

AS/NZS 1158.1.1:2022



Australian/New Zealand Standard™

Lighting for roads and public spaces

Part 1.1: Vehicular traffic (Category V) lighting—Performance and design requirements



AS/NZS 1158.1.1:2022

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- Centre for Pavement Engineering Education
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- Department of Transport (VIC)
- Department of Transport and Main Roads (QLD)
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- Lighting Council New Zealand
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Australian/New Zealand Standard™

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Part 1.1: Vehicular traffic (Category V) lighting— Performance and design requirements

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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee LG-002, Lighting for Roads and Public Spaces, to supersede AS/NZS 1158.1.1:2005.

The objective of this document is to specify performance and design requirements for Category V lighting schemes, including requirements relating to the energy efficiency of the luminaires used. It also specifies the luminaire data and other design data that is needed to facilitate the lighting design and the assessment of conformance to the requirements of this document.

This document is intended to be read in conjunction with AS/NZS 1158.0, AS/NZS 1158.1.2, AS/NZS 1158.2, AS/NZS 60598.2.3 and SA/SNZ TS 1158.6.

This document forms part of the AS/NZS 1158 series which covers lighting schemes for the generality of roads and outdoor public areas. A list of all parts in this series can be found in the Standards Australia online catalogue.

The major changes in this edition are as follows:

- (a) Expansion of [Section 2](#) into two sections.
- (b) Addition of a subclause on adaptive lighting.
- (c) Addition of information on energy performance assessment and reporting.
- (d) Addition of information on lighting at railway crossings.
- (e) Revision of [Clause 4.3](#) on curves.
- (f) Revision of requirements for isolated intersections.
- (g) Addition of [Appendix C](#) on energy performance indicators.
- (h) Addition of [Appendix D](#) on design steps for a proposed Category V lighting scheme.
- (i) Addition of [Appendix E](#) on lighting to assist dark adaptation.
- (j) Clarification of lighting requirements for through carriageways at interchange merging and diverging lanes.

The terms “normative” and “informative” have been used in this document to define the application of the appendix 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 performance criteria for road and public space lighting schemes may include any or all of the three basic aims:

- (a) Facilitation of safe movement.
- (b) Reduction of the fear of crime at night.
- (c) Contribution to the amenity of an area through increased aesthetic appeal.

However, as the most common primary aim of a scheme is the safe movement of people, the series divides road and public space lighting into two broad categories — Category V lighting and Category P lighting as defined in AS/NZS 1158.0.

Category V lighting is acknowledged to be an effective accident counter-measure. It has been demonstrated that Category V lighting can provide significant community benefits and that the costs involved in providing the lighting may be offset by the financial returns from the reduction in road accidents.

Studies in Australia, New Zealand, and other countries have led to the conclusion that Category V traffic route lighting is likely to reduce night-time casualty accidents by about 30 % over the road network.

For each lighting subcategory described in this document, conformance with the light technical parameters (LTPs) and their prescribed values are necessary for the particular application. Conformance to this document is achieved by meeting all the required values of the LTPs for the designated subcategory. A higher quality of lighting scheme may be achieved within a subcategory by, for example, increasing the minimum level of average luminance, decreasing glare and improving uniformities.

The LTPs in this document apply irrespective of the source of power: mains, solar, wind, or battery.

The decision of whether to install a road lighting scheme in conformance with this document and, if so, which subcategory of lighting is appropriate, rests with the road controlling authority and is subject to the requirements of applicable legislation. This decision is typically based on factors such as night-time traffic flows, accident statistics and other patterns of use.

When a geographically specific road lighting scheme incorporates a road or roads controlled by more than one relevant authority, those authorities should be consulted to confirm the subcategory of road lighting to be specified for the road lighting scheme.

