treats UWLR as per the following;

Upward waste light ratio (UWLR)is defined as the proportion of the luminous flux emitted by the luminaire above the horizontal, in the installed position. The metric was developed by the Joint Standards Australia/Standards New Zealand Committee LG/2, Road Lighting, and is published in documents AS/NZS 1158.0:1997 and 1158.1:1997,Road Lighting, and 1158.2:1997, Lighting for Roads and Public Spaces (Part 2: Computer Procedures).

By using the above method, all the LED replacements would be outside the limits outlined in Table 3.10 of AS/NZS 1158.3.1:2020:3.7.2.

The increased UWLR for the LED lamps is a result of the lamps being directly visible below 90° horizontal.

Generally UWLR will increase with an up tilt in luminaire position.

DGI

All of the DGIp values for the tests with the LED replacement lamps are within the limits specified in Table 3.9 of AS/NZS 1158.3.1-2020:3.7.1.3. Caveats noted in regards to the definitions in the standard intended for new LED luminaires that have planar openings and arrays of luminaires.

Luminous Intensity

The 70W Roadster when tested with the 42W LED replacement exceeded both the limits.

The 125W Roadster when tested with the discharge lamp exceeded both the limits.

The 80W Round when tested with the 18W LED replacement exceeded the limit at 90°.

Luminaire Lumen Output:

Three of the tests with the LED replacements are down on lumen output compared to the discharge lamps they are replacing to varying degrees. The fourth test was slightly up in output. In all cases this alters both the light directly beneath the luminaires, but also the angles at which the peak intensities occur.

Temperature Measurement Test

The Lamp Tc measured in all four luminaires tested with the LED replacements were below the Tc Max as specified by the lamp manufacturer.

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Other Notes

Some other points of interest, is leaving the iron core ballasts in circuit does have knock on effect to the PF, compared to when the LED lamps are powered up on their own.

The 42 W LED lamp is more like a “corn cob” style of lamp. There are 4 distinct rows of LEDs. When screwing these lamps into the luminaire there is no set final position, so the rows of LEDs could easily end up in different positions, possibly effecting the distribution. During the testing one of the LED sections was made to be facing directly down.

4.2. Compliance with previous standards

General

For compliance with AS/NZS 1158.3.1:2005, refer to summary of results in Table 4-2

For compliance with AS/NZS 1158.3.1:1999, refer to summary of results in Table 4-3

Equivalent LED lamps fitted in traditional luminaires are mostly compliant with previous standards AS/NZS 1158.3.1:2005 and AS/NZS 1158.3.1:1999 with the exception of Luminaire Lumen Output and UWLR of the 18 W LED lamp fitted in the 80 W MV Round Type luminaire. This is addressed below.

Luminaire Lumen Output:

Three of the tests with the LED replacements are down on lumen output compared to the discharge lamps they are replacing to varying degrees. The fourth test was slightly up in output. In all cases this alters both the light directly beneath the luminaires, but also the angles at which the peak intensities occur.

Compliance to previous standards is unable to be determined from photometric testing alone. To show compliance it is recommended that a lighting design study be performed to ensure adequate lux is present at ground level.

Recommendations

The 18 W LED lamp fitted in the 80 W MV Round Type luminaire was found to be non-compliant with previous standards as this failed to meet UWLR requirements.

Typically luminaires that have the round drop bowl style diffuser have a large shield around them which would aid by cutting off some of the upward light (the main issue with this lamp / luminaire combination).

