ETD 49 (25066) WC
January 2025

BUREAU OF INDIAN STANDARDS
DRAFT FOR COMMENTS ONLY

Draft National Lighting Code of India

Part 1 Lighting Vocabulary

First Revision of SP 72 (Part 1)

Illumination Engineering and Luminaries Sectional Committee, ETD 49	Last Date for Comments: 02-03-2025

FOREWORD

(Formal clauses of the draft will be added later)

The primary goal of this terminology is to furnish precise definitions, ensuring a uniform understanding of each term within the realm of lighting. The terms included in this section have been carefully selected based on their relevance to the contents of the National Lighting Code, aiming to maintain clarity and consistency in their interpretation within the lighting field.

This section was first published in 2010. This revision has been undertaken to align the definitions in line with latest practices at international level. Additionally, new definitions pertinent to lighting have been incorporated. The definitions given in this section are in line with the IEC 60050-845 'International Electrotechnical Vocabulary (IEV)- Part 845: Lighting'.

Draft National Lighting Code of India

PART 1 LIGHTING VOCABULARY

(First Revision)

1 SCOPE

This Part of the code (Part 1) covers definitions and terms used in the field of lighting, which have been considered relevant keeping in view the contents of the code.

2 TERMINOLOGY

In addition to the definitions given in this Part 1, for more details on vocabulary on lighting, reference may be made to the following standards.

IS 1885 (Part 16/Sec 1): Electrotechnical Vocabulary: Part 16 Lighting, Section 1 General aspects

IS 1885 (Part 16/Sec 2): Electrotechnical Vocabulary: Part 16 Lighting, Section 2 General illumination lighting fittings and lighting for traffic and signaling

IS 1885 (Part 16/Sec 3): Electrotechnical Vocabulary: Part 16 Lighting, Section 3 Lamps and auxiliary apparatus.

IEC 62504: General lighting - Light Emitting Diode (LED) products and related equipment - Terms and definitions

3 RADIATION, QUANTITIES AND UNITS

3.1 General Terms

3.1.1 *Electromagnetic Radiation* —

a) Emission or transfer of energy in the form of electromagnetic waves with the associated photons.
b) These electromagnetic waves or these photons.

NOTE — The French term "radiation" applies preferably to a single element of any radiation, characterized by one wavelength or one frequency.

3.1.2 *Optical Radiation* — Electromagnetic radiation at wavelengths between the region of transition to X-rays (λ=1nm) and the region of transition to radio waves (λ=1mm)

3.1.3 *Visible Radiation* — Any optical radiation capable of causing a visual sensation directly.

NOTE — There are no precise limits for spectral range of visible radiation since they depend upon the amount of radiant power reaching the retina and the responsivity of the observer. The lower limit is generally taken between 360 nm and 400 nm and the upper limit between 760 nm and 830 nm.

3.1.4 *Infrared Radiation* — Optical radiation for which the wavelengths are longer than those for visible radiation.

NOTE — For infrared radiation, the range between 780 nm and 1mm is commonly subdivided into:

a) IR-A 780 nm -1400 nm
b) IR-B 1.4 µm - 3 µm
c) IR-C 3 µm -1 mm

3.1.5 *Ultraviolet Radiation* — Optical radiation for which the wavelengths are shorter than those for visible radiation.

NOTE — For ultraviolet radiation, the range between 100 nm and 400 nm is commonly subdivided into:

a) UV-A 320 nm - 400 nm
b) UV-B 290 nm - 320 nm
c) UV-C 200 nm - 290 nm

3.1.6 *Light*

a) Perceived light (*see* **4.2.1**)
b) Visible radiation (*see* **3.1.3**)

NOTES

1 The word light is sometimes used in sense **3.1.2** for optical radiation extending outside the visible range, but this usage is not recommended.

2 The term 'light' in English and 'light' in German are also used especially in visual signalling for certain lighting devices and light signals.

3.1.7 *Monochromatic Radiation* — Radiation characterized by a single frequency. In practice, radiation of a very small range of frequencies which can be described by stating a single frequency.

