



Sports lighting

Part 1: General principles



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The following are represented on Committee LG-009:

- Australian Football League
 - Australian Industry Group
 - Baseball Australia
 - CIE Australia
 - Cricket Australia
 - Department of National Parks, Sport and Racing
 - IES: The Lighting Society
 - Lighting Council Australia
 - Parks and Leisure Australia
 - Sports and Play Industry Association
 - Sport and Recreation Victoria
 - Tennis Australia
-

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Australian Standard®

Sports lighting

Part 1: General principles

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PREFACE

This Standard was prepared by the Standards Australia Committee LG-009 Sports Lighting, to supersede AS 2560.1—2002.

The AS 2560 series is in two main parts. Part 1 deals with the lighting of places, both indoors and outdoors, where sport is played. Part 2 addresses the lighting of a specific sport or associated sporting venue.

When revision is completed, the series will consist of the following:

AS

2560	Sports lighting
2560.1	Part 1: General principles (this Standard)
2560.2.1	Part 2.1: Specific applications—Lighting for outdoor tennis
2560.2.2	Part 2.2: Specific applications—Lighting of multipurpose indoor sports centres
2560.2.3	Part 2.3: Specific applications—Lighting for football (all codes)
2560.2.4	Part 2.4: Specific applications—Lighting for outdoor netball and basketball
2560.2.5	Part 2.5: Specific applications—Swimming pools
2560.2.6	Part 2.6: Specific applications—Baseball and softball
2560.2.7	Part 2.7: Specific applications—Outdoor hockey
2560.2.8	Part 2.8: Specific applications—Bowling greens

The AS 2560 series is not intended to apply to lighting systems for television coverage. Generally, specialist lighting requirements are needed for these installations; usually requiring relatively higher vertical illuminance levels, and higher uniformity. However, the general principles of AS 2560 should be applied to such venues, specifically (but not limited to): the methods of calculation, glare limitation, and the assessment of the installation. For guidance on TV lighting requirements, refer to the following documents:

- (a) Free TV Australia Operation Practice OP-31, Lighting Requirements for Television.
- (b) CIE 169:2005 Practical guidelines for the lighting of sport events for colour television and filming, International Commission on Illumination (CIE), Vienna, 2005.
- (c) CIE Publication No. 83, Guide for the lighting of sports events for colour television and film systems, International Commission on Illumination (CIE), Vienna.

The various sporting organisations often publish their own technical recommendations.

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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STANDARDS AUSTRALIA

Australian Standard Sports lighting

Part 1: General principles

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard contains recommendations and requirements for the lighting of places, both indoors and outdoors, where sport is played. It includes general principles and recommendations for sports lighting, descriptions of suitable types of lighting equipment, and requirements regarding methods for the assessment or measurement of sports lighting installations.

This Standard is intended to be read in conjunction with the applicable section of AS 2560.2 covering the sport of interest. Taken together, these Standards cater for the requirements of different levels of play, e.g. recreational, training, club, national and international, and provide for the visual requirements of participants, officials and spectators, as appropriate.

This Standard does not detail the special requirements of lighting for television coverage.

This Standard makes recommendations, but does not set requirements, regarding obtrusive light released into the environment from sports lighting installations (See Clause 2.10.4.).

1.2 APPLICATION

For this Standard to be applied, the lighting needs of sports areas should be considered at the design and layout stage of the planning of such venues, in order that lighting equipment and supporting structures may be located so as to provide the required uniformity of illumination, to minimize glare and obstruction to participants and play respectively and to minimize the obtrusive effects of outdoor lighting.

For each type of sport there are preferred locations for the mounting of lighting equipment. These locations are related to the nature of the sport, the direction of play and other factors. Early consultation between the architect (venue designer) and the lighting designer is desirable to ensure provision is made for suitable locations and mountings for lighting equipment. A completely satisfactory installation is often difficult to achieve when limited by physical constraints, which can be avoided if lighting is considered at the design stage.

