

Australian/New Zealand Standard™

Traffic signal lanterns

AS/NZS 2144:2002

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Traffic signal lanterns

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee LG-006 Road Traffic Signals to supersede AS 2144—1995. It is one of a number of Standards which set out requirements for the equipment associated with traffic signal installations. These include the following:

AS

- 2339 Traffic signal posts and attachments
- 2353 Pedestrian push-button assemblies
- 2578 Traffic signal controllers
- 2578.1 Part 1: Physical and electrical compatibility
- 2703 Vehicle loop detector sensors
- 2979 Traffic signal mast arms
- 4113 Traffic signal lamps
- 4113.1 Part 1: Lamps for 240 V a.c. operation
- 4113.2 Part 2: Lamps for a.c. operation at extra-low voltage
- 4191 Portable traffic signal systems

AS/NZS

- 2144 Traffic signal lanterns (this Standard)
- 4192 Illuminated flashing arrow signs

The Standard includes requirements for the dimensions of certain features of traffic signal lanterns and associated components, arising from a specific desire on the part of 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. In particular, Appendix F gives recommended dimensions for the attachment of visors and target boards which have the objective of achieving interchangeability between components supplied by different manufacturers.

The requirements have the objective of ensuring that, with the exception of replaceable items such as lamps and LED arrays, lanterns will continue to function effectively for a period of at least 20 years; furthermore, that surface finishes applied to the exterior of lanterns (e.g. powder coatings, paint) will last for at least 10 years without the need for further treatment.

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 (see references in Appendix C).

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.

It is recommended that the tests necessary to determine compliance with this Standard be conducted by laboratories that are independently accredited as having competence to carry out the type of measurements involved.

A number of changes have been introduced in this edition, all with the objective of enlarging the scope of the Standard to cover traffic signals using light emitting diodes (LEDs) as the light source.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard Traffic signal lanterns

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for the design, construction and performance of traffic signal lanterns that use either incandescent, or light emitting diode (LED) light sources and are intended to control the movement of vehicles, including bicycles, and pedestrians. It does not apply to the control equipment that may be necessary for the functioning of the lanterns.

For vehicular lanterns, two basic levels of performance are specified, namely, for general purpose lanterns and for extended range lanterns. Requirements are also specified for a variety of special purpose lanterns.

NOTES:

- 1 Requirements for the use of traffic signal lanterns in the control of vehicular and pedestrian traffic are set out in the AS 1742 series.
- 2 See Appendix A for the information which should be supplied with an inquiry or order for traffic signal lanterns to this Standard.

1.2 REFERENCED DOCUMENTS

The Standards referred to in this document are listed in Appendix B.

NOTE: See Appendix C for bibliographical details of other sources of information.

1.3 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

NOTE: Definitions of lighting quantities are of the simplified form given in AS 3665, which are intended to convey a basic understanding of the concepts involved. For the more precise primary definitions of these terms reference should be made to AS 1852.845.

1.3.1 Aspect

A single optical system of a traffic signal lantern, capable of being illuminated at any given time.

1.3.2 Beam axis (for vehicular lanterns)

A straight line passing through the geometric centre of the lens in the direction of maximum intensity of the light emitted by the lantern, as determined in accordance with Paragraph D3.1 of Appendix D.

1.3.3 Bicycle lantern

A lantern which is intended for the control of bicycle traffic.

1.3.4 Chromaticity

A term referring to colour quality expressed numerically.

1.3.5 Chromaticity coordinates

Two numbers that fix the position of a point on a colour diagram in order to numerically and graphically represent the colour of an object or light source.

NOTE: In essence the numbers represent the proportions of two of three primary colours in a mixture that matches the colour specified. These proportions are often expressed in terms of the coordinates x, y in the CIE colorimetric system (see AS 2633).

1.3.6 Extended range lantern

A 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: Extended range lanterns are available with nominal signal diameters of 200 mm and 300 mm. Compliance with Clause 3.3.3 or 3.3.4 Table 3.2, 3.6, 3.7 or 3.8, all as appropriate, is the determinant of whether a lantern is of the extended range type.

1.3.7 Extra low voltage

Voltages not exceeding 50 V a.c. or 120 V ripple-free d.c. (refer also to Clause 1.3.22).