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4.3. Summary of results

Table 4-1 - Summary of results – Compliance with AS/NZS 1158.3.1:2020

Lamp Type:	**70 W Metal Halide**	**42 W LED**	**80W Mercury Vapour**	***18 W LED***	***80 W Mercury Vapour***	**18 W LED**	**125 W Mercury Vapour**	**42 W LED**	**Comments** ***Compliance with Standards (and/or manufacturer's specification) and comparative assessment***
Luminaire Type:	**70W Roadster Type**		**80W Round Type**		**80W Roadster Type**		**125W Roadster Type**		
Report No.	LL24643	LL24644	LL24633	LL24636	LL24640	LL24641	LL24637	LL24638A	-
UWLR	0.03	0.04	0.10	0.19	0.04	0.06	0.04	0.03	**Compliance** Clause 3.7.2 of AS/NZS 1158.3.1:2020 and Table 3.10 state a maximum UWLR of 1% for light source type: SSL and luminaire application: 'local roads'. Normally UWLR would be calculated in the installed position. If the luminaires have upward tilt applied, generally the UWLR would get worse, not better. The following lamp (luminaire) are compliant: Nil The following lamp (luminaire) are not compliant: All **Comparative assessment** 3 of the 4 tests with the LED lamps have a higher UWLR compared to the HID lamps. The 42 W LED lamp fitted in the 125 W MV luminaire has a lower UWLR than the traditional lamp.

Lamp Type:	70 W Metal Halide	42 W LED	80W Mercury Vapour	*18 W LED*	*80 W Mercury Vapour*	18 W LED	125 W Mercury Vapour	42 W LED	Comments *Compliance with Standards (and/or manufacturer's specification) and comparative assessment*
Luminaire Type:	**70W Roadster Type**		**80W Round Type**		**80W Roadster Type**		**125W Roadster Type**		
DGI	N/A	5932	N/A	2785	N/A	2659	N/A	6125	**Compliance** Clause 3.7.1.3 of AS/NZS 1158.3.1:2020 and Table 3.9 state a maximum DGI_P value of 40 000 for luminaire subcategories PR and PP at mounting heights of ≥ 6 m The following lamp (luminaire) are compliant: 42 W LED (Roadster Type) 18 W LED (Roadster Type) 18 W LED (Round Type) 42 W LED (Roadster Type) **Comparative assessment** A comparison has not been done as DGI is calculated for LED luminaires only.
Luminaire Lumen Output	3402lm	3690lm	2450lm	2044lm	2299lm	1943lm	4162lm	3705lm	**Compliance** A lighting design study needs to be done. **Comparative assessment** 3 of the 4 test with LEDs have a lower total lumen output compared to the tests with the HID lamps. The 42 W LED lamp fitted in 70 W MH roadster type housing has a higher total lumen output than the traditional lamp.

Lamp Type:	70 W Metal Halide	42 W LED	80W Mercury Vapour	*18 W LED*	*80 W Mercury Vapour*	18 W LED	125 W Mercury Vapour	42 W LED	Comments *Compliance with Standards (and/or manufacturer's specification) and comparative assessment*
Luminaire Type:	**70W Roadster Type**		**80W Round Type**		**80W Roadster Type**		**125W Roadster Type**		
Luminous Intensity *80° to less than 90°*	693.6cd	796.7cd	544.6cd	515.5cd	517.9cd	409.5cd	845.0cd (749.2cd; over 4000 lm)	707.7cd	**Compliance** Clause 3.7.1.2 (*Luminous Intensity*) of AS/NZS 1158.3.1:2020 states a maximum luminous intensity for a luminaire, at any azimuth angle shall not exceed values in Table 3.8. At angles between 80° to 90° 20luminous intensity must be ≤ 720 cd absolute for luminaires with luminaire luminous flux ≤ 4000 lm and ≤ 180 cd/1000 lm for luminaires with luminaire luminous flux > 4000 lm (applicable to 125 W MV). The following lamp (luminaire) are compliant: 70 W MH (Roadster Type) 80 W MV (Round Type) 18 W LED (Round Type) 80 W MV (Roadster Type) 18 W LED (Roadster Type) 42 W LED (Roadster Type) The following lamp (luminaire) are not compliant: 42 W LED (Roadster Type) 125 W MV (Roadster Type) **Comparative assessment** One each LEDs and discharge tests had issues being outside the limits of the standard at 80° to less than 90°.