1.3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1680	Interior and workplace lighting
1680.1	Part 1: General principles and recommendations
2560	Sports lighting
2560.2	Part 2: Specific applications
4282	Control of the obtrusive effects of outdoor lighting

AS/NZS

2293 Emergency escape lighting and exit signs for buildings (series)

60598 Luminaires

60598.1 Part 1: General requirements and tests (IEC 60598-1, Ed. 8.0 (2014) MOD)

60598.2.5 Part 2.5: Particular requirements—Floodlights (IEC 60598.2.5:1998, MOD)

ISO CIE*

S 008 Lighting of Work Places—Part 1: Indoor

S 017 International Lighting Vocabulary

067 Guide for the photometric specification and measurement of sports lighting installations

112 Glare evaluation system for use within outdoor sports and area lighting (E)

117 Discomfort Glare in Interior Lighting

IEC

60050-845 International Electrotechnical Vocabulary—Part 845: Lighting

Australian Government, Civil Aviation Safety Authority, Manual of Standards

Part 139: Aerodromes

* International Commission on Illumination, Vienna.

1.4 DEFINITIONS

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

1.4.1 Quantities and units of light**1.4.1.1 Average horizontal illuminance ($\bar{E}_h$)**

The arithmetic mean of the horizontal illuminance values determined for all of the points in either the calculation or measurement grid as applicable to the method of determination (See Clause 2.5.1).

1.4.1.2 Brightness (luminosity)

The attribute of visual sensation according to which a surface appears to emit or reflect more or less light. This is a subjective effect which cannot be measured in absolute units, and the term should only be used to describe the appearance of a source or surface.

1.4.1.3 Illuminance

The luminous flux arriving at a surface divided by the area of the illuminated surface.

Unit: lux (lx). Symbol: E .

$$\text{NOTE: } 1 \text{ lx} = \frac{1 \text{ lm}}{\text{m}^2}.$$

1.4.1.4 Illumination

A general expression for the quantity of light arriving at a surface. The physical measure of illumination is illuminance.

1.4.1.5 Initial illuminance

The value of average illuminance that is initially provided by the lighting system, that is, with new light sources (i.e. aged to 100 h), clean luminaires and, where applicable, clean interior surfaces.

1.4.1.6 Luminance

The physical quantity corresponding to the brightness of a surface (e.g. a light source, 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 ($\frac{\text{cd}}{\text{m}^2}$). Symbol: L .

1.4.1.7 Luminous flux

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

Unit: lumen (lm). Symbol: ϕ .

1.4.1.8 Luminous intensity

The concentration of luminous flux emitted in a specified direction. Intensity is the luminous flux per unit solid angle (steradian).

$$1 \text{ cd} = \frac{1 \text{ lm}}{\text{sr}}$$

Unit: candela (cd). Symbol: I .

1.4.1.9 Maintained illuminance (E_m)

The defined level below which the average illuminance on the reference plane of a lighting system is not allowed to fall.

NOTES:

- 1 It is the minimum illuminance at which maintenance is to be carried out.
- 2 The term applies to horizontal or vertical illuminance.

1.4.1.10 Maintained value

The value of any relevant parameter (e.g. light source lumen output) as it would be when average illuminance equals E_m .

1.4.1.11 Maximum horizontal illuminance (E_{hmax})

The maximum of only those horizontal illuminance values determined for all of the points in either the calculation or measurement grid as applicable to the method of determination.

1.4.1.12 Minimum horizontal illuminance (E_{hmin})

The minimum of only those horizontal illuminance values determined for all of the points in either the calculation or measurement grid as applicable to the method of determination.

1.4.1.13 Uniformity gradient (G)

The rate of change of illuminance over a defined area. Determined, usually from calculated illuminance figures, as a ratio relating the illuminance at a nominated grid point and the illuminance at the eight immediately adjacent surrounding grid points.

It is expressed as a ratio of illuminance change to grid dimensions e.g. 20% for 5 m for a 5 m × 5 m grid, and although the calculation is performed for every grid point over the area of interest (e.g. the PPA) the only value typically recorded is the highest (i.e. worst) value.

1.4.1.14 Uniformity ratios (U_1 and U_2)

Two ratios, each providing a numerical representation of the uniformity of illuminance over a given area as follows:

$\frac{E_{\min}}{\bar{E}}$ = The ratio of the minimum illuminance to the average illuminance on the relevant plane within the calculation/measurement area (U_1).

$\frac{E_{\min}}{E_{\max}}$ = The ratio of the minimum illuminance to the maximum illuminance on the relevant plane within the calculation/measurement area (U_2).

Where $E_{\max}$ and $E_{\min}$ are chosen from only the values of illuminance corresponding to the calculation/measurement grid.

NOTE: The uniformity ratios can be calculated for any set of illuminance measurements including vertical or horizontal, maintained or initial.