1.3.8 False sun signal

Any instance where the apparent state of a signal aspect is caused by incident light (assumed to be white) and is incorrect.

NOTE: False sun signals can be caused by sun phantom (an 'off' signal appears 'on' – refer to Clause 1.3.24) or by veiling reflections (an 'on' signal is obscured or appears white or of indeterminate colour – refer to Clause 1.3.28).

1.3.9 General purpose lantern

A 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: General purpose lanterns commonly have nominal signal diameters of 200 mm. However, compliance with Clause 3.3.3 or 3.3.4 and Table 3.1, 3.3., 3.4 or 3.5 all as appropriate, is the determinant of whether a lantern is of the general purpose type. In the case of a lantern that complies with 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.

1.3.10 Geometric axis

A straight line through the geometric centre of the face of the aspect under test, perpendicular to the axis through the mounting studs.

1.3.11 Intrinsic sun-phantom

The luminous intensity of a simulated sun-phantom signal, measured under the conditions specified in Paragraph D3.5.1 of Appendix D.

NOTE: 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.

1.3.12 Lantern face

A group of aspects on a lantern which apply to traffic approaching from one direction.

1.3.13 Light sources

(a) *Incandescent light source*

A lamp using a heated filament to produce light. Also referred to as a 'tungsten' lamp. Includes quartz-halogen and tungsten halogen lamps.

(b) *LED light source*

One or more light emitting diodes (LEDs), typically mounted on one printed circuit board and arranged to all point in the one direction.

1.3.14 LED lens diameter

The diameter of the (circular) light emitting lens or face of a light emitting diode.

1.3.15 LED

Light emitting diode.

1.3.16 Lens

An 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.

1.3.17 Luminance

The physical quantity corresponding to the brightness of a surface (e.g. a lamp, luminaire, sky or reflecting material) in a specified direction. It is the luminous intensity of an area of the surface divided by that area.

Unit: Candela per square metre (cd/m^2). Symbol: L .

1.3.18 Luminous flux

The measure of the quantity of light. For a lamp or luminaire it normally refers to the total light emitted irrespective of the directions in which it is distributed.

Unit: lumen (lm). Symbol: Φ .

1.3.19 Luminous intensity

The concentration of luminous flux emitted in a specified direction.

Unit: candela (cd). Symbol: I .

1.3.20 Optical system

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

1.3.21 Pedestrian lantern

A lantern which is intended for the control of pedestrian traffic.

1.3.22 Ripple-free d.c.

A direct current with a superimposed sinusoidal ripple voltage, the ripple content having an r.m.s. value not exceeding 10% of the total peak value.

1.3.23 Signal

The visual indication provided by an illuminated aspect.

1.3.24 Sun-phantom

A reflection of sunlight and skylight from the optical surfaces of an aspect such that it could be mistaken for the 'on' state of the aspect. (Refer also to Clause 1.3.8).

1.3.25 Target board

A panel surrounding the lantern to improve the visibility of the signal.

1.3.26 Traffic signal lantern

An assembly comprising one or more aspects, together with means of connecting them to the power supply and facilities for mounting the complete assembly.

NOTE: Throughout this Standard a traffic signal lantern is referred to as a 'lantern'.

1.3.27 Vehicular aspect

An aspect which is primarily intended for the control of road vehicle traffic (does not include bicycle or pedestrian aspects).

1.3.28 Veiling reflection

The reflection of incident light (assumed to be white) from an aspect such that the aspect appears white or desaturated in colour. (Refer to also to Clause 1.3.8)

1.3.29 Visor (cowl)

An attachment to the signal face to minimize sun-phantom and veiling illuminance effects or to reduce the possibility of a signal being seen by traffic for which it is not intended, or all three.

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) Batch code, serial number, or other marking to identify the month and year of manufacture.

NOTE: It is recommended that lanterns be marked in accordance with AS/NZS ISO 9001 to facilitate product identification and traceability as required for the application of quality management systems based on the provisions of that Standard.