Lamp Type:	70 W Metal Halide	42 W LED	80W Mercury Vapour	*18 W LED*	*80 W Mercury Vapour*	18 W LED	125 W Mercury Vapour	42 W LED	Comments *Compliance with Standards (and/or manufacturer's specification) and comparative assessment*
Luminaire Type:	**70W Roadster Type**		**80W Round Type**		**80W Roadster Type**		**125W Roadster Type**		
Luminous Intensity *At 90°*	212.6cd	360.1cd	270.8cd	441.8cd	217.5cd	211.5cd	339.3cd (333.0cd; over 4000 lm	250.6cd	**Compliance** Clause 3.7.1.2 (*Luminous Intensity*) of AS/NZS 1158.3.1:2020 states a maximum luminous intensity for a luminaire, at any azimuth angle shall not exceed values in Table 3.8. At angles of 90°, 21luminous intensity must be ≤ 300 cd absolute for luminaires with luminaire luminous flux ≤ 4000 lm and ≤ 80 cd/1000 lm for luminaires with luminaire luminous flux > 4000 lm (applicable to 125 W MV). The following lamp (luminaire) are compliant: 70 W MH (Roadster Type) 80 W MV (Round Type) 80 W MV (Roadster Type) 18 W LED (Roadster Type) 42 W LED (Roadster Type) The following lamp (luminaire) are not compliant: 42 W LED (Roadster Type) 18 W LED (Round Type) 125 W MV (Roadster Type) **Comparative assessment** Two of the LED results had issues being outside the limits of the standard at 90°. One of the discharge lamps had issues being outside the limits of the standard at 90°

Lamp Type:	70 W Metal Halide	42 W LED	80W Mercury Vapour	*18 W LED*	*80 W Mercury Vapour*	18 W LED	125 W Mercury Vapour	42 W LED	Comments *Compliance with Standards (and/or manufacturer's specification) and comparative assessment*
Luminaire Type:	**70W Roadster Type**		**80W Round Type**		**80W Roadster Type**		**125W Roadster Type**		
Temperature Measurement Tests									
Report No.	N/A	LL2313001 A-I	N/A	LL2312501 A-R01	N/A	LL2312901 A-I	N/A	LL2312801 A-I	-
Tc Max.	N/A	87.6°C	N/A	62.5°C	N/A	58.8°C	N/A	34.8°C	**Compliance** All of the Tc Max measurements for the LED lamps were within the manufacturer's specified limits. **Comparative assessment** A comparison was not done as the specifications only apply to the LED lamps.

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Table 4-2 - Summary of results – Compliance with AS/NZS 1158.3.1:2005

Lamp Type:	**70 W Metal Halide**	**42 W LED**	**80W Mercury Vapour**	***18 W LED***	***80 W Mercury Vapour***	**18 W LED**	**125 W Mercury Vapour**	**42 W LED**	**Comments** ***Compliance with AS/NZS 1158.3.1:2005***
Luminaire Type:	**70W Roadster Type**		**80W Round Type**		**80W Roadster Type**		**125W Roadster Type**		
Report No.	LL24643	LL24644	LL24633	LL24636	LL24640	LL24641	LL24637	LL24638A	-
Lamp Lumens (lm)	4377	5480	3423	2786	3423	2786	5774	5480	**Compliance** A lighting design study needs to be done.
Limit @ 80° (cd)	787.9	986.4	606.1	501.5	606.1	501.5	1039.3	986.4	**Compliance**
Measured @ 80° (cd)	693.6	796.7	544.6	**515.5**	517.9	409.5	845.0	707.7	Clause 2.5.3.2 *(Glare)* and Table 2.10 of AS/NZS 1158.3.1:2005 state (for luminaire classification: 'Type 4') *'the intensity shall not be more than –'* (i) 80cd/1000 lamp lumens at a (vertical) angle of 90°; The following lamp (luminaire) are compliant: 70 W MH (Roadster Type) 42 W LED (Roadster Type) 80 W MV (Round Type) 80 W MV (Roadster Type) 18 W LED (Roadster Type) 125 W MV (Roadster Type) 42 W LED (Roadster Type) The following lamp (luminaire) are not compliant: 18 W LED (Round Type)