1.4.2 Luminaires and lighting systems

1.4.2.1 Ballast (choke)

Equipment used with discharge light sources for stabilizing the discharge.

1.4.2.2 Cut-off angle (of a luminaire)

The angle, measured from nadir in a given vertical half-plane, between the vertical axis and the line of sight at which all surfaces of high luminance (of light sources and of the luminaire) just cease to be visible.

NOTE: The term 'shielding angle' is sometimes used to refer to the degree of cut-off with respect to the horizontal, i.e. shielding angle = 90° – cut-off angle.

1.4.2.3 Diffused lighting

Lighting which comes from many directions by means of one or more large area sources or by several small sources, so that an object near an illuminated surface does not cast a dense shadow on that surface.

1.4.2.4 Directional lighting

Lighting which comes predominantly from a particular direction, so that an object placed near an illuminated surface casts a dense shadow on that surface.

1.4.2.5 Emergency lighting

Lighting provided (usually automatically) from an independent system when the mains lighting fails.

1.4.2.6 Floodlight

A luminaire designed for area or sports lighting. (See Clauses 3.2.2 and 3.2.3.)

1.4.2.7 General lighting

Lighting designed to illuminate an area without special provision for local requirements within that area.

NOTE: General lighting is normally provided by an arrangement of luminaires which produces approximately uniform illuminance throughout an interior.

1.4.2.8 LED driver

An LED driver is an electrical device which regulates the power to an LED or a string (or strings) of LEDs. An LED driver responds to the changing needs of the LED, or LED circuit, by providing a constant quantity of power to the LED as its electrical properties change with temperature. The driver can also either provide for fixed illumination, or enable the LED light source to dim, as required. They may be integral or external to the luminaire.

1.4.2.9 Light loss factor (LLF)

The ratio of the illuminance provided by an installation in the average condition of dirtiness and with a light source of average age expected in service, to the initial illuminance provided by the same installation. It is always less than unity.

$$LLF = LDD * LLD$$

NOTES:

- 1 This light loss factor makes no allowance for failed light sources that have not been replaced.
- 2 This light loss factor does not allow for room surface depreciation. (Refer to AS 1680.1.)
- 3 Also known as Maintenance Factor (MF).

1.4.2.10 Light source lumen depreciation (LLD) factor

The ratio of the lumen output of a light source after a given time in operation to the initial lumen output. (See Figure 4.1 for examples.)

1.4.2.11 Local lighting

The illumination of a task area by a luminaire or luminaires provided for the purpose.

NOTE: This method of lighting frequently contributes little, if any, general illumination and in such cases should be used only in conjunction with general lighting.

1.4.2.12 Luminaire

Equipment which houses the light source(s) and directs the light in desired directions. It includes items necessary for fixing, protecting and operating the light source(s).

1.4.2.13 Luminaire dirt depreciation (LDD) factor

The ratio of the illuminance provided by a notional average luminaire in an installation, in an average condition of dirtiness (based on the environment and maintenance schedule) but with a new light source, to the initial illuminance provided by the same luminaire.

1.4.2.14 Mounting height

The vertical distance between the luminaire and the ground or floor, or between the luminaire and some other specified plane such as the top of a table tennis table.

1.4.2.15 Reflector

A device for controlling the luminous flux from a light source by reflection from suitably shaped surfaces. These may be either specular (e.g. mirrored glass or polished aluminium) or diffuse (e.g. vitreous enamel). In the former, the light is reflected in accordance with the laws of optical reflection. In the latter the light is diffused, largely without reference to any particular direction.

1.4.2.16 Rooflight

An opening in the solid fabric or structure of a roof intended to admit natural light into an interior.

NOTE: Rooflights are normally glazed (glass or plastics, clear or translucent) and include skylights, sawtooth and monitor or lantern lights.

1.4.2.17 Room index (K)

A number, representative of the geometry of a rectangular room, used in lighting calculations. It is given by the following equation:

$$K = \frac{a \times b}{h(a + b)} \quad \dots 1.1$$

where

a, b = The dimensions of the sides of the room

h = The vertical distance between the horizontal reference plane and the luminaire plane

NOTE: Results are typically rounded to the nearest value in the series 0.75, 1.00, 1.25, 1.50, 2.00, 2.50, 3.00, 4.00, 5.00.

1.4.3 Light sources

NOTE: See Table 3.1 for information on properties of light sources used for sports lighting.