- (c) The catalogue number or similar plus any other information necessary to obtain, either directly or from manufacturers information supplied, all details required to replace each separately supplied component of the aspect or lantern as applicable. Examples of such information include lamp and LED specifications, part numbers of LED arrays, and the pattern details for arrays with LEDs of varying angular distribution.
- (d) On LED printed circuit boards or 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 5.1.2).
- (f) Identification of supply conductors and connecting terminals in accordance with the requirements of 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 Standard.

NOTE: Manufacturers making a statement of compliance with this joint Australian/New Zealand Standard on a product, packaging, or promotional material related to that product are advised to ensure that such compliance is capable of being verified.

SECTION 2 SIGNAL COLOURS AND DISPLAYS

2.1 SIGNAL COLOURS

2.1.1 All technologies

When tested in accordance with Appendix D, the colour of the light emitted by each individual 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 points specified in Table 2.1.

2.1.2 LED aspects

All LEDs in any aspect must be the same nominal colour.

2.2 SIGNAL DISPLAYS

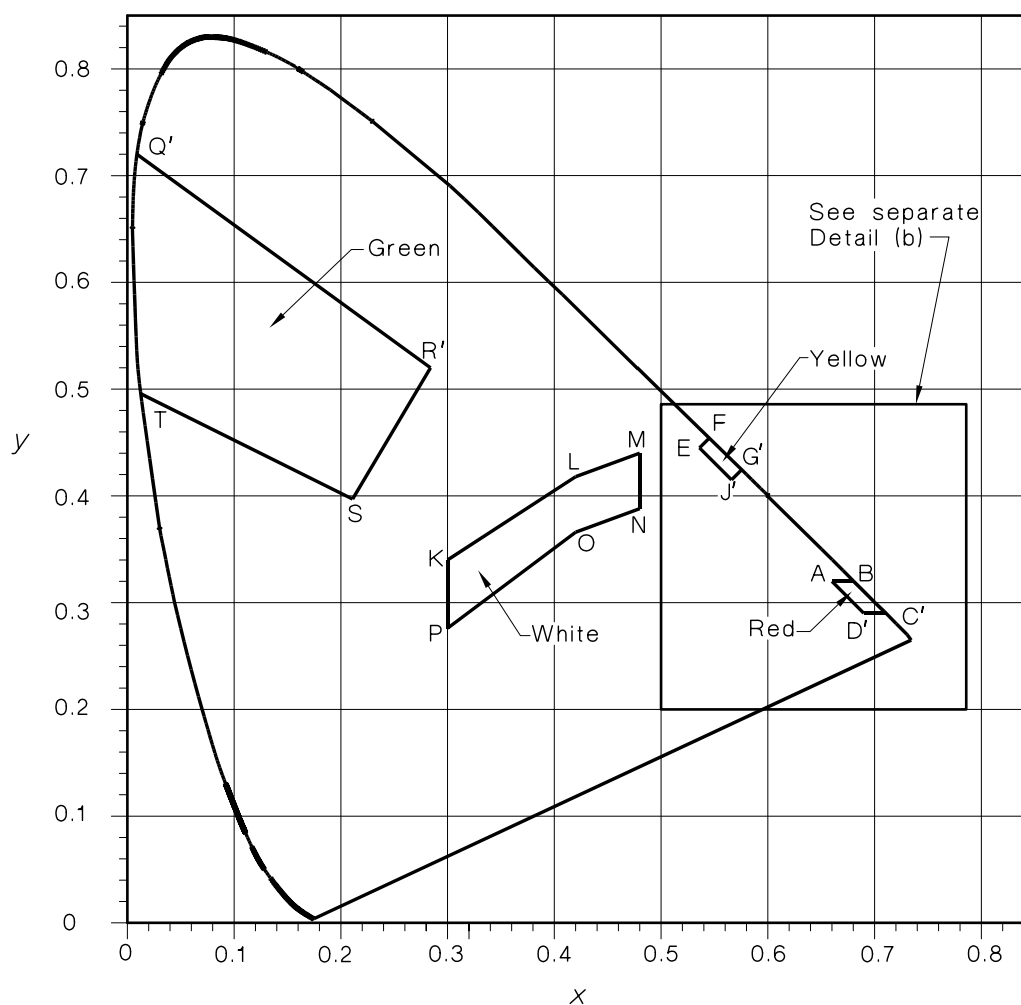
Individual aspects of the lantern shall be arranged so that the colours and types of signal displayed on the lantern face comply with the relevant requirements of AS 1742.14.