Lamp Type:	70 W Metal Halide	42 W LED	80W Mercury Vapour	*18 W LED*	*80 W Mercury Vapour*	18 W LED	125 W Mercury Vapour	42 W LED	Comments *Compliance with AS/NZS 1158.3.1:2005*
Luminaire Type:	**70W Roadster Type**		**80W Round Type**		**80W Roadster Type**		**125W Roadster Type**		
Limit @ 90° (cd)	350.2	438.4	273.8	222.9	273.8	222.9	461.9	438.4	**Compliance**
Measured @ 90° (cd)	212.6	360.1	270.8	**441.8**	217.5	211.5	339.3	250.6	Clause 2.5.3.2 *(Glare)* and Table 2.10 of AS/NZS 1158.3.1:2005 state (for luminaire classification: 'Type 4') *'the intensity shall not be more than –'* (ii) 120cd/1000 lamp lumens at a (vertical) angle of 90° at any angle of azimuth. The following lamp (luminaire) are compliant: 70 W MH (Roadster Type) 42 W LED (Roadster Type) 80 W MV (Round Type) 80 W MV (Roadster Type) 18 W LED (Roadster Type) 125 W MV (Roadster Type) 42 W LED (Roadster Type) The following lamp (luminaire) are not compliant: 18 W LED (Round Type)

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Lamp Type:	70 W Metal Halide	42 W LED	80W Mercury Vapour	*18 W LED*	*80 W Mercury Vapour*	18 W LED	125 W Mercury Vapour	42 W LED	Comments *Compliance with AS/NZS 1158.3.1:2005*
Luminaire Type:	**70W Roadster Type**		**80W Round Type**		**80W Roadster Type**		**125W Roadster Type**		
UWLR - Limit	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	**Compliance**
UWLR - Measured	0.03	0.04	0.10	**0.19**	0.04	0.06	0.04	0.03	Clause 2.5.3.3 *(Upward waste light)* and Table 2.10 of AS/NZS 1158.3.1:2005 state (for luminaire classification: 'Type 4'): *'The limiting value of UWLR in Table 2.10 shall not be exceeded for the selected luminaire when mounted with the upcast angle, where applicable, specified in the design.'* The following lamp (luminaire) are compliant: 70 W MH (70 W Roadster Type) 42 W LED (70 W Roadster Type) 80 W MV (80 W Round Type) 80 W MV (80 W Roadster Type) 18 W LED (80 W Roadster Type) 125 W MV (125 W Roadster Type) 42 W LED (125 W Roadster Type) The following lamp (luminaire) are not compliant: 18 W LED (80 W Round Type)

Table 4-3 - Summary of results – Compliance with AS/NZS 1158.3.1:1999

Lamp Type:	**70 W Metal Halide**	**42 W LED**	**80W Mercury Vapour**	***18 W LED***	***80 W Mercury Vapour***	**18 W LED**	**125 W Mercury Vapour**	**42 W LED**	**Comments** ***Compliance with AS/NZS 1158.3.1:1999***
Luminaire Type:	**70W Roadster Type**		***80W Round Type***		**80W Roadster Type**		**125W Roadster Type**		
Report No.	LL24643	LL24644	LL24633	LL24636	LL24640	LL24641	LL24637	LL24638A	-
Lamp Lumens (lm)	4377	5480	3423	2786	3423	2786	5774	5480	**Compliance** A lighting design study needs to be done.
Peak Intensity Limit (cd)	1750.8	2192.0	1369.2	1114.4	1369.2	1114.4	2309.6	2192.0	**Compliance**
Peak Intensity Measured (cd)	1126.5	1140.6	747.3	527.0	735.2	508.0	1252.3	1163.3	Clause 2.3.3.2 *(Glare)* and Table 2.5 of AS/NZS 1158.3.1:1999 states (for luminaire classification: 'Type 4') *'The peak intensity shall not exceed 400 cd per 1000 lamp lumens'* The following lamp (luminaire) are compliant: all The following lamp (luminaire) are not compliant: nil
Peak Intensity Angle (°)	70.5	64.5	63.5	73.5	70.5	71.0	69.5	65.5	**Compliance**
Peak Intensity < 75° (vertical)	Y	Y	Y	Y	Y	Y	Y	Y	Clause 2.3.3.2 *(Glare)* and Table 2.5 of AS/NZS 1158.3.1:1999 states (for luminaire classification: 'Type 4') *'The γ (vertical) angle of the peak intensity shall not exceed 75 degrees'* The following lamp (luminaire) are compliant: all The following lamp (luminaire) are not compliant: nil

