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# **SYDNEY TRAINS BILLBOARDS**

***Site 2: Pyrmont***

## **EVALUATION OF LIGHTING IMPACT**

Prepared by:

**Lighting, Art and Science**

for

**Ethos Urban**

## Table of Contents

<b>1. INTRODUCTION .....</b>	<b>1</b>
<b>2. RELEVANT STANDARDS .....</b>	<b>1</b>
<b>3. AS/NZS4282.....</b>	<b>1</b>
<b>3.1 Environmental Zone .....</b>	<b>1</b>
<b>3.2 Curfew period.....</b>	<b>2</b>
<b>3.3 Light technical parameters (LTPs) .....</b>	<b>2</b>
3.3.1 Illuminance in the vertical plane .....	2
3.3.2 Luminous Intensity emitted by luminaires .....	3
3.3.3 Luminance .....	3
3.3.4 Threshold Increment .....	3
3.3.5 Upward Light Ratio (ULR) .....	3
3.3.6 Relevant Light Technical Parameters .....	4
<b>4. NSW TRANSPORT CORRIDOR ADVERTISING AND SIGNAGE GUIDELINES .....</b>	<b>4</b>
<b>5. CASA Manual of Standards Part 139-Aerodromes- section 9.21.....</b>	<b>5</b>
<b>6. PROPOSED SIGNAGE.....</b>	<b>6</b>
<b>7. PARAMETERS.....</b>	<b>9</b>
<b>8. METHODOLOGY .....</b>	<b>10</b>
<b>9. CONFORMANCE .....</b>	<b>11</b>
<b>10. CONCLUSION.....</b>	<b>13</b>
<b>11. REFERENCES: .....</b>	<b>14</b>
<b>12. ANNEXURE A – Relevant tables from AS/NZS4282.....</b>	<b>15</b>
<b>13. ANNEXURE B – CASA Control Area .....</b>	<b>16</b>
<b>14. ANNEXURE C – Typical Sign Modules.....</b>	<b>17</b>
<b>15. ANNEXURE D – AGI32 Compliance Report and calculation model non-Curfew L1 .....</b>	<b>18</b>
<b>16. ANNEXURE E– AGI32 Compliance Report and calculation model Curfew.....</b>	<b>19</b>

## 1. INTRODUCTION

Lighting Art & Science has been engaged to assess the light obtrusion of proposed new LED billboard signs at the Western Distributor, Pyrmont. The proposal is for two signs mounted on a single pole on the East side of the Western Distributor near Bulwara Road.

The proposed signs will be digital LED signs with variable content.

## 2. RELEVANT STANDARDS

There are several standards that may have relevance to this site.

- AS/NZS4282: *Control of obtrusive effects of outdoor lighting*, gives control for the levels of spill light that can be reasonably expected in an urban environment. This is not called up in any NSW legislation, however conformance is commonly required in LEPs ( Local Environmental Plans). The standards main concentration is on the impact on residents.
- NSW Transport Corridor Advertising and Signage Guidelines (NSWTAG) specifies luminance limits on signs by day and night concentrating on the impact on traffic.
- CASA Manual of Standards Part 139-Aerodromes- section 9.21 (CASA MoS Pt 139)

Both AS/NZS4282 and NSWTAG include limits on the graphical content including dwell time, change in luminance between images and colour; however, these are outside the scope of this study.

## 3. AS/NZS4282

*AS4282 Control of the obtrusive effect of outdoor lighting* was written to establish limits of light obtrusion that provide a reasonable balance between impact of light on the amenity of the neighbour and the ability to have an external lighting installation.

This standard is only applicable to night-time hours.

The preface of the standard states “These criteria have been employed to ensure that the standard is both *credible* to the interested parties and *pragmatic* in application.”

The standard recommends limits for several light technical parameters (LTP) based on the ambient conditions (Environmental Zones), and time of night (Non-curfew and Curfew Period).

### 3.1 Environmental Zone

The higher the ambient conditions, the higher the allowable obtrusive lighting limit.

Table 3.1 is an extract from the standards detailing the various environmental zones.

The environmental zones relate to the nature of the surrounding areas and represent not only the expected ambient lighting but also the level of activity.

**TABLE 3.1**  
**ENVIRONMENTAL ZONES**

<b>Zones</b>	<b>Description</b>	<b>Examples</b>
A0	Intrinsically dark	UNESCO Starlight Reserve. IDA Dark Sky Parks. Major optical observatories No road lighting -unless specifically required by the road controlling authority
A1	Dark	Relatively uninhabited rural areas No road lighting - unless specifically required by the road controlling authority
A2	Low district brightness	Sparsely inhabited rural and semi-rural areas
A3	Medium district brightness	Suburban areas in towns and cities
A4	High district brightness	Town and city centres and other commercial areas Residential areas abutting commercial areas
TV	High district brightness	Vicinity of major sports stadium during TV broadcasts
V	Residences near traffic routes	Refer AS/NZS1158.1.1
R1	Residences near local roads with significant setback	Refer AS/NZS 1158.3.1
R2	Residences near local roads	Refer AS/NZS 1158.3.1
R3	Residences near a roundabout or local area traffic management device	Refer AS/NZS 1158.3.1
RX	Residences near a pedestrian crossing	Refer AS/NZS 1158.4

NOTE: Recreational areas are not considered commercial.