1.4.3.1 Discharge lamp

A light source in which the light is produced either directly or by the excitation of phosphors by an electric discharge through a metal vapour (e.g. mercury, sodium), gas (e.g. xenon), or a mixture of several gases and vapours.

1.4.3.2 Fluorescent lamp

A tubular discharge light source in which most of the light is emitted by a layer of fluorescent material deposited on the wall of the glass tube and excited by ultraviolet radiation from the discharge.

1.4.3.3 High pressure mercury vapour lamp

A light source in which the light is produced by an electric discharge through mercury vapour, the pressure of the vapour being typically greater than 100 kPa during operation.

The outer bulb may either be clear or have a fluorescent coating.

1.4.3.4 High pressure sodium vapour lamp

A light source in which the light is produced by an electric discharge through sodium vapour and in which, during operation, the partial pressure of the vapour is of the order of 10 kPa.

1.4.3.5 Incandescent lamp

A light source in which light is produced by a filament, usually made of tungsten, heated to incandescence by the passage of an electric current through it. The filament is enclosed in a glass bulb which is either evacuated or, more usually, filled with an inert gas at low pressure

NOTE: Often known as a 'tungsten light source'.

1.4.3.6 Induction lamp

A light source in which radiation is produced by an electromagnetic field inducing excitation of a gas, the source of the field being outside the envelope containing the gas. The radiation is typically of light frequency but in some instances excites a fluorescent coating.

NOTE: This category of light source includes so-called 'plasma light sources' and 'microwave light sources'.

1.4.3.7 Light-emitting diode (LED)

Solid state device embodying a p-n junction, emitting visible radiation when excited by an electric current.

NOTES:

- 1 This definition does not include enclosure(s) and terminals.
- 2 The output of an LED is a function of its physical construction, material used and exciting current. The optical emission may be in the ultraviolet, visible, or infrared wavelength regions.
- 3 The term 'LED' normally refers to the LED die (or chip), or LED package. It is also used as a generic term representing the technology.
- 4 (Refer to IEC 60050-845, 845-04-40, modified and CIE S 017/E: 2011 ILV, 17-662, modified.)

1.4.3.8 Luminous efficacy (of a light source)

The ratio of the luminous flux emitted by a light source to the electric power which it consumes.

Unit: lumen per watt ($\frac{\text{lm}}{\text{W}}$)

1.4.3.9 Luminaire efficacy rating (LER)

The ratio of the total luminaire luminous flux, in lumens, and the total luminaire power input, in watts. (Unit: $\frac{\text{lm}}{\text{W}}$)

1.4.3.10 Metal halide lamp

A discharge light source in which the light is produced by an electric discharge through a mixture of a metallic vapour (usually mercury) and the products of the dissociation of halides, (e.g. halides of thallium, indium and sodium).

1.4.3.11 Reflector lamp

An incandescent or discharge light source in which part of the bulb, generally of suitable shape, is coated with a reflecting material to control the light. The sealed beam light source is a typical example.

1.4.3.12 Solid state lighting (SSL)

A group of devices that embody p-n junctions that emit visible radiation when excited by an electric current. They can be further defined by the type of technology used, that is, light emitting diodes (LEDs), organic light-emitting diodes (OLEDs) or polymer light emitting diodes (PLEDs).

1.4.3.13 Tungsten halogen (quartz) lamp

An incandescent light source, usually with a quartz envelope, having a gas filling containing a certain proportion of halogens. Tungsten iodine and tungsten bromine light sources are of this type.

1.4.4 Light source colour characteristics**1.4.4.1 Chromaticity**

An objective expression of the quality of a colour of light regardless of its luminance.

NOTE: Chromaticities are often expressed in terms of the coordinates x , y in the CIE xyY colour space.

1.4.4.2 Colour appearance (of a light source)

Objectively, the chromaticity of a truly white surface illuminated by the source; subjectively, the hue of a white surface illuminated by the source, or the degree of warmth associated with the source colour.

NOTES:

- 1 Light sources with a correlated colour temperature of from 2000 K to 3500 K are usually described as having a warm colour appearance and light sources with a correlated colour temperature above 5000 K as having a cool colour appearance.
- 2 The colour appearance, although related to the spectral energy distribution of the source, is evaluated by the eye and gives no indication of the spectral energy distribution of light sources, i.e. sources of differing spectral energy distributions may have identical colour appearances.