Australian/New Zealand Standard

Lighting for roads and public spaces

Part 1.1: Vehicular traffic (Category V) lighting—Performance and design requirements

Section 1 Scope and general

1.1 Scope and application

1.1.1 Scope

This document specifies performance and design requirements for Category V lighting schemes, including requirements relating to the energy efficiency of the luminaires used. It also specifies the luminaire data and other design data that is needed to facilitate the lighting design and the assessment of conformance to the requirements of this document.

The document does not apply in Australia to public transport areas where the mandatory requirements of the *Disability Discrimination Act 1992 (Cth)* and subordinate instruments including the *Disability Standards for Accessible Public Transport 2002 (Cth)* (DSAPT) and the *Disability (Access to Premises - Buildings) Standards 2010 (Cth)* (Premises Standards) are applicable, see [Clause 2.1](#).

With the exception of lighting for isolated intersections (see [Clause 4.5](#)), this document does not apply to single-luminaire schemes in otherwise unlit roads nor to additional luminaires installed in lit roads for reasons of increased security, including instances where such luminaires are typical of those used in Category V lighting schemes.

1.1.2 Application

This document is intended to be read in conjunction with AS/NZS 1158.0, AS/NZS 1158.1.2, AS/NZS 1158.2, AS/NZS 60598.2.3 and SA/SNZ TS 1158.6.

This document is intended to be applied in its entirety in Australia and New Zealand; however, a number of differences exist with respect to the requirements that apply in each country. These are indicated by the qualification “In Australia” or “In New Zealand”, or similar.

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 for informative purposes are listed in the Bibliography.

AS/NZS 1158.2, *Lighting for roads and public spaces, Part 2: Computer procedures for the calculation of light technical parameters for Category V and Category P lighting*

AS/NZS 1158.5, *Lighting for roads and public spaces, Part 5: Tunnels and underpasses*

AS/NZS 60598.2.3, *Luminaires, Part 2.3: Particular requirements—Luminaires for road and street lighting (IEC 60598-2-3, Ed. 3.1 (2011) MOD)*

AS ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

CIE S 025/E, *Test Method for LED Lamps, LED Luminaires and LED Modules*

IES LM-79, *Approved method: Optical and Electrical Measurements of Solid-State Lighting Products*

IES LM-80, *Approved method: Measuring luminous flux and color maintenance of LED packages, arrays and modules*

IES LM-84-20, *Approved method: Measuring optical radiation maintenance of LED lamps, light engines, and luminaires*

IES TM-21, *Technical Memorandum: Projecting long-term lumen, photon, and radiant flux maintenance of LED light sources*

1.3 Terms and definitions

For the purposes of this document, the terms and definitions given in AS/NZS 1158.0 and the following apply.

1.3.1

competent person

person who has acquired, through education, training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the task required

Note 1 to entry: A competent person may be determined by the road controlling authority.

1.3.2

divided carriageway

road where opposing traffic directions are separated by a physical barrier

Note 1 to entry: Also known as barrier wall, raised median, non-trafficable landscaping

Note 2 to entry: Since it is possible for traffic to use the painted median area, a road with a painted median may be treated as a single carriageway road.

1.3.3

may

indicates the existence of an option

1.3.4

shall

indicates that a statement is mandatory

1.3.5

should

indicates a recommendation

1.4 Symbols and abbreviations

For the purpose of this document, the symbols and abbreviations given in AS/NZS 1158.0 apply.

1.5 Basis of conformance to this document

1.5.1 Lighting design

The design of the lighting scheme shall be deemed to conform to this document if —

- (a) the luminaire used conforms to AS/NZS IEC 60598.2.3; and
- (b) when created in accordance with [Section 4](#), it satisfies the LTPs of [Table 3.1](#) throughout its lifecycle when considered together with the included maintenance scheme; and
- (c) the information specified in [Appendix B](#) is documented.