*Table 3.1: Environmental Zones AS/NZS4282:2019 (table 3.1)*

### 3.2 Curfew period

The standard includes a curfew period during which the light technical parameters are significantly reduced. It is assumed that during these periods the majority of residential activity will have ceased, and people will be sleeping.

The stricter curfew limits only apply to the windows of 'habitable' rooms defined in the standard as; "A room within a dwelling that is occupied by people for extended periods, especially at night, e.g. living room, bedroom and study but not bathroom, kitchens or storage room."

The default time for the curfew period is 11:00pm to 6:00am; however, the consent authority can amend the times.

### 3.3 Light technical parameters (LTPs)

AS/NZS4282 applies limits to five light technical parameters.

Conformance with the standard is by calculation rather than measurement. This enables approval prior to the installation of the lighting separate from the contribution of existing lighting.

The light technical parameters are as follows:

#### 3.3.1 Illuminance in the vertical plane

This is a measure of the general light spill onto the property. The levels are calculated at the face of the building/regulatory building line in the vertical plane and facing perpendicular to the fence, or building.

The illuminance in the vertical plane is an assessment of the extent to which the lighting will light up the interior of a residence facing the installation.

The Illuminance reduces proportionally to the square of distance from the light source. As a result, the further away from the light source the less the impact. The illuminance also reduces as the angle from the perpendicular increases.



The **illuminance** is a measure of the amount of light falling on a surface and is measured in **lux**.

The illuminance used in AS/NZS4282 is the direct illuminance resulting from the installation; that is the light that comes directly from the light fittings.

In all installations there is also indirect light that is reflected off the ground, walls of buildings, objects in the lit area and in some cases reflections from clouds and the sky.

The standard only addresses direct illumination effects. This is due to the standard being designed to determine conformance or non-conformance. Direct illumination can be readily and reliably calculated. Indirect illumination is a result of light reflected off the ground and other surfaces and will change depending on things like, the colour of buildings, the colour of clothes people are wearing, whether trees have leaves etc. and whether the surfaces are wet or dry.

Although inter-reflected light does have an effect, it cannot be reliably calculated and therefore cannot be a criteria for conformance.

The standard only looks at the illuminance resulting from the proposed installation and not the cumulative impact of the other lighting in an area (e.g. nearby street lighting etc.).

### **3.3.2 Luminous Intensity emitted by luminaires**

This is a measure of the brightness of the light source in a given direction and is used by the standard as an approximation of the glare generated.

This is governed by the brightness of the light source, the glare control of the light fitting and the viewing angle. This affect does not reduce with distance; however, with a very small light source the perception will reduce as the image of the light on the eye becomes smaller than the size of the light receptors in the eye. In addition, if the distance is long enough there will be a reduction in the brightness due to the permeability of the air.

It is used in this standard as an indication of the level of distraction or discomfort the lighting might cause. The luminous intensity relates to a specific direction and will depend on the light distribution of the light fitting and the direction of view.

**Luminous Intensity** is the light leaving a source in a given direction and is measured in **candelas**.

As the luminous intensity varies with the area the relationship with glare only works for physically small light sources. As a result, it is not used for the assessment of signage or large area sources.

### **3.3.3 Luminance**

The **Luminance** is the light that leaves the area of a surface in all directions. It is measured in **candela/m<sup>2</sup>**. The eye sees by distinguishing the difference in luminance between the different objects and surfaces.

Luminance is a better indication of the obtrusive effects of large area sources such as signs or floodlit facades.

### **3.3.4 Threshold Increment**

This is a measure of the disability glare that results from the light sources and their impact on driver's ability to read signs, signals and see objects. The threshold increment is calculated from the driving position for cars driving on roads that are near the lighting installation. AS/NZS4282 assumes a background luminance based on the Environmental Zone.

### **3.3.5 Upward Light Ratio (ULR)**

Upward Light Ratio is the ratio of the light that is emitted from the luminaires, in their aimed positions, divided by the total light emitted by the luminaires. This is a measure of the contribution of the installation to sky glow.

AS/NZS4282 has a standard limit or ULR for internally lit signs of 50%.

### 3.3.6 Relevant Light Technical Parameters

The relevant Light Technical Parameter limits from AS/NZS4282 are indicated in Tables 3.2 and 3.3.

