

AS 2144:2023



STANDARDS
Australia



Traffic signal lanterns



AS 2144:2023

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Traffic signal lanterns

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Preface

This Standard was prepared by Standards Australia Committee LG-006, Road Traffic Signals, to supersede AS 2144:2014.

The objective of this document is to specify requirements for the design, construction and performance of traffic signal lanterns that control the movement of vehicles, including bicycles, and pedestrians.

This document is one of a number of Standards on equipment associated with traffic signal installations. A list of these Standards can be found in the Standards Australia online catalogue.

The major changes in this edition are as follows:

- (a) Addition of pedestrian countdown timer requirements.
- (b) Revision of dimming control requirements
- (c) Removal of prescriptive 5mm LED size to ensure any LED size is covered.
- (d) Revision of LED longevity requirements.
- (e) Revision of environmental test requirements.
- (f) Revision of signal switching response time.

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance

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Introduction

The document includes requirements for the dimensions of certain features of traffic signal lanterns and associated components, arising from a specific desire by road and traffic authorities for uniformity in the appearance of traffic signalling equipment to road users and from the need to facilitate the compatibility of equipment from different manufacturers.

NOTE 1 [Appendix D](#) gives recommended dimensions for visors and the attachment of target boards in order to achieve interchangeability between components supplied by different manufacturers.

The photometric requirements for vehicular lanterns have been derived from the considerable body of research which has been conducted in Australia into factors affecting the visibility of these signals.

NOTE 2 See Further reading list in the Bibliography.

The photometric requirements apply to new lanterns. In service, the photometric performance will deteriorate, sometimes appreciably. Therefore, to ensure that the lanterns continue to perform at a satisfactory level, a maintenance program will be necessary.

NOTES

Australian Standard®

Traffic signal lanterns

Section 1 Scope and general

1.1 Scope

This document specifies requirements for the design, construction and performance of traffic signal lanterns that control the movement of vehicles, including bicycles, and pedestrians.

This document does not apply to external control equipment that may be necessary for the functioning of the lanterns.

For vehicular lanterns, two basic levels of performance are specified for general purpose lanterns and for extended range lanterns. Requirements are also specified for lanterns that display symbols.

NOTE 1 Refer to the AS 1742 series for requirements relating to the use of traffic signal lanterns in the control of vehicular and pedestrian traffic.

NOTE 2 See [Appendix A](#) for the information to accompany an inquiry or order for traffic signal lanterns covered by this document.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1214, *Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)*

AS 1275, *Metric screw threads for fasteners*

AS 1742.14, *Manual of uniform traffic control devices, Part 14: Traffic signals*

AS 2339, *Traffic signal posts and attachments*

AS 60068.2.2, *Environmental testing, Part 2.2: Tests—Tests B: Dry heat*

AS 60068.2.6, *Environmental testing, Part 2.6: Tests—Test Fc: Vibration (sinusoidal)*

AS 60068.2.14, *Environmental testing, Part 2.14: Tests—Test N: Change of temperature*

AS 60529, *Degrees of protection provided by enclosures (IP Code)*

AS/NZS 2053 (all parts), *Conduits and fittings for electrical installations*

AS/NZS 3100, *Approval and test specification—General requirements for electrical equipment*

AS/NZS 3123, *Approval and test specification—Plugs, socket-outlets and couplers for general industrial application*

AS/NZS 5000.1, *Electric cables—Polymeric insulated, Part 1: For working voltages up to and including 0.6/1 (1.2) kV*

AS/NZS 61000.6.1:2006, *Electromagnetic compatibility (EMC), Part 6.1 Generic standards—Immunity for residential, commercial and light-industrial environments*

AS/NZS 61558 (all parts), *Safety of transformers, reactors, power supply units and combinations thereof*

IEC 60068-2-52, *Environmental testing: Salt mist, cyclic (sodium chloride solution)*

IEC 60998-2-1, *Connecting devices for low-voltage circuits for household and similar purposes, Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units*

IEC 60998-2-2, *Connecting devices for low-voltage circuits for household and similar purposes, Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units*

ISO/CIE 19476, *Characterization of the performance of illuminance meters and luminance meters*

CIE 015, *Colorimetry*

CIE 018, *The basis of physical photometry*

CIE 233, *Calibration, characterization and use of array spectroradiometers*

ANSI/IES LM-80, *Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules*

ANSI/IES TM-21, *Projecting Long-Term Luminous, Photon, and Radiant Flux Maintenance of LED Light Sources*

IEEE 1789, *Recommended practices for modulating current in high-brightness LEDs for mitigating health risks to viewers*

1.3 Terms and definitions

For the purposes of this document, the terms and definitions in AS 1852.845 and the following apply.

1.3.1

aspect

single optical system of a traffic signal lantern

1.3.2

beam axis

<for vehicular lanterns> axis about which the luminous intensity distribution is substantially symmetrical

Note 1 to entry: See [Clause B.3.1](#) for the method for determining beam axis.

1.3.3

bicycle lantern

lantern that controls bicycle traffic

1.3.4

chromaticity

property of a colour stimulus defined by its *chromaticity coordinates* ([1.3.5](#)), or by its dominant or complementary wavelength and purity taken together

Note 1 to entry: The chromaticity is a quantitative representation of a colour quality, usually expressed by the chromaticity coordinates.