1.5.2 Installed lighting scheme

After installation of a lighting scheme conforming to [Clause 1.5.1](#), the installed lighting scheme shall be deemed to continue to conform to this document if —

- (a) the installation accurately replicates the final design throughout its life cycle;
- (b) the final design documentation includes any changes to the original design made in response to circumstances arising during installation and these changes do not cause non-conformance to the original lighting design; and
- (c) either —
 - (i) the maintenance schedule specified in [Appendix B](#) Item (I) is implemented; or
 - (ii) an alternative maintenance schedule is implemented that can demonstrate a maintenance factor equal to or better than the design value.

Section 2 Objectives and determination of lighting subcategories

2.1 Road classification

[Figure 2.1](#) shows representative land use types and associated road classifications together with the applicable lighting categories and subcategories.

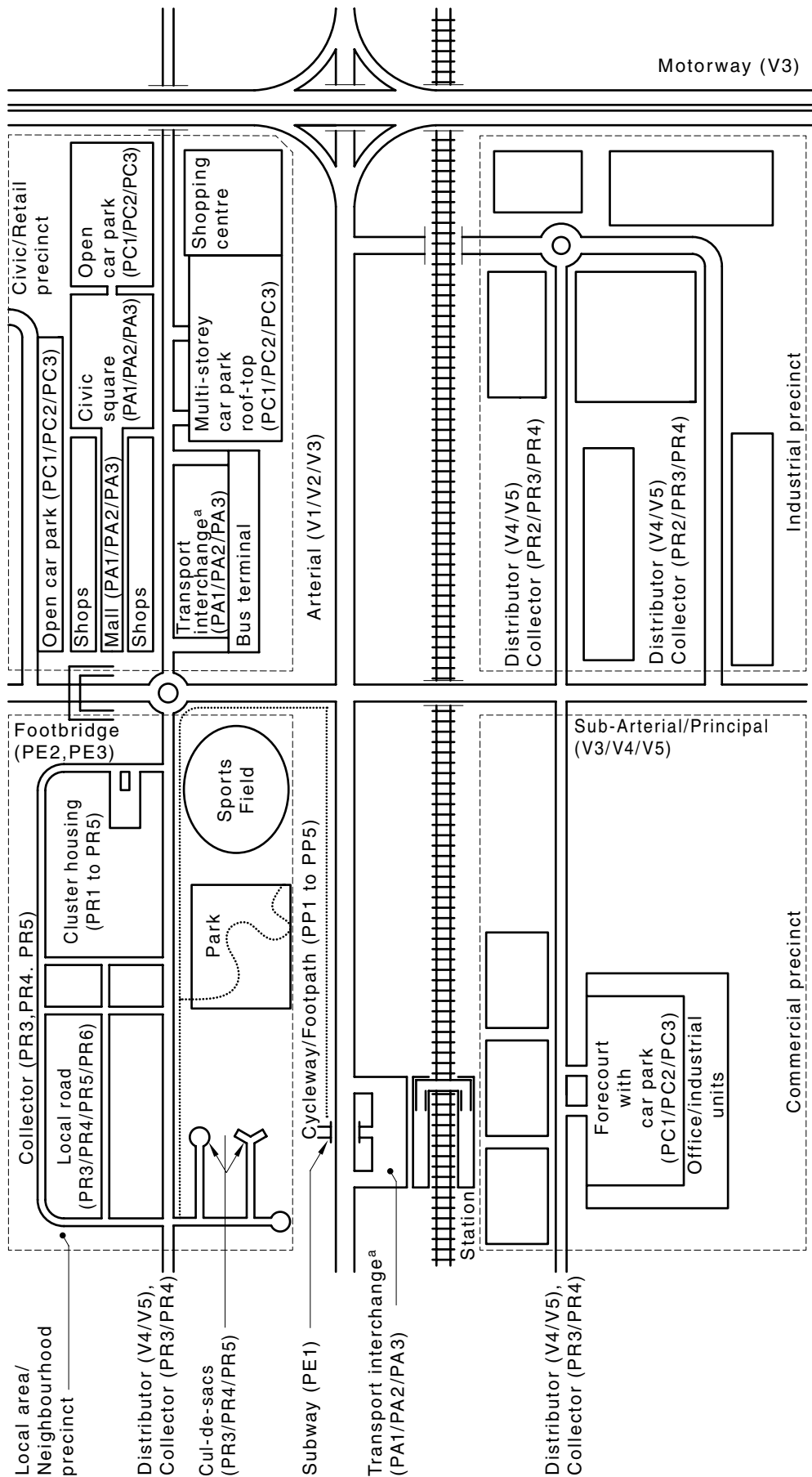
NOTE 1 For selection of an appropriate Category V subcategory, see [Table 2.1](#).