NOTE — The wavelength in air or in vacuum is also used to characterize a monochromatic radiation.

3.1.8 *Spectrum (of a Radiation)* — Graphical representation of radiant energy is called Spectrum.

NOTES

1 There are line spectra, continuous spectra, and spectra exhibiting both these characteristics.

2 This term is also used for spectral efficiencies (excitation spectrum, action spectrum).

3.1.9 *Spectral Line*

a) Monochromatic radiation emitted or absorbed in a transition between two energy levels.
b) Its manifestation in a spectrum.

3.1.10 *Polarized Radiation* — Radiation whose electromagnetic field, which is transversal, is oriented in defined directions.

NOTE — The polarization may be linear, elliptic or circular.

3.1.11 *Diffraction* — Deviation of the direction of propagation of a radiation, determined by the wave nature of radiation, and occurring when the radiation passes the edge of an obstacle.

3.1.12 *Wavelength (λ)* — Distance in the direction of propagation of a periodic wave between two successive points at which oscillation has same phase.

Unit: meter (m)

NOTE — The wavelength in a medium is equal to the wavelength in vaccum divided by the refractive index of the medium. Unless otherwise stated, values of wavelength are generally those in air. The refractive index of standard air (for spectroscopy: t = 15°C, p = 101325Pa) lies between 1.00027 and 1.00029 for visible radiations.

$$\lambda = \frac{V}{v}$$

Where,
λ is the wave length
V is the phase velocity (m/s) in that medium, and
v the frequency (Hz).

3.1.13 *Wave Number (s)*

The reciprocal of the wavelength, Unit metre (1/m).

3.1.14 *Point Source* — Source of radiation the dimensions of which are small enough, compared with the distance between the source and the irradiated surface, for them to be neglected in calculations and measurements.

NOTE — A points source which emits uniformly in all directions is called isotropic point source or uniform point source.

3.1.15 *Solid Angle (ω)* — Solid angle is the ratio of the sphere surface area enclosed to the square of the radious.

$$\omega = \frac{A_{sphere}}{R^2} = \frac{dA}{R^2}$$

Unit: Steradian, (sr)

3.2 Radiant, Luminous and Photon Quantities and their Units

3.2.1 *Light Stimulus* — Visible part of electromagnetic radiation entering the eye and producing a sensation of light.

3.2.2 *CIE Standard Photometric Observer* — Ideal observer having a relative spectral responsivity curve that conforms to the V(λ) function for photopic vision or V’(λ) function for scotopic vision and that complies with the summation law implied in the definition of luminous flux.

3.2.3 *Radiant Flux; Radiant Power (Φ_e; Φ; P)* — Total energy emitted from a radiating source per unit time.

Unit: J s^{-1} or Watt (W);

3.2.4 *Luminous Flux* (Φ_v; Φ) — Quantity derived from radiant flux (Φ_e) by evaluating the radiation according to its action upon the CIE standard photometric observer. For photopic vision:

$$\phi_v = K_m \int_0^{\infty} \frac{d\phi_e(\lambda)}{d\lambda} V(\lambda) d\lambda$$

Where $\frac{d\phi_e(\lambda)}{d\lambda}$ is the spectral distribution of the radiant flux and V(λ) is the spectral luminous efficiency.

Unit: Lumen (lm)

3.2.5 *Photon Flux (Φp ; Φ)*— Quotient of the number of photons dNp emitted, transmitted, or received in an element of time dt, by that element.

$$\phi_P = \frac{dN_P}{dt}$$

unit: s^{-1}

NOTE — For a beam of radiation whose spectral distribution is

$$\frac{d\phi_e(\lambda)}{d\lambda} \; or \; \frac{d\phi_e(v)}{dv}$$

, the photon flux Φ_p is

$$\phi_P = \int_0^{\infty} \frac{d\phi_e(\lambda)}{d\lambda} \frac{\lambda}{hc_0} d\lambda = \int_0^{\infty} \frac{d\phi_e(v)}{dv} \frac{1}{hv} dv$$

where h, Planck's constant = (6.6260755± 0.000 0040) × 10^{-34} J.s

and C_o, speed of light in vacuum = 299,792,458 m.s^{-1}

3.2.6 *Radiant Energy (Q_e; Q)* — Time integral of the radiant flux, ever a given duration Δt.

$$Q_e = \int_{\Delta t} \phi_e dt$$

unit: J = W.s

3.2.7 *Quantity of Light (Q_v; Q)* — Time integral of the luminous flux Φ_v over a given duration

$$Q_v = \int_{\Delta t} \Phi_v dt$$

unit: lm.s

Other unit: lumen-hour (lm.h).