TABLE 2.1
SIGNAL COLOUR BOUNDARIES

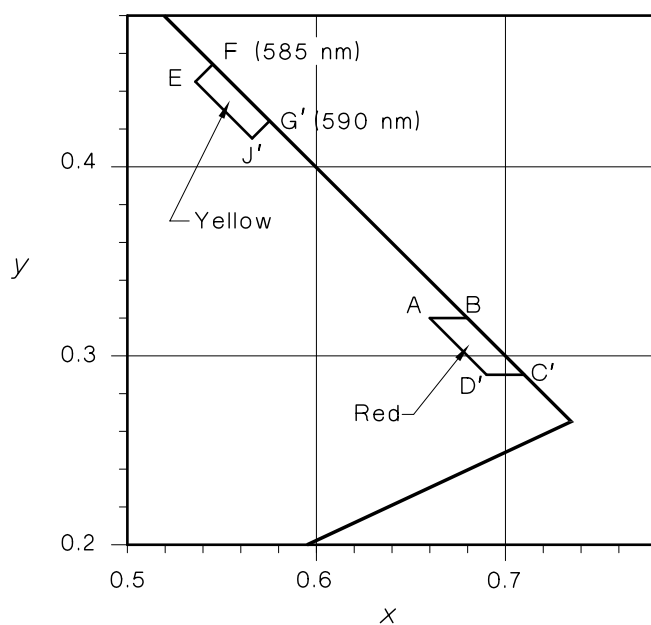
1	2	3	4
Colour of signal	Reference point (See Figure 2.1)	Chromaticity coordinates	
		<i>x</i>	<i>y</i>
Red	A	0.660	0.320
	B	0.680	0.320
	C'	0.710	0.290
	D'	0.690	0.290
Yellow	E	0.536	0.445
	F	0.545	0.454
	G'	0.575	0.424
	J'	0.566	0.415
Green	Q'	0.009	0.720
	R'	0.284	0.520
	S	0.207	0.397
	T	0.012	0.494
White	K	0.300	0.340
	L	0.420	0.418
	M	0.480	0.440
	N	0.480	0.388
	O	0.420	0.366
	P	0.300	0.276

NOTE: The limits specified in Table 2.1 are those recommended in CIE Publication No 107. The limits are illustrated in Figure 2.1 on a CIE 1931 chromaticity diagram.

* See CIE Publication No 15 or AS 2633 for further information about this diagram.



(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, both in terms of general appearance and measured intensity distributions. It does this for both incandescent and LED light sources and, within each source group, sets out different requirements for general purpose and extended range aspects plus symbols such as arrows, pedestrians, bicycles, bus and tram signals. In the case of LED symbols, it specifies different requirements for outline versus filled arrangements of LEDs plus LED aspects with and without diffusers, lens etc. Limits regarding sun phantom and veiling reflection behaviour are also specified.

3.2 APPEARANCE OF VEHICULAR ASPECTS WITH A CIRCULAR DISPLAY

3.2.1 Incandescent light sources

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.

3.2.2 LED light sources

Each aspect should present a pattern of light points that is uniformly distributed across the circular aperture and is uniform in any variation in intensity when viewed from any angle within the viewing range. There should be no single dark patches. The above requirements do not preclude the mixing of LEDs of various angular distributions as each type of LED can be set out in a uniform pattern, with the patterns interrelating.

NOTE: Acceptable patterns include symmetrical matrices, radial lines, radial wedges, single or interlocked spirals and concentric rings of LEDs.

3.3 INTENSITY DISTRIBUTION OF VEHICULAR ASPECTS WITH A CIRCULAR DISPLAY

3.3.1 Background technical information

The intensity distributions in Tables 3.1 and 3.3 to 3.5 are based on the analysis of Fisher and Cole (Ref. 1) and the intensity distributions in Tables 3.2 and 3.6 to 3.8 are based on the extension of this work by Hulscher (Ref.2).