Lamp Type:	70 W Metal Halide	42 W LED	80W Mercury Vapour	*18 W LED*	*80 W Mercury Vapour*	18 W LED	125 W Mercury Vapour	42 W LED	Comments *Compliance with AS/NZS 1158.3.1:1999*
Luminaire Type:	**70W Roadster Type**		***80W Round Type***		**80W Roadster Type**		**125W Roadster Type**		
Peak Intensity @ 90° in plane of peak intensity - Limit	525.2	657.6	410.8	334.3	410.8	334.3	692.9	657.6	**Compliance** Clause 2.3.3.2 *(Glare)* and Table 2.5 of AS/NZS 1158.3.1:1999 states (for luminaire classification: 'Type 4') *'The luminous intensity at γ angle of 90 degrees, in the vertical plane in which the peak intensity lies, shall not exceed 120 cd per 1000 lumens'* The following lamp (luminaire) are compliant: 70 W MH (70 W Roadster Type) 42 W LED (70 W Roadster Type) 80 W MV (80 W Round Type) 80 W MV (80 W Roadster Type) 18 W LED (80 W Roadster Type) 125 W MV (125 W Roadster Type) 42 W LED (125 W Roadster Type) The following lamp (luminaire) are not compliant: 18 W LED (80 W Round Type)
Peak Intensity @ 90° in plane of peak intensity - Measured	201.2	350.3	269.1	**441.8**	210.7	203.8	326.9	244.2	

Lamp Type:	70 W Metal Halide	42 W LED	80W Mercury Vapour	*18 W LED*	*80 W Mercury Vapour*	18 W LED	125 W Mercury Vapour	42 W LED	Comments *Compliance with AS/NZS 1158.3.1:1999*
Luminaire Type:	**70W Roadster Type**		***80W Round Type***		**80W Roadster Type**		**125W Roadster Type**		
UWLR - Limit	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	**Compliance**
UWLR - Measured	0.03	0.04	0.10	**0.19**	0.04	0.06	0.04	0.03	Clause 2.3.3.3 *(Upward waste light)* and Table 2.5 of AS/NZS 1158.3.1:1999 states *'The UWLR for the selected luminaires shall be not more than the applicable value given in Column 4 of Table 2.5.'*. For luminaire classification: 'Type 4', the maximum UWLR is 12%. The following lamp (luminaire) are compliant: 70 W MH (70 W Roadster Type) 42 W LED (70 W Roadster Type) 80 W MV (80 W Round Type) 80 W MV (80 W Roadster Type) 18 W LED (80 W Roadster Type) 125 W MV (125 W Roadster Type) 42 W LED (125 W Roadster Type) The following lamp (luminaire) are not compliant: 18 W LED (80 W Round Type)

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APPENDIX A

Photometric Tests – Luminaire and Lamp together – reports issued

LL24633

LL24636

LL24637

LL24638a

LL24640

LL24641

LL24643

LL24644

Photometric Tests – Lamp Lumens – data used for determining limits

LL24679

LL24680

LL24694

LL24695

LL24696

Temperature Tests

LL2312501A-I-R01

LL2312801A-I

LL2312901A-I

LL2313001A-I

Electrical Summary

J13351 – Lamp Comparison