NOTE 2 For selection of an appropriate Category P or public space subcategory, refer to AS/NZS 1158.3.1.

The exact names of the various road types and their associated operating characteristics may vary between relevant authorities. The layout of roads in older suburbs may not conform to the schematic layout shown in [Figure 2.1](#). In particular, the local roads and some arterials can coalesce into a grid arrangement of roads.

Documentation for the lighting design shall clearly state the road type and associated lighting category and subcategory that were assigned. The applicable lighting category and subcategory should be determined by the road controlling authority.

When determining the appropriate lighting category and subcategory, each separate element shall be assessed by taking into account its operational characteristics. Consideration should be given to the likely night-time usage, which can differ from daytime usage with respect to traffic density or the presence of pedestrians. For example, a neighbourhood collector road can have relatively low traffic volumes with pedestrian activity during the day but, at night, be used by heavy vehicles servicing industrial or retail precincts.



a See [Clause 1.1.1](#) regarding the Disability Discrimination Act 1992 (Cth) otherwise PA1/PA2/PA3

NOTE [Table 2.1](#) contains typical applications of the Category V lighting subcategories V1, V2, V3, V4 and V5. Typical applications of the Category P lighting subcategories can be found in AS/NZS 1158.3.1.

Figure 2.1 — Example of road and public space types and indicative lighting categories and subcategories

2.2 General objectives

The objectives of road lighting are to —

- (a) facilitate safe movement;
- (b) reduce the fear of crime at night; and
- (c) contribute to the amenity of an area through increased aesthetic appeal.

Category V lighting is used when the visual requirements of motorists predominate and, generally, to facilitate the objectives stated.

To accomplish these objectives, the lighting shall reveal the following visual information:

- (i) The road itself.
- (ii) The course of the road ahead.
- (iii) Kerbs.
- (iv) Footpaths.
- (v) Road furniture.
- (vi) Surface imperfections.
- (vii) All road users, including pedestrians, cyclists and vehicles, and their movements.
- (viii) Other animate or inanimate obstacles.

Road lighting should be realized in such a way that minimizes potential compromise of its general environment. For example, spill light is generally wasted light and energy, especially upward light that produces sky glow. Life cycle energy usage of a lighting scheme should be minimized, not only to save on cost but to also limit associated greenhouse gas emissions.

The provision of road lighting should not compromise other road safety objectives, e.g. by creating a potential collision hazard through the use of road lighting poles or columns that are of an inappropriate type or that are inappropriately placed.

NOTE Refer to the relevant appendix of AS/NZS 1158.1.2 for guidance on the selection and location of road lighting poles and columns.

2.3 Design objectives

2.3.1 Principal objectives

2.3.1.1 General

The principal design objectives for Category V lighting are to provide the following:

- (a) Luminance and luminance uniformity of the carriageway surface to a specified level, see [Table 3.1](#).
- (b) Glare control (*TI*, Threshold Increment) to a specified level.
- (c) Illuminance on intersections, carriageway verges and other nominated locations to a specified level.
- (d) Limitation of upward light from luminaires to a specified level.
- (e) Minimization of energy consumption.

NOTE See [Appendix C](#) for energy performance indicator calculations.