**Maximum Values of Light Technical Parameters**

Zones	Vertical illuminance levels ( $E_v$ ) lx		Threshold Increment ( $T$ )	
	Non-Curfew	Curfew	%	Default adaptation level ( $L_{ad}$ )
A2	5	1	20%	0.2
A3	10	2	20%	1
A4	25	5	20%	5

*Table 3.2 Excerpt from table 3.2 of AS/NZS4282*

**Maximum Average Luminance of Surfaces (cd.m<sup>2</sup>)**

Environmental Zones				
A0	A1	A2	A3	A4
0.1	0.1	150	250	350

*Table 3.3 Excerpt from table 3.5 of AS/NZS4282*

The complete tables from AS/NZS4282 are included as Annexure A

## 4. NSW TRANSPORT CORRIDOR ADVERTISING AND SIGNAGE GUIDELINES

The NSW Transport Corridor Advertising and Signage Guidelines have specific criteria for digital signs in Section 2.5.8 Digital signs. These relate to motion in the content, the dwell time of the content and the transition time to minimise distraction to drivers. These criteria are principally associated with the sign digital content and are outside the scope of this analysis.

Table 6 in the Guidelines sets luminance limits for the day and night operation of digital signs.

Lighting Condition	Zone 1 (cd/m <sup>2</sup> )	Zones 2 and 3 (cd/m <sup>2</sup> )	Zone 4 (cd/m <sup>2</sup> )
Full sun on face of signage	No limit	No limit	No limit
Daylight luminance		6000	6000
Morning and evening twilight and inclement weather	700	700	500
Night-time	350	350	200

*Table 4.1 Copy of Table 6 from NSW Transport Corridor Advertising and Signage Guidelines*



The zones referred to in the table are different to the Environmental Zones in AS/NZS4282 and are defined as follows:

**“Zone 1** covers areas with generally very high off-street ambient lighting, e.g. display centres similar to Kings Cross in Sydney, and Central Business District locations. This would normally be expected to include land zoned B8 Metropolitan Centre and may include land zoned B3 Commercial Core or B4 Mixed Use, but does not exclude other land use zones.

**Zone 2** covers areas with generally high off-street ambient lighting e.g. some major shopping/commercial centres with a significant number of off-street illuminated advertising devices and lights. This could be expected to include land zoned B3 Commercial Core or B4 Mixed Use, but does not exclude other land use zones.

**Zone 3** covers areas with generally medium off-street ambient lighting e.g. small to medium shopping/commercial centres. This would normally be expected to include land zoned B1 Neighbourhood Centre and B2 Local Centre, but does not exclude other land use zones.

**Zone 4** covers areas with generally low levels of off-street ambient lighting e.g. most rural areas, or areas that have residential properties nearby. This would normally be expected to include most RU Rural land use zones apart from the RU5 Village zone, but does not exclude other land use zones.”

## **5. CASA Manual of Standards Part 139-Aerodromes- section 9.21**

The CASA (Civil Aviation Safety Authority) Standard relates to the potential confusion for pilots landing at a local aerodrome. This only relates to lights within specific corridors around the approach to the runways.

The zone of control for CASA is shown in Annexure B.

## 6. PROPOSED SIGNAGE

The location of site is shown below.