3.2.8 *Radiant Intensity (for a Source, in a Given Direction) (I_e; I)* — Quotient of the radiant flux dΦ_e leaving the source and propagated in the element of solid angle dΩ containing the given direction by the element of solid angle.

$$I_e = \frac{d\Phi_e}{d\Omega}$$

Unit: W.sr^{-1}

3.2.9 *Luminous Intensity (for a Source, in a Given Direction) (I_v; I)* — Quotient of the luminous, flux dΦ_v leaving the source and propagated in the element of solid angle d containing the given direction, by the element of solid angle.

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

Unit: cd = lm.sr^{-1}

3.2.10 *Luminance (in a Given Direction, at a Given Point of Real or Imaginary Surface (L_v ; L)* — Flux per unit solid angle and per unit projected area perpendicular to the specified direction. Quantity defined by the formula.

$$I_v = \frac{d\Phi_v}{dA.Cos\theta.d\Omega}$$

Where, dΦ_v is the luminous flux transmitted by an elementary beam passing through the given point and propagating in the solid angle dΩ containing the given direction; dA is the area of a section of that beam containing the given point, θ is the angle between the normal to that section and the direction of the beam.

Unit: cd.m^{-2} = lm.m^{-2} sr^{-1}

3.2.11 *Illuminance (at a point of a surface) (E_v ; E)* — Luminous flux dΦ_v incident on an element of the surface containing the point, per unit area dA of that element.

Equivalent Definition: Integral, taken over the hemisphere visible from the given point, of the expression L_V Cosθ.dΩ, where Lv is the luminance at the given point in the various directions of the incident elementary beams of solid angle dΩ, and θ is the angle between any of these beams and the normal to the surface at the given point.

$$E_v = \frac{d\Phi_v}{dA} = \int_{2\Pi\, sr} L_v Cos\theta\, d\Omega$$

Unit 1x = 1m.m.$^{-2}$

3.2.12 *Candela (cd)* — SI unit of luminous intensity - The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540×10^{12} hertz and that has a radiant intensity in that direction of 1/683 watt per steradian.

1 cd = 1 $lm.sr^{-1}$

3.2.13 *Lumen (lm)* — SI unit of luminous flux — Luminous flux emitted in unit solid angle (steradian) by a uniform point source having a luminous intensity of 1 candela.

Equivalent Definition — Luminous flux of a beam of monochromatic radiation whose frequency is 540 x 10^{12} hertz and whose radiant flux is 1/683 watt.

3.2.14 *Lux (Ix)* — SI unit of illuminance - Illuminance produced on a surface of area 1 square metre by a luminous flux of 1 lumen uniformly distributed over that surface.

1 lx = $lm.m^{-2}$

NOTE — Non-metric unit: lumen per square foot (lm. ft^{-2}) or foot-candle (fc) (USA) = 10.764 lx.

3.2.15 *Candela Per Square Metre (cd. m^{-2})* — SI unit of luminance.

NOTE — This unit has sometimes called the nit (nt) (name discouraged) Other units of luminance:

Metric, non-SI: lambert (L) =

$$\frac{10^4}{\pi}\ cd.m^{-2}$$

Non-metric: footlambert (fL) = 3.426 $cd.m^{-2}$

3.2.16 *Radiant Efficiency (of a Source of Radiation) (η_e ; η)* — Ratio of the radiant flux of the emitted radiation to the power consumed by the source.

Unit: 1

NOTE — It must be specified whether or not the power dissipated by auxiliary equipment such as ballasts, etc, if any, is included in the power consumed by the source.