These objectives are realized by the choice of relevant lighting subcategory and appropriate design procedure. The realization of the objective carriageway luminance values will depend on the reflection properties of the road surface.

2.3.1.2 Maintenance

The lighting scheme shall conform to this document during maintenance cycles over the life of an installation.

The calculations in [Clause 2.3.1.1\(a\) to \(e\)](#) shall use the maintenance regime determined by the road controlling authority.

2.3.2 Other considerations

Other aspects of a road lighting scheme that may affect the initial and long-term performance quality include:

- (a) Reliability and maintainability over the service life of the selected hardware components.
- (b) Ability to complement or enhance the visual amenity of the traffic route.
- (c) Life cycle costs of the scheme.
- (d) Obtrusive light effects.

NOTE Refer to AS/NZS 4282 for guidance on obtrusive light from public lighting.

2.4 Lighting subcategories and their application

2.4.1 General

For the purpose of this document, the lighting subcategories set out in [Table 2.1](#) shall apply. [Table 2.1](#) describes typical applications for each of the lighting subcategories given and provides guidance for the selection of the most appropriate lighting subcategory for that use.

NOTE For selection of categories for roads in New Zealand, refer to the specification and guidelines for road lighting design at <https://www.nzta.govt.nz/resources/>.

As it would be unrealistic and impractical to apply one numerical set of values for each of the selection criteria for a lighting subcategory, terms have been employed in [Table 2.1](#) to accommodate the relevant requirements of each town or city across Australia and New Zealand.

The terms “mixed”, “low”, “medium”, “high”, “very high” and “moderate” are provided as a guide to enable the relevant authorities to develop their own specific lighting hierarchy.

2.4.2 Adaptive lighting

2.4.2.1 General

For lighting schemes that use central management system (CMS) controls for adaptive lighting application, the lighting levels may, in some instances, need to be adapted or changed to different levels (higher or lower). Where adaptive lighting is used, the selected level shall conform with the requirements of its subcategory. The control system shall be failsafe.

If a dynamic system is used, suitable delays for switching between levels should be in place to avoid nuisance switching.

NOTE 1 See [Appendix A](#) for a sample design brief.

NOTE 2 Changing the luminaire flux output will generally have a proportional change in luminance and illuminance values. Uniformity, surround verge illuminance, and UWLR ratios will remain the same. However, with typical schemes, TI values will increase with increasing luminaire flux output.

2.4.2.2 Adaptive lighting considerations

Technology allows for more flexibility in the variation of lighting levels on all categories of road, depending upon usage at any given time. As usage is reduced, the lighting level may be reduced unless there are over-riding reasons not to do so such as a high accident rate or fear of crime.

Adaptive lighting is often referred to as dimming but is actually adapting the lighting to the correct lighting subcategory in order to meet specific road parameters at a particular time. It may be that the highest lighting level a lighting scheme can achieve is only used on rare occasions, where traffic density is higher than typical, such as near a football stadium on the evening of a match, while the typical lighting level may only require a lower lighting subcategory.

There are also environmental benefits of using adaptive lighting levels, including reduced light intrusion, light pollution, electrical energy consumption and carbon emissions.

[Table 2.1](#) gives details of the lighting subcategories and guidelines on the application of these subcategories. Many of these parameters remain fixed throughout the night, such as design speed, traffic composition and whether there are parked vehicles, but some of the parameters, such as traffic density or ambient luminance, can change throughout the night. When these parameters change, this may result in the ability to select a different lighting subcategory, thus allowing an adaptive lighting solution.