[SOURCE: CIE S 017/E:2020, 17-23-052, modified – Notes 1 and 2 to entry replaced with new Note 1]

1.3.5

chromaticity coordinates

coordinates expressing the quotients of each of a set of three tristimulus values and their sum

Note 1 to entry: As the sum of the three chromaticity coordinates is equal to 1, two of them are sufficient to define a chromaticity

Note 2 to entry: In the CIE standard colorimetric systems, the chromaticity coordinates are represented by the symbols x , y , z or x_{10} , y_{10} , z_{10} .

Note 3 to entry: The chromaticity coordinates have unit one.

Note 4 to entry: The chromaticity coordinates are a numerical representation of a chromaticity.

[SOURCE: CIE S 017/E:2020, 17-23-053, modified – Notes 4 and 5 to entry replaced with new Note 4]

1.3.6

diffuser

component of an optical system used to alter the spatial distribution of radiation and depending essentially on the phenomenon of diffusion

1.3.7

dimmed state

state where luminous intensity lies between 50 % and 65 % (inclusive) of full output of the *light source* ([1.3.18](#))

Note 1 to entry: See [Clause 6.5](#).

1.3.8

extended range lantern

vehicular lantern with a light output and distribution which is suitable for traffic signalling applications that require recognition by vehicle drivers from distances of up to 240 m

Note 1 to entry: These lanterns are available with a nominal signal diameter of 300 mm. Conformance to [Clause 3.3.3](#) and [Tables 3.4](#), [3.5](#) or [3.6](#), as appropriate, determines whether a lantern is of the extended range type.

1.3.9

flicker frequency

dominant frequency of the light output

1.3.10

flicker percentage

quotient of the difference between the maximum and minimum instantaneous luminous intensity to the average luminous intensity, multiplied by 100

Note 1 to entry: The flicker percentage is usually evaluated over one power line cycle, nominally 20 ms in Australia

1.3.11

general purpose lantern

vehicular lantern with a light output and distribution which is suitable for traffic signalling applications that require recognition by vehicle drivers from distances of up to 100 m

Note 1 to entry: These lanterns commonly have nominal signal diameters of 200 mm. Conformance to [Clause 3.3.3](#) and [Tables 3.1](#), [3.2](#), [3.3](#), [3.7](#) or [3.8](#), as appropriate, determines whether a lantern is of the general purpose type.

1.3.12

geometric axis

straight line through the geometric centre of the face of the *aspect* ([1.3.1](#)) under test, perpendicular to the axis through the mounting studs

1.3.13

goniometer

instrument capable of rotation about two axes which are mutually perpendicular, each axis having an angular scale

1.3.14 illuminance

E_v ; E

density of incident *luminous flux* (1.3.20) with respect to area at a point on a real or imaginary surface

$$E_v = \frac{d\Phi_v}{dA}$$

where

Φ_v = luminous flux

A = the area on which the luminous flux is incident

Note 1 to entry: Illuminance can be derived from the spectral irradiance distribution by

$$E_v = K_m \int_0^{\infty} E_{e,\lambda}(\lambda) V(\lambda) d\lambda$$

where

K_m = maximum luminous efficacy

$E_{e,\lambda}(\lambda)$ = spectral irradiance at wavelength λ

$V(\lambda)$ = spectral luminous efficiency.

Note 2 to entry: The corresponding radiometric quantity is “irradiance”. The corresponding quantity for photons is “photon irradiance”.

Note 3 to entry: The illuminance is expressed in lux ($lx = lm \cdot m^{-2}$).

Note 4 to entry: The illuminance is a measure of how much visible light is incident on a real or imaginary surface in space. It is linked to the spectrum of the light through the $V(\lambda)d\lambda$ function.

[SOURCE: CIE S 017/E:2020, 17–21–060, modified – Notes 4 and 5 to entry replaced with new Note 4]

1.3.15 intrinsic sun-phantom

luminous intensity of a simulated sun-phantom signal

Note 1 to entry: It is measured under the conditions specified in [Clause B.3.5](#).

Note 2 to entry: Measurements of intrinsic sun-phantom are made without masks and detachable external devices (e.g. visors and louvres) fitted. Such measurements give an indication of the inherent susceptibility of an aspect to sun-phantom.

1.3.16 lantern face

group of *aspects* (1.3.1) on a lantern which apply to traffic approaching from one direction

1.3.17 lens

element of the optical system which distributes the luminous flux from the light source into preferred directions and which may filter the light to give the desired signal colour

1.3.18 light source

one or more light emitting devices within an *aspect* (1.3.1)

Note 1 to entry: Light emitting devices are typically mounted on one printed circuit board and arranged to all point in the one direction.

1.3.19 luminance

L_v ; L

density of *luminous intensity* (1.3.21) with respect to projected area in a specified direction at a specified point on a real or imaginary surface

$$L_v = \frac{dI_v}{dA \cos \alpha}$$

where

I_v = luminous intensity

A = area

α = angle between the normal to the surface at the specified point and the specified direction

Note 1 to entry: In a practical sense, the definition of luminance can be thought of as dividing a real or imaginary surface into an infinite number of infinitesimally small surfaces which can be considered as point sources, each of which has a specific luminous intensity, I_v , in the specified direction. The luminance of the surface is then the integral of these luminance elements over the whole surface.