3.2.17 *Luminous Efficacy of a Source (η_v ; η)* — Quotient of the luminous flux emitted by the power consumed by the source.

Unit: $lm.W^{-1}$

NOTE — *see* note **3.2.16**.

3.2.18 *Luminous Efficacy of Radiation (K)* — Quotient of the luminous flux Φ_v by the corresponding radiant flux Φ_e.

$$K = \frac{\Phi_v}{\Phi_e}$$

Unit : $lm.W^{-1}$

NOTE — When applied to monochromatic radiations, the maximum value of K(l) is denoted by the symbol Km

K_m = 683 $lm.W^{-1}$ for $u_m = 540 \times 10^{12}$ Hz (λ_m = 555nm) for photopic vision K'_m = 1700 lm.

W^{-1} for λ'_m = 507 mn for scotopic vision.

For other wavelengths, K(l) = K_mV (l) and K'(l) = K'_mV'(l)

4 VISION, COLOUR RENDERING

4.1 The Eye

4.1.1 *Retina* — Membrane situated on inner lining of the eye that is sensitive to light stimuli; It contains photoreceptors, the cones and the rods and nerve cells that transmit to the optic nerve the signals resulting from stimulation of the photoreceptors.

4.1.2 *Cones* — Photoreceptors in the retina containing light-sensitive pigments capable of initiating the process of photopic vision.

4.1.3 *Rods* — Photoreceptors in the retina containing a light-sensitive pigment capable of initiating the process of scotopic vision.

4.1.4 *Yellow Spot; Macula Lutea* — Layer of photostable pigment covering parts of the retina in the foveal region.

4.1.5 *Fovea; Fovea Centralis* — Central part of the retina, thin and depressed, which contains almost exclusively, cones and forming the site of most distinct vision.

NOTE — The fovea subtends an angle of about 0.026 radian (1.5°) in the visual field.

4.1.6 *Foveola* — Central region of the fovea which contains only cones.

NOTE — The foveola subtends an angle of about 0.017 radian (1°) in the visual field.

4.1.7 *Adaptation* — The process by which the state of the visual system is modified by previous and present exposure to stimuli that may have various luminance, spectral distributions and angular subtenses.

NOTES

1 The terms light adaptation and dark adaptation are also used, the former when the luminances of the stimuli are of at least several candelas per square metre, and the latter when the luminances are of less than some hundredths of a candela per square metre.

2 Adaptation to specific spatial frequencies, orientations, sizes, etc., are recognized as being included in this definition.

4.1.8 *Chromatic Adaptation* — Adaptation by stimuli in which the dominant effect is that of different relative spectral distributions.

4.1.9 *Photopic Vision* — Vision by the normal eye when it is adapted to levels of luminance of at least several candelas per square metre.

NOTE — The cones are the principal active photoreceptors in photopic vision.

4.1.10 *Scotopic Vision* — Vision by the normal eye when it is adapted to levels of luminance less than some hundredths of a candela per square metre.

NOTE — The rods are the principal active photoreceptors in scotpic vision.

4.1.11 *Mesopic Vision* — Vision intermediate between photopic and scotopic vision.

NOTE — In mesopic vision, both the cones and the rods are active.

4.1.12 *Hemeralopia; Night-Blindness* — Anomaly of vision in which there is a pronounced inadequacy or complete absence of scotopic vision.

4.1.13 *Defective Colour Vision* — Anomaly of vision in which there is a reduced ability to discriminate between some or all colours.

4.1.14 *Purkinje Phenomenon* — Reduction in the brightness of a predominantly long-wavelength colour stimulus relative to that of a predominantly short-wavelength colour stimulus when the luminances are reduced in the same proportion from photopic to mesopic or scotopic levels without changing the respective relative spectral distributions of the stimuli involved.

NOTE — In passing from photopic to mesopic or scotopic vision, the spectral luminous efficiencies change, the wavelength of maximum efficiency being displaced towards the shorter wavelengths.