Description of road or area type	Basic operating characteristics	Vehicle activity	Vehicle speed	Pedestrian activity	Lighting subcategory	
Arterial or main roads in central and regional activity centres of capital and major provincial cities, and other areas with major abutting traffic generators	Mixed vehicle and pedestrian	Very high/high	Moderate to low	Very high/high	V1	
	Stationary vehicles alongside the carriageway					
	Through and local traffic					
	High traffic generation from abutting properties					
Arterial roads that predominantly carry through traffic from one region to another, forming principal avenues of communication for traffic movement, with major abutting traffic generators	Mixed vehicle and pedestrian	High	High to moderate	High	V2	
	Stationary vehicles alongside the carriageway					
	Through and local traffic					
	High traffic generation from abutting properties					
Freeways, motorways and expressways consisting of divided highways for through traffic with no access for traffic between interchanges and with grade separation at all intersections	Vehicles only	Very high/high	High	None	V3	
Arterial roads that predominantly carry through traffic from one region to another, forming principal avenues of communication for traffic movements	Mixed vehicle and pedestrian	High to moderate	Moderate	High		
	Stationary vehicles alongside the carriageway					
	Through and local traffic					
	Moderate traffic generation from abutting properties					
Sub-arterial or principal roads that connect arterial or main roads to areas of development within a region or that carry traffic directly from one part of a region to another part	Mixed vehicle and pedestrian	Moderate	Moderate to low	Low	V4 or V5	
	Low traffic generation from abutting properties					

Section 3 Light technical parameters for each lighting subcategory

3.1 General

The principal design objectives outlined in [Clause 2.3.1](#) are formally specified in terms of various light technical parameters (LTPs) that—

- (a) relate to the attainment of the required level of lighting performance; and
- (b) limit the adverse effects of the lighting on —

- (i) users of the lit space, such as pedestrians and vehicle drivers; and

EXAMPLE Control of glare.

- (ii) night sky viewing conditions.

EXAMPLE Reduction of consequent sky glow.

NOTE 1 These are often referred to as environmental parameters.

NOTE 2 Refer to AS/NZS 4282 for further information on parameters that limit adverse lighting effects.

Details of the applicable parameters are set out in [Clauses 3.1.1](#), [3.1.2](#) and [3.1.3](#). The mathematical definitions of these LTPs are set out in AS/NZS 1158.2.

The values for these parameters shall be as specified in [Table 3.1](#). These are the minimum permissible values, except for parameters TI , U_{E1} and $UWLR$, for which the values given are the maximum permissible. These requirements apply throughout each maintenance cycle over the life of the installation.

When adaptive lighting is used, see [Clause 2.4](#) for requirements and recommendations.

The design methods and rules necessary to achieve conformance to the required values of the LTPs shall be as specified in [Section 4](#).

Table 3.1 — Values of light technical parameters for Category V lighting

1	2	3	4	5	6	7	8	9	10	11
Lighting subcategory	Light technical parameters									
	For straight sections, curves and intersections					For intersections and other specified locations			For non-SSL luminaires	For SSL luminaires
	Average carriageway luminance ^{a,b} $\bar{L}$ cd.m ⁻² $\geq$	Overall uniformity ^{c,b} min/avg (U_o) $\geq$	Longitudinal uniformity ^b (U_L) min/max $\geq$		Threshold increment ^{d,e} (TI) $\leq$	Surround verge illuminance ^b (E_{SL} and E_{SR}) $\geq$	Point horizontal illuminance ^{a,b} (E_{Ph}) $\geq$	Illuminance (horizontal) uniformity ^d Cat V (U_{E1}) max/min $\leq$	Upward waste light ratio ^d (UWLR) $\leq$	Upward waste light ratio ^d (UWLR) $\leq$
V1	1.50	0.33	Australia	New Zealand	%	%	lx		%	%
V2	1.00	0.33	0.5	0.3	15	50	15	8	3	1
V3	0.75	0.33	0.5	0.3	15	50	10	8	3	1
V4 ^f	0.50	0.33	0.5	0.3	15	50	7.5	8	3	1
V5	0.35	0.33	0.5	0.3	15	50	5	8	3	1
			0.5	0.3	15	50	3.5	8	3	1

^a These values are maintained.

^b Conformance is achieved by being greater than or equal to the applicable table value.