1.4.4.3 *Colour rendering*

A general expression for the degree to which a light source faithfully shows the colours of objects.

NOTE: The colour rendering properties of a light source are usually expressed in terms of the CIE colour-rendering index (R_a) or in terms of CIE light source colour rendering groups (see Clause 3.1.4).

1.4.4.4 *Colour rendering index*

Measure of the degree to which the colours of objects illuminated by a given light source conform to those of the same objects under an ideal light source of similar colour appearance.

NOTE: The CIE General Colour Rendering Index (R_a) is derived from changes in the colour appearance of a set of eight standard surface colours when the ideal light source is either daylight or a tungsten filament light source. It is expressed on a scale having a maximum of 100; the higher the value of the index the better the colour rendering.

1.4.4.5 *Correlated colour temperature (of a light source) (T_K)*

The temperature of a black body radiator that emits light of a colour appearance closest to that of the light source being considered.

Unit: kelvin (K).

1.4.5 The task and its surroundings

1.4.5.1 *Officials*

All officials, both on and off the field, court or similar, required to view and make judgments on the play e.g. umpires, linesman, off-field referees.

1.4.5.2 *Participant*

Any person taking part in the applicable game, activity or sport.

1.4.5.3 *Principal playing area (PPA)*

All portions of all surfaces which the ball or similar (e.g. puck, bowl, jack, badminton bird) or participants may touch and be considered as in play according to the rules.

1.4.5.4 *Reference plane (plane of interest)*

The horizontal, vertical, or inclined plane in which the visual task lies. Unless otherwise specified, the reference plane is assumed to be a horizontal plane at floor or ground level extending throughout the entire room or area concerned.

1.4.5.5 *Task area*

The area within which the task is located. This may be the whole of the room, playing area or a small part of it.

1.4.5.6 *Task detail*

The minute portion of the task which is under observation at any given moment, e.g. the ball, the participant.

1.4.5.7 *Task surroundings*

Surfaces visible within 45 degrees of the line of sight when details anywhere on the task are looked at. The surfaces may be in the same plane as the task or at some distance from it.

NOTES:

- 1 Surfaces within 15 degrees of the line of sight are referred to as the 'immediate task surroundings'.
- 2 The actual size and shape of the task surroundings will depend on the size and shape of the task, the distance of the task from the eye of the observer and from the surface(s) against which the task is seen.

1.4.5.8 Task (Visual)

Observation of play within the task area.

1.4.5.9 Total playing area (TPA)

The PPA plus those areas immediately adjacent to the PPA which a player might be reasonably expected to traverse during play.

1.4.5.10 Visual field

The full extent of what can be seen by a person looking in a given fixed direction.

1.4.6 Optical properties of materials**1.4.6.1 Diffusion**

The scattering of light rays so that they travel in many different directions rather than in parallel or radiating lines.

NOTE: Such scattering may be caused by passing the light through a diffusing medium (such as opal glass) or by reflecting it from a diffusely reflecting surface (such as matt finished plaster).

1.4.6.2 Reflectance or reflectance factor (ρ)

The ratio of the total luminous flux reflected from a surface to the total luminous flux which arrives at the surface. Usually expressed as a decimal in the range 0 to 1, but may also be expressed as a percentage.

1.4.6.3 Transmittance (τ)

The ratio of the total luminous flux which passes through a light-transmitting material to the total luminous flux which arrives at the surface of the material. Usually expressed as a decimal in the range 0 to 1 but may also be expressed as a percentage.

1.4.7 Visual effects**1.4.7.1 Adaptation**

The process which takes place as the eye adjusts to the brightness or the colour of the visual field.

NOTE: The term is also used, usually qualified, to denote the final stage of the process. For example, 'dark adaptation' denotes the state of the eye when it has become adapted to very low brightness.

1.4.7.2 Adaptation level

The level to which the eye becomes adjusted in a given visual environment.

1.4.7.3 Contrast

Subjectively, the difference in appearance of two parts of a visual field seen simultaneously or successively, the difference may be one of brightness or colour or both; objectively, the luminance difference expressed numerically according to pre-defined formulas.

1.4.7.4 Flicker

Impression of regular fluctuations of brightness or colour. Flicker is associated especially with the light from discharge light sources and occurs when the frequency of variation lies between a few cycles per second and the frequency above which the variations are too rapid to be registered by the eye.