*Figure 6.1 – Western Distributor, Pyrmont*



Figure 6.2 –Photomontage sign 1



Figure 6.3 –Photomontage sign 2



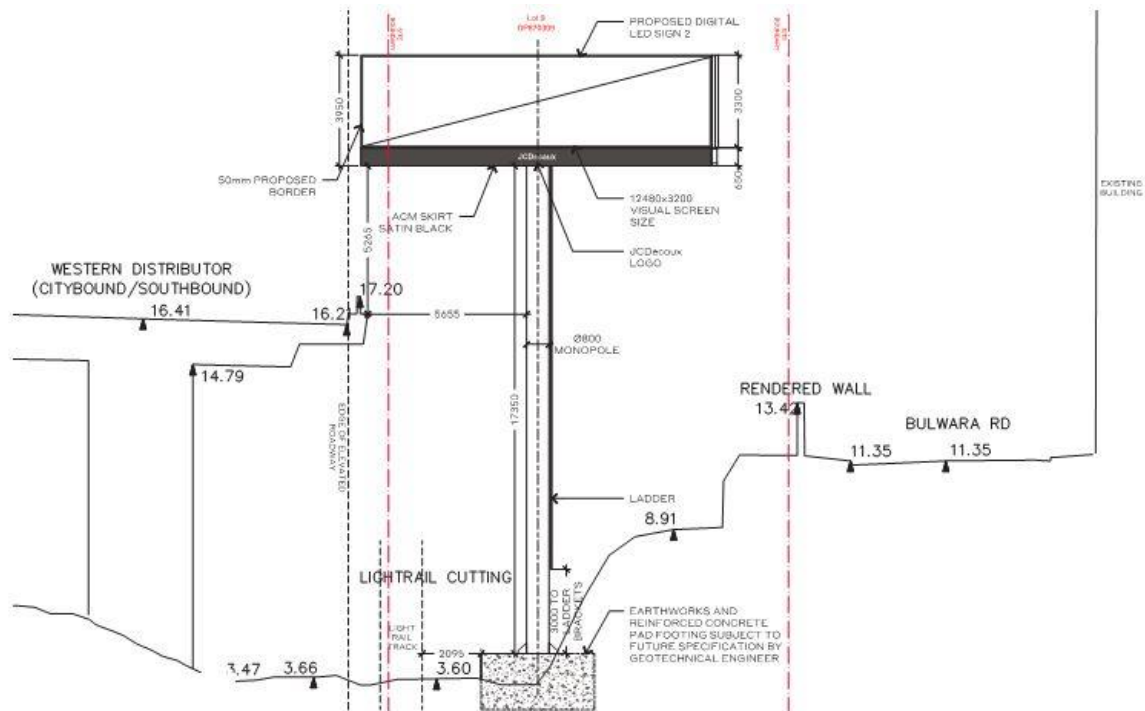


Figure 6.4 – Elevation sign 2

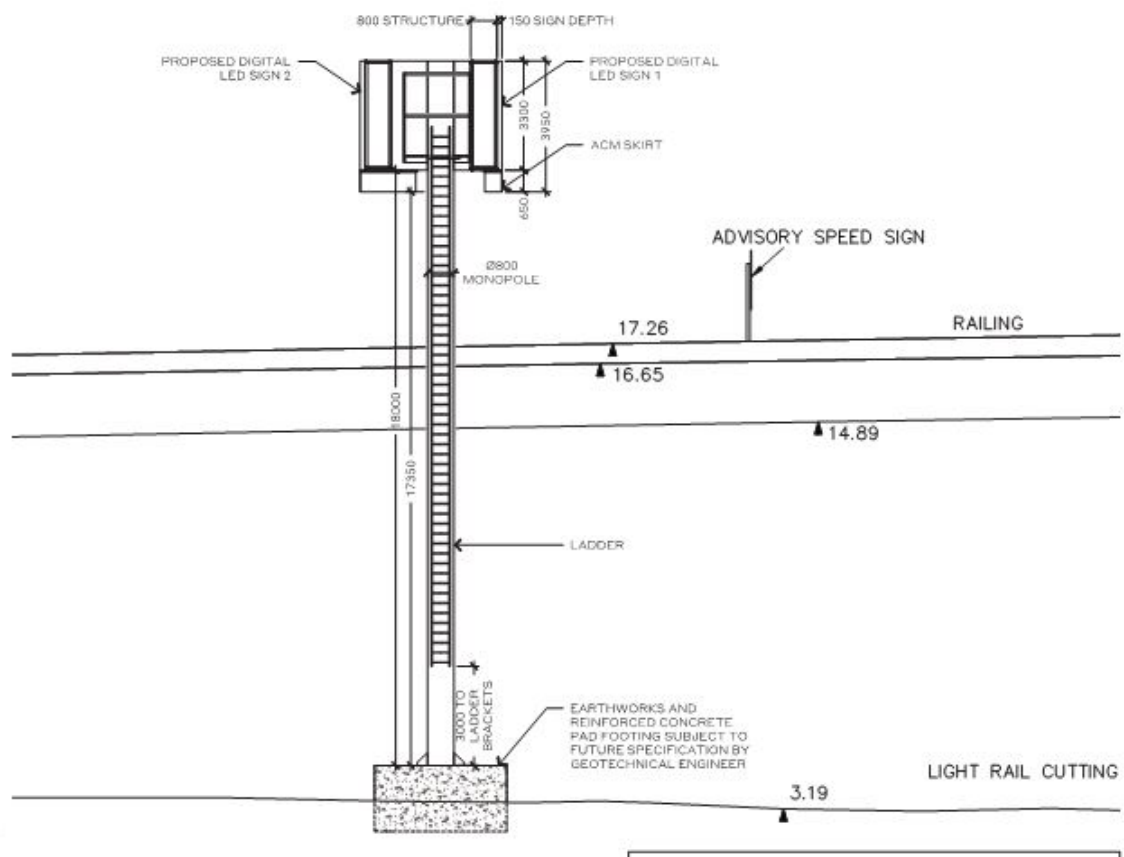
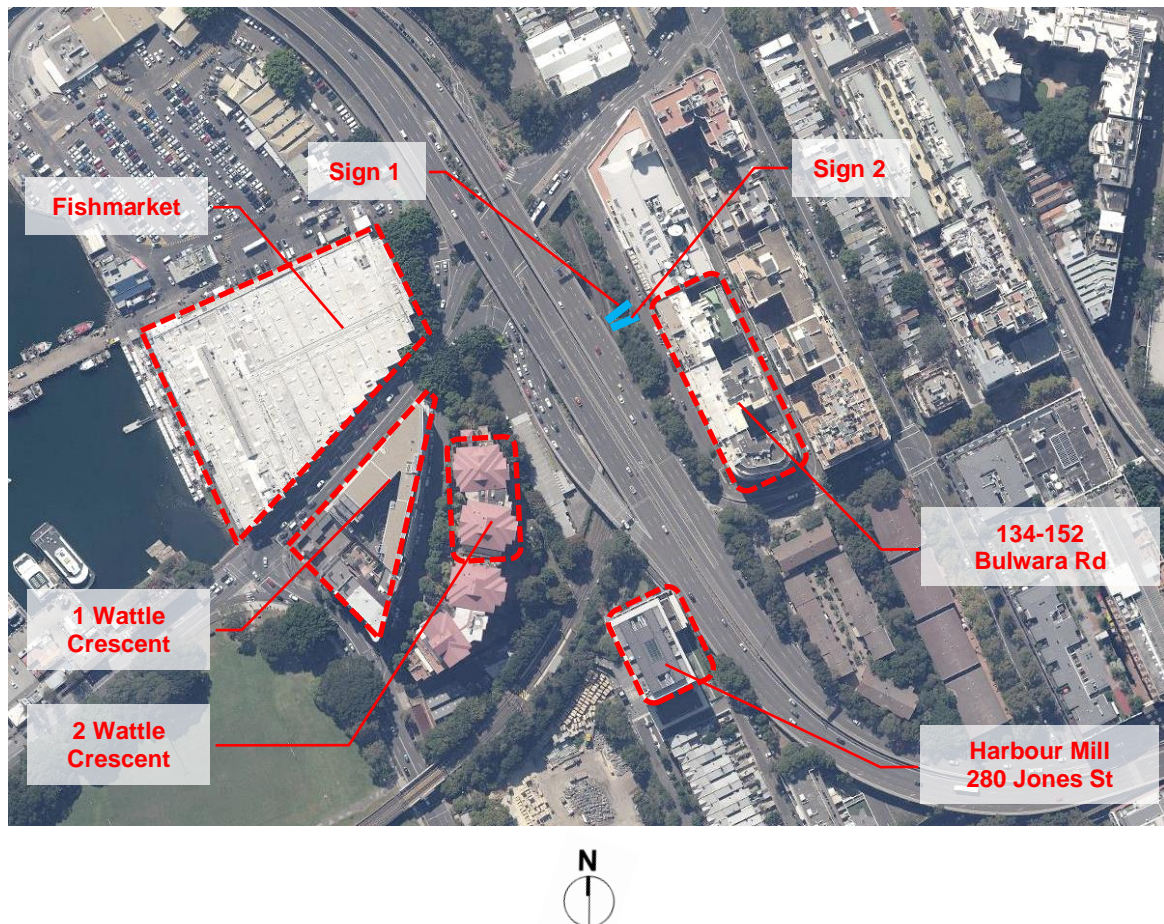