^c The value of U_o may be 0.32 or 0.31 provided the value for $\bar{L}$ is 5 % or 10 %, respectively, above the specified value in column 2.

^d Conformance is achieved by being less than or equal to the applicable table value.

^e Where legacy installations with HID luminaires are upgraded, the threshold increment value may be no greater than the existing HID installation and may not exceed 20 %.

^f V4 is the minimum subcategory recommended for application in New Zealand.

NOTE 1 For the purpose of determining conformance to [Table 3.1](#), the specified LTPs should be taken as being justified to two decimal places.

NOTE 2 See [Table 2.1](#) for typical applications of each of the lighting subcategories for which LTPs are specified.

NOTE 3 The specification of separate requirements for U_L in Australia and New Zealand arises from differences in the method of calculating this parameter, particularly the assumed observer position chosen, see [Clause 4.2.1](#).

NOTE 4 See [Section 4](#) for the design methods and rules for use in assessing conformance to the specified LTPs.

3.1.1 Applicable parameters — All road elements

The following LTP shall apply to all elements of the road lighting scheme:

Parameter	Symbol
Upward waste light ratio	UWLR

The maximum permissible value for this parameter is specified in [Table 3.1](#) and applies to each luminaire used in the road lighting scheme.

3.1.2 Applicable parameters — Straight sections and larger radius curves

The following LTPs shall apply to straight sections, including uninterrupted through carriageways of intersections and to curves having a radius of curvature of 100 m or more:

Parameter	Symbol
Average carriageway luminance	$\bar{L}$
Overall uniformity	U_o
Longitudinal uniformity	U_L
Threshold increment	TI
Surround (verge) illuminance ratio	E_{SL} and E_{SR}

The specified values for these parameters in [Table 3.1](#) shall apply to the carriageway, except for parameter E_{SL} and E_{SR} . The values for E_{SL} and E_{SR} shall apply principally to a defined portion of the road verge adjacent to the carriageway.

3.1.3 Applicable parameters — Intersections, small radius bends and other specified locations

The following LTPs shall apply to —

- (a) intersections;
- (b) curves with a radius of less than 100 m; and
- (c) other required locations.

Parameter	Symbol
Point horizontal illuminance	E_{Ph}
Illuminance (horizontal) uniformity Cat V	U_{E1}

Unless an exemption is given in [Section 4](#) for a specific application, the above parameters apply in addition to those in [Clause 3.1.2](#). The specified values for these parameters in [Table 3.1](#) apply over a defined area of the carriageway and surrounds in accordance with [Section 4](#).

NOTE See [Clause 3.1.2](#) for the LTPs applicable to uninterrupted through carriageways at intersections.

3.2 Luminaire requirements

3.2.1 Upward waste light ratio

The amount of light emitted by the luminaires in directions above the horizontal shall be controlled by the specification of maximum values for the upward waste light ratio (UWLR).

The limiting value of UWLR in [Table 3.1](#) shall not be exceeded for the selected luminaire when mounted with the tilt angle specified in the design.

NOTE The UWLR typically increases as the installed tilt increases.

3.2.2 Luminaire performance

NOTE For luminaire specification, refer to SA/SNZ TS 1158.6.

3.2.3 Light source considerations

The choice of light source should be based on an analysis of all the factors relevant to the particular application, including aesthetics, environmental factors, light source mortality, lumen depreciation, cost and energy use.

NOTE For correlated colour temperature and colour rendering index for light sources, refer to SA/SNZ TS 1158.6.

3.2.4 Design lumen value

The initial lamp lumens for non-SSL luminaires or initial luminaire lumens for SSL luminaires, as conventionally evaluated using the CIE 1924 standard observer (i.e. “V λ ” function), shall be used in calculations. No re-rating lumen multipliers, such as those based on either the changing sensitivity of the eye at low light levels or the enhanced receptiveness of the eye to white light, shall be used in Category V lighting.