The equation in the definition can mathematically be interpreted as a derivative (i.e. a rate of change of luminous intensity with projected area) and could alternatively be rewritten in terms of the average luminous intensity, $\bar{I}_v$, as:

$$L_v = \lim_{A \rightarrow 0} \frac{\bar{I}_v}{A} \frac{1}{\cos \alpha}$$

Hence, luminance is often considered as a quotient of averaged quantities; the area, A , should be small enough so that uncertainties due to variations in luminous intensity within that area are negligible; otherwise, the quotient

$$\bar{L}_v = \frac{\bar{I}_v}{A} \frac{1}{\cos \alpha}$$

gives the average luminance and the specific measurement conditions have to be reported with the result.

Note 2 to entry: For a surface being irradiated, an equivalent formula in terms of illuminance, E_v , and solid angle, Ω , is

$$L_v = \frac{dE_v}{d\Omega \cos \theta}$$

where

θ = the angle between the normal to the surface being irradiated and the direction of irradiation.

This form is useful when the source has no surface (e.g. the sky, the plasma of a discharge).

Note 3 to entry: An equivalent formula is

$$L_v = \frac{d\Phi_v}{dG}$$

where

Φ_v = luminous flux

G = geometric extent

Note 4 to entry: Luminous flux can be obtained by integrating luminance over projected area, $A \cdot \cos \alpha$, and solid angle, Ω : —

$$\Phi_v = \iint L_v \cdot \cos \alpha \, dA \, d\Omega$$

Note 5 to entry: Since the optical extent, expressed by $G \cdot n^2$, where G is geometric extent and n is refractive index, is invariant, the quantity expressed by $L_v \cdot n^{-2}$ is also invariant along the path of the beam if the losses by absorption, reflection and diffusion are taken as 0. That quantity is called “basic luminance”.

Note 6 to entry: The equation in the definition can also be described as a function of luminous flux, Φ_v . In this case, it is mathematically interpreted as a second partial derivative of the luminous flux at a specified point (x, y) in space in a specified direction (ϑ, φ) with respect to projected area, $A \cdot \cos \alpha$, and solid angle, Ω

$$L_v(x, y, \vartheta, \varphi) = \frac{\partial^2 \Phi_v(x, y, \vartheta, \varphi)}{\partial A(x, y) \cdot \cos \alpha \cdot \partial \Omega(\vartheta, \varphi)}$$

where

α = angle between the normal to that area at the specified point and the specified direction

Note 7 to entry: The corresponding radiometric quantity is “radiance”. The corresponding quantity for photons is “photon radiance”.

Note 8 to entry: The luminance is expressed in candela per square metre ($\text{cd} \cdot \text{m}^{-2} = \text{lm} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$).

Note 9 to entry: The luminance is a measure of the apparent brightness of the visible light emitted from a surface or object. It is linked to the spectrum of the light through the $V(\lambda)$ function.

[SOURCE: CIE S 017/E:2020, 17–21–050, modified – Notes 9 and 10 to entry replaced with new Note 9]

1.3.20

luminous flux

Φ_v ; Φ

change in luminous energy with time

$$\Phi_v = \frac{dQ_v}{dt}$$

where

Q_v = luminous energy emitted, transferred or received

t = time

Note 1 to entry: Luminous flux is a quantity derived from the radiant flux, Φ_e , by evaluating the radiation according to its action upon the CIE standard photometric observer. Luminous flux can be derived from the spectral radiant flux distribution by

$$\Phi_v = K_m \int_0^\infty \Phi_{e,\lambda}(\lambda) V(\lambda) d\lambda$$

where

K_m = maximum luminous efficacy

$\Phi_{e,\lambda}(\lambda)$ = spectral radiant flux

$V(\lambda)$ = spectral luminous efficiency

λ = wavelength.

Note 2 to entry: The distribution of the luminous intensities as a function of the direction of emission, e.g. given by the polar angles (ϑ, φ) , is used to determine the luminous flux, Φ_v , within a certain solid angle, Ω , of a source:

$$\Phi_v = \iint_{\Omega} I_v(\vartheta, \varphi) \sin \vartheta \, d\varphi \, d\vartheta$$

Note 3 to entry: The corresponding radiometric quantity is “radiant flux”. The corresponding quantity for photons is “[photon flux](#)”.

Note 4 to entry: The luminous flux is expressed in lumen (lm).

Note 5 to entry: The luminous flux is a measure of how much visible light is generated by a source, transmitted through a space, incident on a surface, etc. It is linked to the spectrum of the light through the $V(\lambda)$ function.

[SOURCE: CIE S 017/E:2020, 17-21-039, modified – Notes 5 and 6 to entry replaced with new Note 5]

1.3.21 luminous intensity

I_v ; I

density of *luminous flux* ([1.3.20](#)) with respect to solid angle in a specified direction

$$I_v = \frac{d\Phi_v}{d\Omega}$$

where

Φ_v = luminous flux emitted in a specified direction

Ω = solid angle containing that direction

Note 1 to entry: For practical realization of the quantity, the source is approximated by a point source.