Figure 6.5 – Side elevation

The pole mounted signs are located to the east of the Western distributor near Bulwara Road.

Sign 1 faces the Fishmarket where new development is proposed that may or may not include residential properties.

Sign 2 faces the residential properties on Bulwara Road, as well as some residential properties located further away, including apartment buildings on 1 & 2 Wattle Crescent, and the Harbour Mill building on 280 Jones Street.



*Figure 6.6 – Plan showing residential sites*

## 7. PARAMETERS

The proposed signs will be a LED sign with variable image content.

There has not been a sign supplier appointed at this stage, so we have based the design on generic sign elements.

We have assessed the signs using a Lambertian source to represent a sign module.

The Lambertian model has a slightly wider distribution than the typical sign and therefore is a conservative estimate of the impact on surrounding residences.

The signs have a variable light output to optimise visibility by day and night.

The proposed sign will have the following physical parameters:

Parameter	Value	Comment
Overall Height	3.3m (3.2m visual screen width)	
Overall Width	15.5m (12.4m visual screen width)	
Module Height	365.76mm Nominal	Refer Note 1
Module Width	365.76mm Nominal	
Number of Modules	306 (34 across x 9 high)	Refer Note 1
Maximum Daylight Luminance	6000 Cd/m <sup>2</sup>	Refer Note 2

Note 1: The size and therefore the number of modules can vary from brand to brand of sign technology.

Note 2: The Maximum Luminance shall be set to 6000 Cd/m<sup>2</sup>.