3.3 Energy performance assessment and reporting

If energy performance assessment and reporting is required by road controlling authorities, it shall be conducted in accordance with the methods in [Appendix C](#). These methods align with the principles in EN 13201-5.

The energy performance of a lighting scheme is determined by the interaction and combined effects of the —

- (a) luminous efficacy and photometric distribution of the selected luminaire;
- (b) appropriateness of the lighting design for the scheme layout and geometry; and
- (c) operation of the lighting system in practice.

The ability to objectively quantify and compare the total systemic energy impacts of road lighting scheme scenarios at the planning stages allows the design to be tailored and optimized for various ways to evaluate the energy use of a proposed lighting scheme, while meeting the required LTPs.

The methods in [Appendix C](#) accommodate lighting levels as dynamic and changing parameters, rather than fixed values. A variable light level and timing facility allows for the application of adaptive lighting techniques such as constant light output (CLO), scheduled control and real-time control. These techniques are enabled by smart control devices and internet-based CMS.

The methods in [Appendix C](#) provide rules for the structured description, calculation, and presentation of annualized energy performance indicators for road, pathway and public space lighting schemes.

NOTE These rules facilitate optimization at the design stage and for ongoing periodic auditing, purposes. This allows for structured and harmonized comparisons of the energy performance implications of —

- (a) various equipment technologies;
- (b) design approaches such as luminaire optics and column layouts;
- (c) adapting at times of low vehicular use, e.g. after midnight, using sensors to adapt between lighting subcategories on approach of vehicles; and/or

- (d) operating of dimming and brightening adaptive control schedules.

Applying these methods provides a standardized framework to design, calculate, benchmark or audit the energy performance of both existing and proposed lighting schemes in a systemic and objective manner for the purposes of benchmarking, continuous improvement or as part of progressive infrastructure procurement processes.

[Appendix C](#) introduces the measures of the power density indicator (PDI) and the annual energy consumption indicator (AECI).

3.4 Maintenance of light technical parameters

3.4.1 General

Significant reductions from the initial values of the LTPs occur in service, primarily as a result of —

- (a) a gradual depreciation in light source lumen output; and
- (b) an accumulation of dirt and ageing of the optical transmitting/reflecting materials.

Given that this depreciation occurs, the values of $\bar{L}$ and E_{ph} shall be maintained by the application of a maintenance factor as detailed in [Clauses 3.4.2 to 3.4.5](#).

A maintenance schedule for the design shall be developed and documented. The values of E_{ph} and $\bar{L}$ shall not fall below the applicable values for these parameters throughout any maintenance cycle in the life of the installation.

3.4.2 Luminaire dirt depreciation factor

The luminaire dirt depreciation factor (LDD) shall be as follows:

Environmental zone	LDD factor			
	Cleaning frequency			
	36 months	48 months	60 months	72 months
Urban and rural	0.95	0.94	0.93	0.92

3.4.3 Light source lumen depreciation

The value of the light source lumen depreciation (LLD) associated with the light source operating hours (replacement interval) to be determined for the calculation of E_{ph} and $\bar{L}$ shall be obtained from data applicable to the specific light source chosen.

For SSL luminaires, depreciation data shall be obtained from the LED chip's test report, produced in accordance with IES LM-80, and be extrapolated using the IES TM-21 calculator, using the temperature of the LED chip when operating in the luminaire.

In situ temperature measurements for the lumen depreciation of LED luminaires shall be made in accordance with Annex A of IES LM-84-20 under typical operating conditions as specified in AS/NZS 60598.2.3. Once these measurements are taken, the data shall be extrapolated using the methods specified in IES TM-21. Temperature measurements shall be conducted at an ambient temperature of 40 °C for Australia and 25 °C for New Zealand.

The lumen depreciation caused by ageing of any optical components, e.g. optical degradation of lenses and visors, should be a part of the LLD.