4.2 Light and Colour

4.2.1 *Perceived Light* — Universal and essential attribute of all perceptions and sensations that are peculiar to the visual system.

NOTE — Light is normally, but not always, perceived as a result of the action of a light stimulus on the visual system.

4.2.2 *Perceived Colour* — is defined as the characteristic of light by which an observer can distinguish between patches of light of the same size, shape, and structure. It reduces itself to a basic description of light in terms of amounts of radiant power at the different wavelengths of the visually effective spectrum, which for most practical purposes is considered to extend from 380 to 780 nm.

Attribute of visual perception consisting of any combination of chromatic and achromatic content. This attribute may be described by chromatic colour names such as yellow, orange, brown, red, pink green, blue, purple, etc., or by achromatic colour names such as white, grey, black, etc., and qualified by bright, dim, light, dark, etc, or by combinations of such names.

NOTES

1 Perceived colour depends on the spectral distribution of the colour stimulus, on the size, shape structure and surround of the stimulus area, on the state of adaptation of the observer's visual system, and on the observer's experience of the prevailing and similar situations of observation.

2 Perceived colour may appear in several modes of colour appearance. The names for various modes of appearance are intended to distinguish among qualitative and geometric differences of colour perceptions. Some of the more important terms of the modes of colour appearance are given in **4.2.3, 4.2.4 and 4.2.5**.

Other modes of colour appearance include film colour, volume colour, illuminant colour, body colour, and Ganzfeld colour. Each of these modes of colour appearance may be further qualified by adjective to describe combinations of colour or their spatial and temporal relationships. Other terms that relate to qualitative differences among colours perceived in various modes of colour appearance are given in **4.2.6, 4.2.7, 4.2.8** and **4.2.9.**

4.2.3 *Object-Colour* — Colour perceived as belonging to an object.

4.2.4 *Surface Colour* — Colour perceived as belonging to a surface from which the light appears to be diffusely reflected or radiated.

4.2.5 *Aperture Colour*— Perceived colour for which there is no definite spatial localization in depth, such as that perceived as filling a hole in a screen.

4.2.6 *Luminous (Perceived) Colour* — Colour perceived to belong to an area that appears to be emitting light as a primary light source, or that appears to be specularly reflecting such light.

NOTE — Primary light source seen in their natural surroundings normally exhibit the appearance of - luminous colours in this sense.

4.2.7 *Non-Luminous (Perceived) Colour*— Colour perceived to belong to an area that appears to be transmitting or diffusely reflecting light as a secondary light source.

NOTE — Secondary light sourced seen in their natural surroundings normally exhibit the appearance of non-luminous colours in this sense.

4.2.8 *Related (Perceived) Colour* — Colour perceived to belong to an area seen in relation to other colours.

4.2.9 *Unrelated (Perceived) Colour* — Colour perceived to belong to an area seen in isolation from other colours.

4.2.10 *Achromatic (Perceived) Colour* —

a) In the perceptual sense — Perceived colour devoid of hue. The colour names white, grey and black are commonly used or, for transmitting objects, colourless and neutral; and
b) In the psychophysical sense — *see* **5.2.2**

4.2.11 *Chromatic (Perceived) Colour*

a) In the perceptual sense — Perceived colour possessing hue. In everyday speech, the word colour is often used in this sense in contradistinction to white, grey or black. The adjective coloured usually refers to chromatic colour and

b) In the psychophysical sense — *see* **5.2.3**

4.2.12 *Brightness; Luminosity (Obsolete)* — Attribute of a visual sensation according to which an area appears to emit more or less light.

4.2.13 *Bright* — Adjective used to describe high levels of brightness.

4.2.14 *Dim* — Adjective used to describe low levels of brightness.

4.2.15 *Lightness (of a Related Colour)* — The brightness of an area judged relative to the brightness of a similarly illuminated area that appears to be white or highly transmitting.

NOTE — Only related colours exhibit lightness.

4.2.16 *Light* — Adjective used to describe high levels of lightness.

4.2.17 *Dark* — Adjective used to describe low levels of lightness.