**Table 7.1 Physical Parameters**

Based on the location of the sign we believe that the applicable environmental limits/zones and LTPs will be as follows:

Environmental Zone to AS/NZS 4282	Zone A4
NSW Transport Corridor Advertising and Signage Guidelines	Zone 3
Maximum Vertical Illuminance – Non-Curfew	25 lx
Maximum Vertical Illuminance – Curfew	5 lx
Maximum Threshold Increment	20% @ L <sub>ad</sub> =5
Maximum average Luminance of Surface	350 cd
Upward Light Output Ratio	50%

**Table 7.2 Applicable limits**

## 8. METHODOLOGY

A site inspection was undertaken on 21 July 2020 to identify residential dwellings surrounding the site and to identify any permanent obstructions to the view of the sign.

The luminance of the sign was taken from the typical technical information for the sign modules.

The specification of the Daktronics DVX-1801-10MN-6000-WN has been included in Annexure C as a typical example of the sign technology and performance.

As the signs have a variable output the night-time luminance can be varied to meet the limits in AS/NZS4282 and the NSW Transport Guidelines.

The sign and the surroundings were modelled using AGI32 an industry standard lighting modelling software with a specific module to calculate obtrusive light to AS/NZS4282.

The Light Technical Parameters were calculated at the night-time average luminance limit in AS/NZS4282 and the NSW Transport Guidelines for the appropriate environmental zones.

If one of the LTPs failed to conform at an average luminance of 350 cd/m<sup>2</sup>, the average luminance of the sign was reduced to achieve conformance. This then sets the maximum average luminance that could be used at night-time.

This model generated a compliance statement relating to the threshold increment and the vertical illuminance. The report and prints of the model are included in Annexure D.



## 9. CONFORMANCE

Table 9.1 summarises the results of the assessment and the level of conformance for sign 1.

Light Technical Parameter	Required Limit	Calculated Result	Dimming level	Conformance
NSWTAG Morning and evening twilight and inclement weather	6000 cd/m <sup>2</sup>	Level set to comply	100% or dimmed to 6000cd/m <sup>2</sup> (Reference Level)	YES
NSWTAG Daytime Luminance	700 cd/m <sup>2</sup>	Level set to comply	12% of Reference Level	YES
NSWTAG Night-time Luminance	350 cd/m <sup>2</sup>	Level set to comply	6% of Reference Level	YES
Maximum Average Luminance as per AS/NZS 4282 table 3.5 Non-Curfew L1	350 cd/m <sup>2</sup>	Level set to comply with threshold increment	276 cd/m <sup>2</sup> 4.6% of Reference Level	YES
Maximum Average Luminance Curfew	350 cd/m <sup>2</sup>	Level set to comply with threshold increment	276 cd/m <sup>2</sup> 4.6% of Reference Level	YES
Maximum Vertical illuminance Non-Curfew L1	25 lux	Level set to comply with threshold increment	0.5 lux 4.6% of Reference Level	YES
Maximum Vertical illuminance Curfew	5 lux	Level set to comply with threshold increment	0.5 lux 4.6% of Reference Level	YES
Maximum Threshold Increment Result Non-Curfew L1 (Annexure C)	20% at L <sub>ad</sub> =5	Level set to comply	20% 4.6% of Reference Level	YES
Maximum Threshold Increment Result Curfew (Annexure C)	20% at L <sub>ad</sub> =5N	Level set to comply	20% 4.6% of Reference Level	YES
CASA MoS Pt 139	Not Applicable in this location	N/A	N/A	N/A
Upward Waste Light Ratio	50%		49.2%	49.2%

*Table 9-1: Summary conformance sign 1*

Table 9.2 summarises the results of the assessment and the level of conformance for sign 2.

Light Technical Parameter	Required Limit	Calculated Result	Dimming level	Conformance
NSWTAG Morning and evening twilight and inclement weather	6000 cd/m <sup>2</sup>	Level set to comply	100% or dimmed to 6000cd/m <sup>2</sup> (Reference Level)	YES
NSWTAG Daytime Luminance	700 cd/m <sup>2</sup>	Level set to comply	12% of Reference Level	YES
NSWTAG Night-time Luminance	350 cd/m <sup>2</sup>	Level set to comply	6% of Reference Level	YES
Maximum Average Luminance as per AS/NZS 4282 table 3.5 Non-Curfew L1	350 cd/m <sup>2</sup>	Level set to comply	348 cd/m <sup>2</sup> 5.8% of Reference Level	YES
Maximum Average Luminance Curfew	350 cd/m <sup>2</sup>	Level set to comply with vertical illuminance	156 cd/m <sup>2</sup> 2.6% of Reference Level	YES
Maximum Vertical illuminance Non-Curfew L1	25 lux	Level set to comply with luminance	11.0 lux 5.8% of Reference Level	YES
Maximum Vertical illuminance Curfew	5 lux	Level set to comply	4.9 lux 2.6% of Reference Level	YES
Maximum Threshold Increment Result Non-Curfew L1 (Annexure C)	20% at L <sub>ad</sub> =5	Level set to comply with luminance	4% 5.8% of Reference Level	YES
Maximum Threshold Increment Result Curfew (Annexure C)	20% at L <sub>ad</sub> =5N	Level set to comply with vertical illuminance	2% 2.6% of Reference Level	YES
CASA MoS Pt 139	Not Applicable in this location	N/A	N/A	N/A
Upward Waste Light Ratio	50%		49.2%	YES