Note 2 to entry: The distribution of the luminous intensities as a function of the direction of emission, e.g. given by the polar angles (ϑ, φ), is used to determine the luminous flux, Φ_v , within a certain [solid angle](#), Ω , of a source:

$$\Phi_v = \iint_{\Omega} I_v(\vartheta, \varphi) \sin \vartheta \, d\varphi \, d\vartheta$$

Note 3 to entry: Luminous intensity can be derived from the spectral radiant intensity distribution by

$$I_v = K_m \int_0^{\infty} I_{e,\lambda}(\lambda) V(\lambda) d\lambda$$

where

K_m = maximum luminous efficacy

$I_{e,\lambda}(\lambda)$ = spectral radiant intensity at wavelength λ

$V(\lambda)$ = spectral luminous efficiency

Note 4 to entry: The corresponding radiometric quantity is “radiant intensity”. The corresponding quantity for photons is “photon intensity”.

Note 5 to entry: The luminous intensity is expressed in candela (cd = lm·sr⁻¹).

Note 6 to entry: The luminous intensity is a measure of how much visible light is emitted by a source in a particular direction. It is linked to the spectrum of the light through the $V(\lambda)$ function.

[SOURCE: CIE S 017/E:2020, 17-21-045, modified – Notes 6 and 7 to entry replaced with new Note 6]

1.3.22

may

indicates the existence of an option

1.3.23**optical system**

assembly of components designed to produce a light or light pattern of specified size, colour, luminous intensity and shape

1.3.24**pedestrian clearance period**

time between the green “Walk” signal and the fixed red “Don’t walk” signal

1.3.25**pedestrian countdown timer**

don’t walk display that uses a numeric display timer in place of a flashing “Don’t walk” symbol

1.3.26**pedestrian lantern**

lantern that controls pedestrian traffic

1.3.27**shall**

indicates that a statement is mandatory

1.3.28**should**

indicates a recommendation

1.3.29**signal**

visual indication provided by an illuminated *aspect* ([1.3.1](#))

1.3.30**sun-phantom**

reflection of sunlight and skylight from the optical surfaces of an *aspect* ([1.3.1](#)) such that it could be mistaken for the “on” state of the *aspect* ([1.3.1](#))

1.3.31**target board**

panel surrounding the lantern to improve the visibility of the signal

1.3.32**traffic signal lantern**

assembly comprising one or more *aspects* ([1.3.1](#)), together with means of connecting them to the power supply and facilities for mounting the complete assembly

Note 1 to entry: In this document, the term “lantern” is used in place of “traffic signal lantern”.

1.3.33**vehicular aspect**

aspect ([1.3.1](#)) that primarily controls road vehicle traffic

Note 1 to entry: This does not include bicycle or pedestrian aspects.

1.3.34**veiling reflection**

reflection of incident light (assumed to be white) from an *aspect* ([1.3.1](#)) that appears white or desaturated in colour

1.3.35**visor**

attachment to the signal face to minimize sun-phantom or veiling reflection effects or to reduce the possibility of a signal being seen by traffic for which it is not intended

1.4 Marking

Each removable aspect of a lantern and the lantern itself shall be legibly and durably marked with the following information, as applicable:

- (a) The name, trade name or trademark of the manufacturer or responsible supplier.
- (b) The batch code, serial number, or other marking to identify the month and year of manufacture.

NOTE 1 Lanterns should be marked in accordance with AS/NZS ISO 9001 to facilitate product identification and traceability as required for the application of quality management systems of that Standard.

- (c) The catalogue number or similar plus any other information necessary to obtain, either directly or from supplied manufacturers' information, all details required to replace each separately supplied component of the aspect or lantern, as applicable.

NOTE 2 Examples of such information include LED specifications, part numbers of LED arrays, and the pattern details for arrays with LEDs of varying angular distribution.

- (d) On printed circuit boards and aspects, clear and permanent identification when de-energized as to the colour when illuminated. Acceptable means include labelling and colour coding.
- (e) The rated voltage of the electrical supply on which the lantern is designed to operate, see [Clause 5.2](#).
- (f) Identification of supply conductors and connecting terminals as specified in [Table 5.1](#).
- (g) Any additional markings necessary for the correct selection of replacement parts and installation of all parts in the appropriate location and orientation for the lantern to meet all applicable performance requirements of this document.

1.5 Testing

Laboratories that perform the tests specified in this document shall meet the requirements of AS ISO/IEC 17025.

NOTE Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories may be able to offer accreditation against the requirements of AS ISO/IEC 17025. A listing of ILAC signatories is available from the ILAC website (www.ilac.org). In Australia and New Zealand, the National Association of Testing Authorities (NATA), Joint Accreditation System of Australia and New Zealand (JAS-ANZ) and International Accreditation New Zealand (IANZ) are signatories to the ILAC MRA.

Section 2 Signal colours and displays

2.1 Signal colours

When tested in accordance with [Appendix B](#), the colour of the light emitted by each aspect of the lantern (defined in terms of its chromaticity coordinates) shall fall within the area of a CIE 1931 chromaticity diagram bounded by the spectrum locus or straight lines (as applicable) joining the appropriate reference points in [Table 2.1](#).