The requirements of Tables 3.1 and 3.3 to 3.5 assume 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 3.2 and 3.6 to 3.8 assume 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 3.8 refer to new lanterns in clean condition. The specified values include an allowance for the reduction in light output which will occur between periodic maintenance operations due to ageing of the lamp and soiling of the optical surfaces of the lantern under average operating conditions over a 100 000 hr (i.e. 10 years) operating period (Ref. 3). In Tables 3.1 and 3.2 this allowance is the same for all three colours. In Tables 3.3 to 3.8 the allowance is different for each colour due to different lumen-loss factors for the different technologies used and a different duty cycle for yellow aspects.

NOTE: Details of the allowances included in each of Tables 3.3 to 3.8 are given in Appendix E.

3.3.2 General conditions and exceptions

3.3.2.1 *Matters independent of means of installation*

Refer to Appendix D for requirements regarding the measurement of luminous intensities, including the normalization of readings.

The luminous intensities required in Clauses 3.3.3 and 3.3.4 shall be achieved with—

- (a) visors and optional accessories (e.g. louvres) not fitted; and
- (b) any devices necessary for compliance with Clause 3.9.1 in place.

The direction 0° down and 0° left and right (the origin of the angular grid set out in Tables 3.1 to 3.8) refers to the beam axis. The beam axis shall not differ by more than 5° down nor 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 value.

For red and green signals, the luminous intensity shall not exceed 1000 cd at angles within the range 1.5° to 20° down and 2.5° to 25° left and right relative to the beam axis. (i.e. this limit shall not apply within the range of 0° to 1.5° down and 2.5° left and right.)

3.3.2.2 *Matters relevant to installation*

NOTE: Maximum intensities are not specified for yellow signals in view of the relatively short intervals for which such signals are normally displayed. The maximum intensity of 1000 cd should limit glare at night for signals used on roads with Category V lighting to AS/NZS 1158 (Parts 1 and 3). However, where traffic signals are to be used on roads with Category P lighting to AS/NZS 1158.3.1, or roads which are unlit, the installing authority should consider the use of aspects with intensities of not greater than 350 cd (Refs 4 and 5), particularly where flashing yellow displays are used.

Under the conditions set out above, the circular aspects of a lantern with intensity distributions in accordance with Table 3.1 to 3.8, as applicable, will provide an easily seen signal, when the background sky luminance is as high as 10 000 cd/m², at distances up to the following:

- (a) General purpose aspects – 100 m
- (b) Extended range aspects – 240 m

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 line of travel by no more than 6 m; and
- (iii) a black target board of the type specified in Clause 7.9 is fitted to the lantern to isolate the signal from the background. If this is not the case, higher values of luminous intensity will be required. (See Ref. 1).

3.3.3 Incandescent vehicular aspects with a circular display

Except where otherwise permitted by this Clause, the luminous intensities provided by an aspect measured in accordance with Appendix D and under the conditions specified in Clause 3.3.2, shall be not less than the values in Table 3.1 or Table 3.2, as applicable, for green signals and red signals, and not less than that set out in the note to each table for yellow signals.

TABLE 3.1
DISTRIBUTION OF LUMINOUS INTENSITY
FROM INCANDESCENT GENERAL PURPOSE 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	200	200	—	100	—	—	—
3	200	—	100	—	—	—	—
5	100	—	—	—	—	15	—
7.5	—	—	—	—	25	—	—
10	25	—	—	—	—	—	—
15	—	—	—	—	—	—	15
20	15	—	—	—	—	—	—

*Limits specified apply to red signals and green signals. For yellow signals multiply specified limits by 2.5.

TABLE 3.2
DISTRIBUTION OF LUMINOUS INTENSITY
FROM INCANDESCENT EXTENDED RANGE 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	600	600	200	—	100	—	—	—
1.5	600	—	—	—	—	—	—	—
3	200	—	—	100	—	—	—	—
5	100	—	—	—	—	—	15	—
7.5	—	—	—	—	—	25	—	—
10	25	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	15
20	15	—	—	—	—	—	—	—

*Limits specified apply to red signals and green signals. For yellow signals multiply specified limits by 2.5.

3.3.4 LED vehicular aspects with a circular display

Except where otherwise permitted by this Clause, the luminous intensities provided by an aspect, measured and normalized in accordance with Appendix D and under the conditions specified in Clause 3.3.2, shall be not less than the values in Tables 3.3 to 3.8 as applicable.