*Table 9-2: Summary conformance sign 2*



## 10. CONCLUSION

The proposed signage is fully compliant with the lighting limits of:

- AS/NZS4282: *Control of obtrusive effects of outdoor lighting*,
- NSW Transport Corridor Advertising and Signage Guidelines (NSWTAG)
- CASA Manual of Standards Part 139-Aerodromes- section 9.21 (CASA MoS Pt 139)

Subject to the dimming levels nominated in table 9.1 and 9.2.



## 11. REFERENCES:

- a) AS/NZS4282:2019
- b) NSW Transport Corridor Advertising and Signage Guidelines
- c) CASA Manual of Standards Part 139-Aerodromes- section 9.21
- d) Daktronics Product Specification DVX-1801-10MN-6000-WN (Typical Example)

## 12. ANNEXURE A – Relevant tables from AS/NZS4282

**TABLE 3.2**  
**MAXIMUM VALUES OF LIGHT TECHNICAL PARAMETERS**

Zones	Vertical illuminance levels ( $E_v$ ) lx		Threshold increment (TI)		Sky glow
	Non-curfew	Curfew	%	Default adaptation level ( $L_{ad}$ )	Upward light ratio
A0	See Note 1	0	N/A	N/A	0
A1	2	0.1	N/A	N/A	0
A2	5	1	20%	0.2	0.01
A3	10	2	20%	1	0.02
A4	25	5	20%	5	0.03
TV	See Table 3.4	N/A	20%	10	0.08
V	N/A	4	Note 2	Note 2	Note 2
R1	N/A	1	20%	0.1	Note 3
R2	N/A	2	20%	0.1	Note 3
R3	N/A	4	20%	0.1	Note 3
RX	N/A	4	20%	5	Note 4

**NOTES:**

- 1 For A0,  $E_v$  shall be as close to zero as practicable without impacting safety considerations.
- 2 Refer to AS/NZS 1158.1.1.
- 3 Refer to AS/NZS 1158.3.1.
- 4 Refer to AS/NZS 1158.4.
- 5 N/A means 'Not Applicable'.
- 6 For an internally illuminated sign in an A2 zone,  $L_{ad} \leq 0.25$  cd/m<sup>2</sup>.

**TABLE 3.5**  
**MAXIMUM AVERAGE LUMINANCE  
OF SURFACES (cd/m<sup>2</sup>)**

Application conditions	Environmental zones				
	A0	A1	A2	A3	A4
See Clause 3.3.5.4	0.1	0.1	150	250	350