NOTE Refer to CIE 015 or AS/NZS 2633 for further information about the chromaticity diagram.

Light sources in any aspect shall be the same nominal colour.

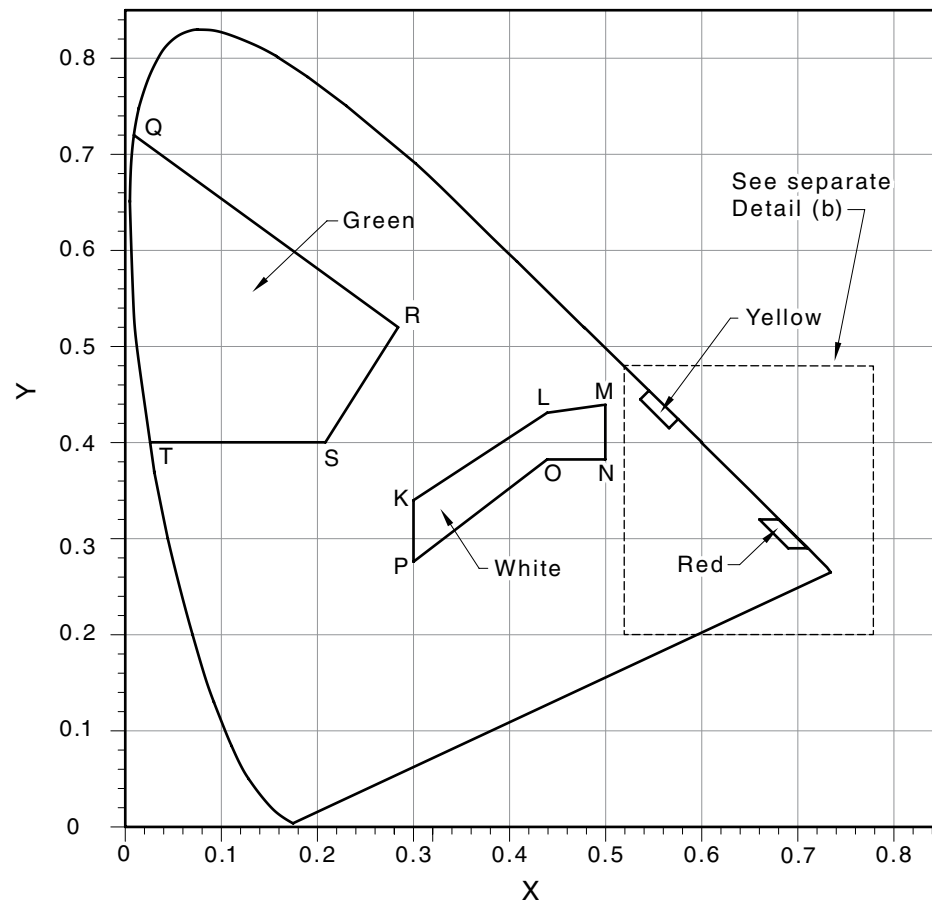
2.2 Signal displays

Individual aspects of the lantern shall be arranged so that the colours and types of signal displayed on the lantern face meet the relevant requirements of AS 1742.14.

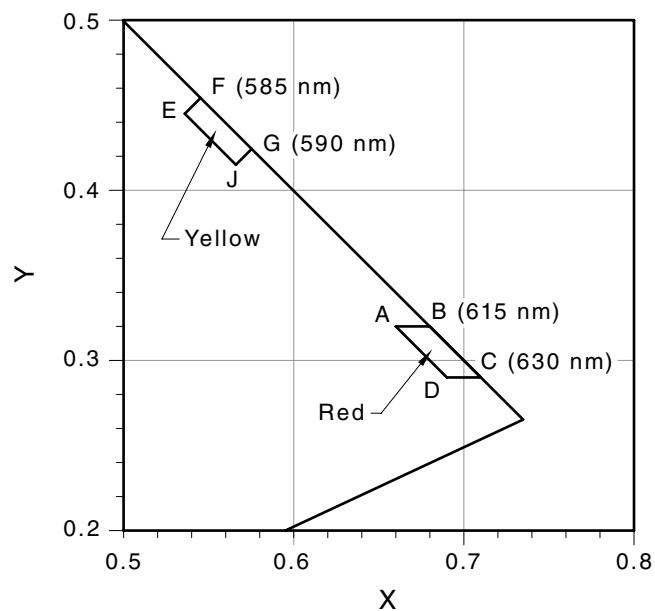
Table 2.1 — Signal colour boundaries

Colour of signal	Reference point (see Figure 2.1)	Chromaticity coordinates	
		<i>x</i>	<i>y</i>
Red	A	0.660	0.320
	B	0.680	0.320
	C	0.710	0.290
	D	0.690	0.290
Yellow	E	0.536	0.444
	F	0.547	0.452
	G	0.575	0.424
	J	0.566	0.415
Green	Q	0.009	0.720
	R	0.284	0.520
	S	0.209	0.400
	T	0.028	0.400
White	K	0.300	0.342
	L	0.440	0.432
	M	0.500	0.440
	N	0.500	0.382
	O	0.440	0.382
	P	0.300	0.276

NOTE Other than for yellow, limits are those within the chromaticity boundaries recommended in CIE S 004.