TABLE 3.3
DISTRIBUTION OF LUMINOUS INTENSITY
FROM LED 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 3.4
DISTRIBUTION OF LUMINOUS INTENSITY
FROM LED 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 3.5
DISTRIBUTION OF LUMINOUS INTENSITY
FROM LED 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 3.6
DISTRIBUTION OF LUMINOUS INTENSITY
FROM LED 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 3.7
DISTRIBUTION OF LUMINOUS INTENSITY
FROM LED 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 3.8
DISTRIBUTION OF LUMINOUS INTENSITY
FROM LED 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	—	—	—	—	—	—	—

3.4 APPEARANCE OF VEHICULAR ASPECTS WITH A SYMBOLIC DISPLAY

3.4.1 General

The symbolic displays displayed shall comply with the relevant requirements specified in Clause 7.7.

Each aspect which exhibits a symbolic display (e.g. directional arrow) shall present a uniform appearance, free from excessively bright or dark spots or sectors within the areas intended to be illuminated (Refer to Figures 7.1 to 7.8 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.

Symbolic displays on vehicular aspects shall not be of the outline type.

3.4.2 LED light sources –no diffuser

An undiffused vehicular symbol using LEDs shall be a solid symbol and shall comply with the following:

- As well as an outline of the shape, there shall be at least one additional row of LEDs in the centre of each 'limb' of the figure.
- The centre to centre distance between any two adjacent LEDs shall be not greater than twice the LED lens diameter.
- All LEDs in the array shall have the same nominal angular distribution of intensity.

3.4.3 LED light sources – diffuser fitted to aspect

The requirements for this type of aspect shall be as per Clause 3.4.1.

3.5 LUMINANCE DISTRIBUTION OF VEHICULAR ASPECTS WITH A SYMBOLIC DISPLAY

3.5.1 Background technical information

For symbolic vehicular signals there are two distinct considerations to be taken into account.

First, the luminous intensities provided by the signal must be sufficiently high for it to be detected from an appropriate distance. Masking of the signal face (see Clause 7.7) will result in a considerable reduction in the luminous intensities provided. The reduction in 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.

Second, the symbol displayed must 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 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 irradiation. It is for this reason that a maximum luminance limit has been specified.

3.5.2 Incandescent light sources

The luminance of each of the individual test areas on the display, measured in accordance with Paragraph D3.4, Appendix D, shall be not greater than 9000 cd/m² for green, red and white signals, and not more than 2.5 times this value for yellow signals. In addition, for each direction of measurement, the following requirements shall apply:

- (a) The luminance values measured for all the test areas shall be in accordance with Table 3.9.
- (b) The variation between the measured luminances of all the test areas shall be not greater than 6:1.

TABLE 3.9
MINIMUM LUMINANCE OF INCANDESCENT SYMBOLIC DISPLAYS
FOR 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, green, white	4 000	1 200
	yellow	10 000	3 000
10° below geometric axis	red, green, white	1 200	1 200
	yellow	3 000	3 000

3.5.3 LED light sources

The luminance of the display, measured and normalized in accordance with Appendix D, shall be not greater than the maximum value applicable to the aspect colour (see Clause 3.5.2). In addition, the measured and normalized luminance values shall be in accordance with Table 3.10.

TABLE 3.10
MINIMUM LUMINANCE OF LED SYMBOLIC DISPLAYS
FOR 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 SYMBOL ASPECTS

3.6.1 General

The symbol displayed by a pedestrian or bicycle aspect shall be as shown in Figure 7.5, 7.6 or 7.7 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 symbolic display shall be inconspicuous when the signal is not energized.

3.6.2 LED light sources – no diffuser

This Standard does not specify criteria for compliance for this type of pedestrian or bicycle symbol, therefore such a symbol cannot comply with this Standard.

NOTES:

- 1 This is due to a lack of relevant data.
- 2 Recommendations on various aspects of the design and performance of these types of symbolic displays are contained in Appendix G.

3.6.3 Additional requirements for bicycle symbols

All bicycle symbol aspects shall be constructed such that the outline of the symbol is defined by a mask and the light source is viewed through a diffuser.