## 13. ANNEXURE B – CASA Control Area

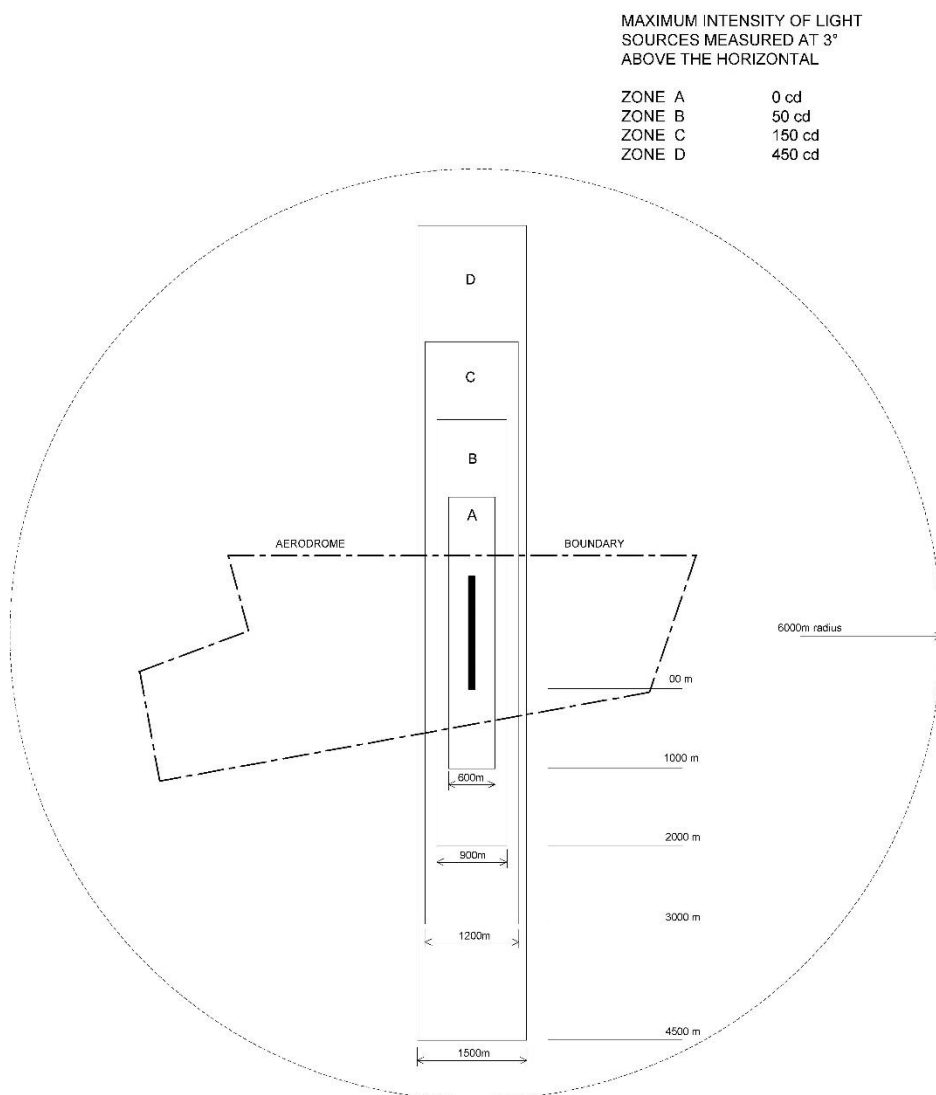


Figure 9.21-1: Maximum lighting intensities



## 14. ANNEXURE C – Typical Sign Modules

# DAKTRONICS PRODUCT SPECIFICATION

## SERIES SPECIFICATION

### DVX-1801-10MN-6000-WN

Pixel Configuration	RGB 3-in-1 SMD
Line and Column Spacing	0.4 inches - 10.16 millimeters
Module Configuration - Pixels (RxC)	36 x 36 pixels
Module Dimensions (HxW)	14.4 x 14.4 inches - 365.76 x 365.76 mm
Maximum Power per Module <sup>1</sup>	76.0752 Watts
Average Power per Module <sup>1</sup>	20 Watts
Display Weight per Module <sup>2</sup>	15.9 pounds - 7.21 kilograms
Processing	22 bit Distributed
Color Capacity	16 bit (281 Trillion Colors)
Dimming	256 levels
Color Temperature	3,000°-10,000° kelvin (adjustable)
Calibration	Full depth, LED to LED
LED Refresh Rate	4800 hertz
LED Lifetime	100,000 hrs
Brightness - Typical Nits	6000 nits (cd/sm)
Horizontal Viewing Angle	160°
Vertical Viewing Angle (Up/Down)	+25/-45°
Contrast Ratio	1200:1
Service Access	Front or Rear
Cabinet Depth	8.716 inches - 221.38 millimeters
Cabinet Construction	Steel and Aluminum (corrosion resistant)
Ingress Protection Rating	IP-66 Rated Components
Working Temperature Rating <sup>3</sup>	-40° to 113° F - -40° to 45° C
Ventilation	Fan, Internal Deflector, Vent Panel
Data Transmission to Display	Direct: Fiberoptic Cable Remote: Internet/Network (IP)

Note 1: Power draw varies depending on display ventilation.

Note 2: Display Weight per Module factors in cabinet, but not the structure.

Note 3: Temperature range is based on typical usage (100% daytime brightness, 50% content, 250W/m<sup>2</sup> solar, no wind).

Note 4: Ventilation solution may require external supplemental A/C in some areas of the world. Please consult your Daktronics representative regarding your area.

Note 5: Consistent with Daktronics policy of continuing product improvement, specifications shown on this document are subject to change without notice.

## DISPLAY SPECIFICATION

### DVX-1801-10MN-6000-WN-HC-468X828-120v-MT-MR-CNTRM

Active Screen Size (HxW)	15.6 feet x 27.6 feet - 4.75 meters x 8.41 meters
Active Screen Size (Square Dimensions)	430.56 square feet - 39.95 square meters
Number of Modules (HxW)	13 Modules x 23 Modules
Total Modules	299 Modules
Matrix Size (HxW)	468 pixels x 828 pixels
Aspect Ratio	0.5652 (Reference - 16:9 = .5625 and 4:3 = .75)
Display Weight	4754.1 lb - 2155.79 kg
Display Weight per Square Dimension	12 lb/sq. ft - 54 kg/sq. m
Total Average Power Consumed	5980 Watts
Total Maximum Power Consumed	22747 Watts
Maximum Power Consumption per Square Dimension	52.8 W/sq. ft - 569.4W/sq. m
Current Draw	103.4 amps @ 220v 1P - 33 amps @ 380/415v 3P - 94.8 amps @ 120/240v - 63.2 amps @ 208Y/120v 3P
Control Method	Rack Mount Control System

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