(a) All relevant colours



(b) Details of boundaries for red and yellow

Figure 2.1 — Signal colour boundaries illustrated on a CIE 1931 chromaticity diagram

Section 3 Photometric performance

3.1 General

This section specifies requirements for the luminous intensity of aspects in general appearance and measured luminous intensity distributions. It sets out different requirements for general purpose and extended range aspects.

It also sets out requirements for —

- (a) aspects that display symbols such as arrows, “Walk” and “Don’t walk” symbols;
- (b) symbols for bicycles, buses and trams and filled arrangements of aspects with and without diffusers, lenses and the like; and
- (c) limits related to sun-phantom and veiling reflection behaviour.

3.2 Appearance of vehicular aspects with a circular display

Each aspect shall present a uniform appearance, free from excessively bright or dark spots or sectors over the whole of the lens, when viewed from angles within the range 0° to 20° down and 0° to 25° left and right, relative to the beam axis.

3.3 Luminous intensity distribution of vehicular aspects with a circular display

3.3.1 Background technical information

The luminous intensity distributions in [Tables 3.1](#) to [3.3](#) are based on the analysis of Fisher and Cole. The luminous intensity distributions in [Tables 3.4](#) to [3.6](#) are based on the extension of this work by Hulscher (1974).

The requirements of [Tables 3.1](#) to [3.3](#) are based on the assumption that the aspect will be aimed at a point approximately 100 m from the aspect face and approximately 1.5 m above the road surface at the centre of the carriageway allocated to approaching traffic.

The requirements of [Tables 3.4](#) to [3.6](#) are based on the assumption that the aspect will be aimed at a point located at the same height and position relative to the boundaries of the carriageway but approximately 240 m from the face of the aspect.

The luminous intensities specified in [Tables 3.1](#) to [3.6](#) refer to new lanterns in clean condition. The specified values include an allowance for the reduction in light output which will occur over 100 000 h for red and green, and 100 000 h for yellow run only 10 % of the time, together with a reduction in light output due to the soiling of the optical surfaces of the lantern under average operating conditions.

NOTE The method by which the luminous intensities specified in [Tables 3.1](#) to [3.6](#) are derived is given in [Appendix C](#).

3.3.2 General conditions and exceptions

3.3.2.1 Non installation-related information

The luminous intensities specified in [Clause 3.3.3](#) shall be achieved with —

- (a) visors and optional accessories (e.g. louvres) not fitted; and
- (b) any devices necessary for conformance to [Clause 3.10](#) in place.

All light sources shall have the same nominal angular distribution of luminous intensity.

The beam axis shall not differ by more than 1° up or 5° down or more than 2.5° left or right from the geometric axis.

The luminous intensity at any point that is one of a left/right symmetrical pair may be up to 20 % below the specified minimum value provided that the mean of the intensities at these two points is not less than that minimum value.

For red and green signals, the maximum luminous intensity shall not exceed —

- (i) 1 500 cd while not in a dimmed state; and
- (ii) 1 000 cd in a dimmed state.

at angles within the range 0° to 20° down and 0° to 25° left and right relative to the beam axis.

NOTE 1 See [Appendix B](#) for requirements regarding the measurement of luminous intensities including the normalization of readings.

NOTE 2 Maximum intensities are not specified for yellow signals in view of the relatively short intervals for which such signals are normally displayed. The maximum luminous intensity of 1 000 cd should limit glare at night for signals used on roads with Category V lighting conforming to AS/NZS 1158.1.1. However, if traffic signals are to be used on roads with Category P lighting conforming to AS/NZS 1158.3.1 or on roads which are unlit, the use of aspects with intensities not greater than 350 cd (Ref. Schmidt-Clausen, 1974) should be considered, particularly where flashing yellow displays are used.

3.3.2.2 Installation-related information

The circular aspects of a lantern with luminous intensity distributions as specified in [Tables 3.1 to 3.6](#) provide an easily seen signal, when the background sky luminance is as high as 10 000 cd/m², at distances up to —

- (a) 100 m for general purpose aspects; and
- (b) 240 m for extended range aspects,

with the signal remaining clearly visible on the approach to it, provided that —

- (i) the height of any aspect above the road surface does not exceed 6 m;
- (ii) the lantern is laterally offset from the driver's line of travel by no more than 6 m; and
- (iii) a target board of the type specified in [Clause 7.6](#) is fitted to the lantern to isolate the signal from the background.

If this is not the case, higher values of luminous intensity may be required (Fisher and Cole).

If a lantern meets the requirements for both general purpose and extended range use, it shall be defined as one or the other according to its intended role as installed.

3.3.3 Vehicular aspects with a circular display

The luminous intensities provided by an aspect, measured and normalized in accordance with [Appendix B](#) and under the conditions specified in [Clause 3.3.2](#), shall be not less than the values in [Tables 3.1 to 3.6](#), as applicable.