3.7 LUMINANCE DISTRIBUTION OF PEDESTRIAN AND BICYCLE SYMBOL ASPECTS

When measured —

- (a) as specified in Paragraph D3.4 of Appendix D, and in accordance with the procedure specified therein; and
- (b) in each of the directions specified in Figure 3.1 with the background surrounding the symbols having negligible light transmission to ensure that it appears black to the viewer.

The luminance of the display shall be within the applicable range set out in Table 3.11 and, 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 figure specified in Table 3.11.

TABLE 3.11
LUMINANCE REQUIREMENTS – PEDESTRIAN AND BICYCLE ASPECTS

Light source	Display luminance range		Average luminance for each direction
	cd/m ²		cd/m ²
Red LED	≥625	≤3000	≥1250
Yellow LED	≥1300	≤7500	≥2600
Green or white LED	≥685	≤3000	≥1370
Red or green incandescent	≥500	≤3000	≥1000
Yellow incandescent	≥1250	≤7500	≥2500

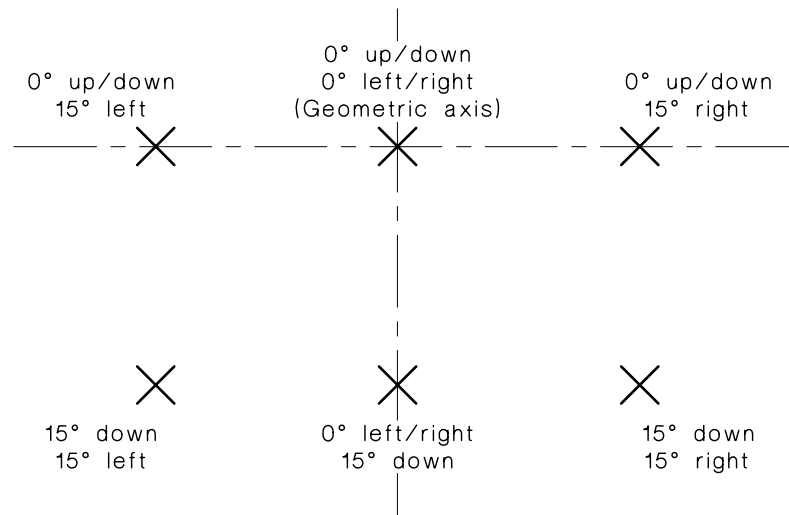


FIGURE 3.1 DIRECTIONS FOR MEASURING THE LUMINANCE OF PEDESTRIAN AND BICYCLE LANTERNS

3.8 VEILING REFLECTIONS

3.8.1 General

Reflections of mainly white light can—

- (a) desaturate the colour of a signal aspect and dilute the contrast between the signal and its background when it is on; or
- (b) produce a white 'signal' when the aspect is off.

Either of these occurrences can cause confusion to drivers.

Each signal display should be arranged, shaped or finished so as to avoid undesirable reflections of the surroundings appearing within the angular zone specified in Clause 3.2 or Clause 3.6, as applicable. Techniques to reduce these reflections include the use of a coloured lens, depolishing the external surface of the display, inclining the face slightly downward, employing a slightly convex face, or by a combination of these measures.

3.8.2 LED aspects

The occurrence of veiling reflections described in Clause 3.8.1 is usually particularly noticeable in LED aspects, where the LEDs are uncoloured when not energized and have either an uncoloured protective face or none at all.

The following requirements shall apply to all LED aspects.

When measured in accordance with Appendix D the combined generated plus reflected light shall comply with the chromaticity requirements of Clause 2.1 and with the applicable maximum intensity value as follows:

- (a) *For 200 mm diameter circular display lanterns*
35 cd for red signals and green signals; and 90 cd for yellow signals and white signals.
- (b) *For 300 mm diameter circular display lanterns*
90 cd for red signals and green signals; and 225 cd for yellow signals and white signals.

(c) *For LED vehicular symbols*

The applicable figure from (a) or (b) multiplied by the factor:

$$\frac{\text{area of symbol}}{\text{area of applicable roundel}}$$

NOTES:

- 1 Area of 200 mm roundel = 0.03142 m²
- 2 Area of 300 mm roundel = 0.07069 m²

3.9 SUN-PHANTOM

3.9.1 Intrinsic sun-phantom

The following requirements shall apply to all aspects except pedestrian and bicycle symbols.