Table 3.1 — Distribution of luminous intensity from general purpose red aspects

Degrees down from beam axis	Minimum normalized luminous intensity, cd						
	Degrees left and right from beam axis						
	0	5	7.5	10	15	20	25
0	250	250	—	125	—	—	—
3	250	—	125	—	—	—	—
5	125	—	—	—	—	19	—
7.5	—	—	—	—	31	—	—
10	31	—	—	—	—	—	—
15	—	—	—	—	—	—	19
20	19	—	—	—	—	—	—

Table 3.2 — Distribution of luminous intensity from general purpose yellow aspects

Degrees down from beam axis	Minimum normalized luminous intensity, cd						
	Degrees left and right from beam axis						
	0	5	7.5	10	15	20	25
0	520	520	—	260	—	—	—
3	520	—	260	—	—	—	—
5	260	—	—	—	—	39	—
7.5	—	—	—	—	65	—	—
10	65	—	—	—	—	—	—
15	—	—	—	—	—	—	39
20	39	—	—	—	—	—	—

Table 3.3 — Distribution of luminous intensity from general purpose green aspects

Degrees down from beam axis	Minimum normalized luminous intensity, cd						
	Degrees left and right from beam axis						
	0	5	7.5	10	15	20	25
0	275	275	—	138	—	—	—
3	275	—	138	—	—	—	—
5	138	—	—	—	—	21	—
7.5	—	—	—	—	34	—	—
10	34	—	—	—	—	—	—
15	—	—	—	—	—	—	21
20	21	—	—	—	—	—	—

Table 3.4 — Distribution of luminous intensity from extended range red aspects

Degrees down from beam axis	Minimum normalized luminous intensity, cd							
	Degrees left and right from beam axis							
	0	2.5	5	7.5	10	15	20	25
0	750	750	250	—	125	—	—	—
1.5	750	—	—	—	—	—	—	—
3	250	—	—	125	—	—	—	—
5	125	—	—	—	—	—	19	—
7.5	—	—	—	—	—	31	—	—
10	31	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	19
20	19	—	—	—	—	—	—	—

Table 3.5 — Distribution of luminous intensity from extended range yellow aspects

Degrees down from beam axis	Minimum normalized luminous intensity, cd							
	Degrees left and right from beam axis							
	0	2.5	5	7.5	10	15	20	25
0	1560	1560	520	—	260	—	—	—
1.5	1560	—	—	—	—	—	—	—
3	520	—	—	260	—	—	—	—
5	260	—	—	—	—	—	39	—
7.5	—	—	—	—	—	65	—	—
10	65	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	39
20	39	—	—	—	—	—	—	—

Table 3.6 — Distribution of luminous intensity from extended range green aspects

Degrees down from beam axis	Minimum normalized luminous intensity, cd							
	Degrees left and right from beam axis							
	0	2.5	5	7.5	10	15	20	25
0	825	825	275	—	138	—	—	—
1.5	825	—	—	—	—	—	—	—
3	275	—	—	138	—	—	—	—
5	138	—	—	—	—	—	21	—
7.5	—	—	—	—	—	34	—	—
10	34	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	21
20	21	—	—	—	—	—	—	—

3.3.4 Additional requirements for HPSM LEDs

The lumen depreciation of HPSM light sources shall be measured in accordance with ANSI/IES LM-80 and calculated to L70 in accordance with ANSI/IES TM-21.

3.3.5 Other technologies

For technologies other than LEDs, different as-new luminous intensities will apply as the degradation in light output over time will be different from that of the LED technology.

NOTE The means of determining these minimum as-new luminous intensities for technologies other than LEDs is given in [Appendix C](#) and will require knowledge of their light output degradation over 100 000 h and the maintenance factors relating to soiling of their optical surfaces.

3.4 Appearance of vehicular aspects that display symbols

Symbols displayed by vehicular aspects shall conform to the relevant requirements of [Clause 7.3](#).

Vehicular aspects that display a symbol (e.g. a directional arrow) shall present a uniform appearance. The illuminated part of each vehicular aspect shall be free from excessively bright or dark spots or sectors (see [Figures 7.1 to 7.5](#) and [Figure 7.9](#), as applicable), over the whole of the display when viewed from any angle within the range 0° to 10° down and 0° to 15° left and right, relative to the geometric axis.

Symbols displayed on vehicular aspects shall not be of the outline type.

3.5 Luminance distribution of vehicular aspects that display symbols

3.5.1 Background technical information

For vehicular aspects that display symbols, the following considerations relating to luminance distribution should be taken into account:

- (a) The luminous intensities provided by the signal should be sufficiently high for it to be detected from 100 m for general purpose lanterns and 240 m for extended range lanterns. Masking of the signal face (see [Clause 7.3](#)) will result in a considerable reduction in the luminous intensities provided. The reduction in luminous intensity will be approximately proportionate to the ratio of the luminous area of the masked signal to that of the unmasked signal. The detection range of the signal will be reduced in proportion to the square root of this ratio.
- (b) The symbol displayed should be recognizable in order to convey the required message. Legibility of the symbol is mainly dependent on its size and contrast (luminance in relation to the ambient light). Increasing the luminous intensity of the signal will improve the detection range but may result in a reduction of the legibility of the symbol, especially at night, due to a visual phenomenon known as halation. It is for this reason that a maximum luminance limit has been specified.

3.5.2 Luminance

The luminance of the display, measured in accordance with [Clause B.3.4](#), shall be —

- (a) not greater than 9 000 cd/m² for green, red and white signals; and
- (b) not more than 2.5 times this value for yellow signals.