For any aspect that has a coloured face when not energized (i.e. with a coloured cover or LEDs that are coloured when not energized), or any white symbol (e.g. T or B symbols), the intrinsic sun-phantom produced by each aspect of the lantern, measured in accordance with Paragraph D3.5.1 of Appendix D, shall be not greater than the following:

(a) *For 200 mm diameter circular display lanterns*

35 cd for red signals and green signals; and 90 cd for yellow signals and white signals.

(b) *For 300 mm diameter circular display lanterns*

90 cd for red signals and green signals; and 225 cd for yellow signals and white signals.

(c) *For LED vehicular symbols*

The applicable figure from (a) or (b) multiplied by the factor:

$$\frac{\text{area of symbol}}{\text{area of applicable roundel}}$$

NOTES:

- 1 Area of 200 mm roundel = 0.03142 m²
- 2 Area of 300 mm roundel = 0.07069 m²

NOTE: All the components of the optical system of a lantern contribute to the coloured element of the sun-phantom that is mainly responsible for masking the true signal (Refs 6 and 7). It is difficult to eliminate sun-phantom entirely by louvres, internal septa or optical design without restricting both the signal intensity and the distribution because, under conditions most likely to give rise to sun-phantom, both the observer's line of sight and the direction of the sun are close to the beam axis. Ref. 8 gives information on the efficiency of various anti-sun-phantom devices.

3.9.2 Performance of removable anti-sun-phantom devices

Where applicable (see Note), the performance of removable anti-sun-phantom devices shall be determined using the test procedure described in Paragraph D3.5.2 of Appendix D. The coloured signal intensities, measured with the anti-sun-phantom device in place, shall be stated and details given of the device to which the measurements relate.

NOTE: The purchaser should specify whether the performance of removable anti-sun-phantom devices is to be determined (see Item (d), Appendix A).

SECTION 4 MECHANICAL AND PHYSICAL FEATURES AND PROPERTIES

4.1 GENERAL ARRANGEMENT

4.1.1 Size and arrangement of aspects

The individual aspects of lanterns shall be of uniform size and shall be arranged so as to display the signal colours in accordance with the requirements of Clause 2.2.

For vehicular lanterns that provide a circular display, the nominal diameter of the exposed face of the lens or apparent light source shall be either 200 mm or 300 mm.

NOTE: Refer to Appendix F for dimensions of visors and target boards.

4.1.2 Mounting facilities

Lanterns shall be provided with facilities to enable them to be effectively secured between two parallel lantern mounting straps complying with AS 2339, spaced apart as shown in Figure 4.1.

Unless otherwise specified, the lantern shall be supplied fully assembled with two mounting straps having the dimension L in Figure 4.1 of AS 2339 as follows:

- (a) For 200 mm diameter vehicular lanterns, $L = 120$ mm.
- (b) For 300 mm diameter vehicular lanterns, and for pedestrian and bicycle lanterns, $L = 250$ mm.

Lanterns shall be attached to the mounting straps by means of studs having an M12 ISO coarse pitch thread complying with AS 1275. Each stud shall be provided with two full hexagon nuts and one flat washer. The mounting studs, nuts and washers shall be hot-dip galvanized in accordance with AS 1214.

4.1.3 Access to optical system

4.1.3.1 Incandescent aspects

Where access for cleaning or lamp replacement purposes is required, separately hinged doors shall be provided to give access to the optical system of each aspect. The doors shall be—

- (a) capable of being opened and closed by a simple one-handed operation, e.g. a half-turn screw or a spring latch;
- (b) arranged so that opening or closing will not result in the disturbance of any pre-set aiming of the optical system; and
- (c) fitted with a positive locking device which will ensure the effectiveness of any seal provided in accordance with Clause 4.3.

NOTE: The above requirements do not apply to access to the electrical wiring and associated components.

4.1.3.2 LED aspects

LED circuit boards, including those encapsulated in removable aspects, shall be separately removable from the lantern with similar ease to that provided by Clause 4.1.3.1 for removal of a lamp.