Where a diffuser is used, the variation between the measured luminances of all the test areas shall be not greater than 6:1.

The measured and normalized luminance values shall be in accordance with [Table 3.7](#).

Table 3.7 — Minimum luminance of symbols displayed by vehicular lanterns

Directions for measurements in vertical plane	Colour of aspect	Minimum average luminance of test areas, cd/m ²	
		Directions for measurements in horizontal plane	
		On geometric axis	15° either side of geometric axis
On geometric axis	Red	5 000	1 500
	Yellow	10 400	3 120
	Green, white	5 500	1 650
10° below geometric axis	Red	1 500	1 500
	Yellow	3 120	3 120
	Green, white	1 650	1 650

3.6 Appearance of pedestrian and bicycle aspects that display symbols

The symbol displayed by a pedestrian or bicycle aspect shall be as shown in [Figures 7.6, 7.7](#) or [7.8](#), as applicable.

When energized, the illuminated symbol shall present a uniform appearance, free from excessively dark spots or sectors, over the whole of the display when viewed from angles within the range 0° to 15° down and 0° to 15° left and right, relative to the geometric axis. The symbol shall be inconspicuous when the signal is not energized.

Other than for aspects that include a pedestrian countdown timer, pedestrian and bicycle aspects that display symbols shall be constructed such that the symbols are defined by masks and the light source is viewed through a diffuser.

For aspects that include a pedestrian countdown timer, neither a mask nor a diffuser shall be used.

3.7 Luminance distribution of pedestrian and bicycle aspects that display symbols

3.7.1 Diffused aspects

When measured —

- (a) in accordance with [Clause B.3.](#); and
- (b) in each of the directions specified in [Figure 3.1](#), with the background surrounding the symbol having negligible light transmission so that it appears black to the viewer,

the luminance of the display shall be within the range specified in [Table 3.8](#). For each direction of measurement, the average of the luminance values for all of the specified measurement locations shall be not less than the applicable minimum value specified in [Table 3.8](#).

NOTE See [Clause B.3.4.1](#) for information on measurements.

Table 3.8 — Luminance requirements — Diffused pedestrian and bicycle aspects

Light source	Display luminance range		Average luminance for each direction
	cd/m ²		cd/m ²
Red	≥ 625	≤ 3 000	≥ 1 250
Yellow	≥ 1 300	≤ 7 500	≥ 2 600
Green or white	≥ 685	≤ 3 000	≥ 1 370

3.7.2 Non-diffused aspects

When measured —

- (a) in accordance with [Clause B.3.4](#); and
- (b) in each of the directions specified in [Figure 3.1](#), with the background surrounding the symbol having negligible light transmission so that it appears black to the viewer,

the luminance of the display shall be within the applicable range specified in [Table 3.9](#).

Table 3.9 — Luminance requirements — Non-diffused pedestrian and bicycle aspects

Light source	Minimum average luminance for each direction cd/m ²	Maximum average luminance for each direction cd/m ²
Red	1 250	3 000
Yellow	2 600	7 500
Green or white	1 370	3 000

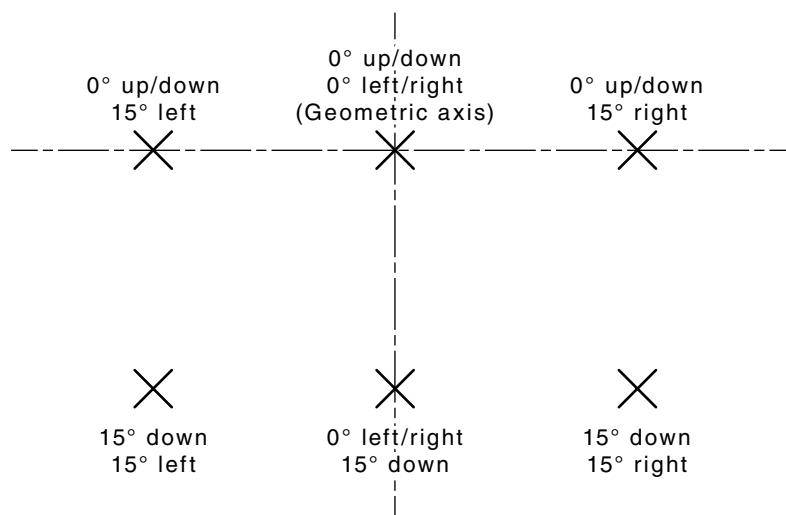


Figure 3.1 — Measuring the luminance of pedestrian and bicycle lanterns

3.8 Pedestrian countdown timer

3.8.1 Physical requirements

The pedestrian countdown timer (PCT) shall be included as part of the “Don’t walk” aspect.

The countdown timer display within the PCT shall have its own connection to the power source. The additional core with which to power the PCT shall be of a voltage applicable to the lantern.

3.8.2 Display requirements

Display requirements for the PCT are as follows:

- (a) The PCT shall be constructed with two seven-segment displays.
- (b) The PCT shall be capable of displaying digits between 1 and 99 inclusive, representing the time in seconds remaining within the pedestrian clearance period.
- (c) Each seven-segment display of the PCT shall not display two consecutive digits simultaneously.