4.2.18 *Hue* — Attribute of a visual sensation according to which an area appears to be similar to one of the perceived colours, red, yellow, green, and blue, or to a combination of two of them.

NOTE — Formerly “Farbton” in German.

4.2.19 *Unitary Hue; Unique Hue* — Perceived hue that can not be further described by the use of hue names other than its own.

NOTE — There are four unitary hues; red, green, yellow and blue.

4.2.20 *Binary Hue* — Perceived hue that may be described as a combination of two unitary hues. For example, orange is a yellowish-red or reddish yellow; violet is reddish-blue, etc.

4.2.21 *Chroma* — Chromaticness, colourfulness, of an area judged as a proportion of the brightness of a similarly illuminated area that appears white or highly transmitting.

NOTE — For given viewing conditions and at luminance levels within the range of photopic vision, a colour stimulus perceived as a related colour, of a given chromaticity and from a surface having a given luminance factor, exhibits approximately constant chrome for all levels of illuminance except when the brightness is very high. In the same circumstances, at a given level of illuminance, if the luminance factor is increased, the chroma usually increases.

4.3 Visual Phenomena

4.3.1 *Visual Acuity; Visual Resolution*

a) *Qualitatively* — Capacity for seeing distinctly fine details that have very small angular separation; and
b) *Quantitatively* — Any of a number of measures of spatial discrimination such as the reciprocal of the value of the angular separation in minutes of are of two neighbouring objects (points or lines or other specified stimuli) which the observer can just perceive to be separate.

4.3.2 *Accommodation* — Adjustment of the dioptric power of the crystalline lens by which the image of an object, at a given distance, is focused on the retina.

4.3.3 *Luminance Threshold* — Lowest luminance of a stimulus which enables it to be perceived.

NOTE — The value depends on field size, surround, state of adaptation, and other viewing conditions.

4.3.4 *Flicker* — Impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time.

4.3.5 *Glare* — Condition of vision in which there is discomfort or a reduction in the ability to see details or objects, caused by an unsuitable distribution or range of luminance, or to extreme contrasts.

NOTE — In Russian, the terms **4.3.5** to **4.3.10** relate to the properties of the light sources and other luminous surfaces which disturb the condition of vision, and not to the changed condition of vision caused by an unsuitable distribution of luminance in the visual field.

4.3.6 *Direct Glare* — Glare caused by self-luminous objects situated in the visual field, especially near the line of sight.

4.3.7 *Glare by Reflections* — Glare produced by reflections, particularly when the reflected images appear in the same or nearly the same direction as the object viewed.

NOTE — Formerly reflected glare.

4.3.8 *Veiling Reflections* — Specular reflections that appear on the object viewed and that partially or wholly obscure the details by reducing contrast.

4.3.9 *Discomfort Glare* — Glare that causes discomfort without necessarily impairing the vision of objects.

4.3.10 *Disability Glare* — Glare that impairs the vision of objects without necessarily causing discomfort.

4.3.11 *Equivalent Veiling Luminance (for Disability Glare or Veiling Reflections)* — The luminance that, when added by superposition to the luminance of both the adapting backgrounds and the object, makes the luminance threshold or the luminance difference threshold the same under the two following conditions: 1) Glare present, but no additional luminance; and 2) Additional luminance present, but no Glare.

4.4 Colour Rendering

4.4.1 *Colour Rendering* — Effect of an illuminant on the colour appearance of objects by conscious or subconscious comparison with their colour appearance under a reference illuminant.

4.4.2 *Reference Illuminant* — An illuminant with which other illuminants are compared.

NOTE — A more particular meaning may be needed in the case of illuminates for colour reproduction.

4.4.3 *Colour Rendering Index (R)* — Measure of the degree to which the psychophysical colour of an object illuminated by the test illuminant conforms to that of the same object illuminated by the reference illuminant, suitable allowance having been made for the state of chromatic adaptation.

4.4.4 *CIE 1974 Special Colour Rendering Index* (R_i) — Measure of the degree to which the psychophysical colour of a CIE test colour sample illuminated by the test illuminant conforms to that of the same sample illuminated by the reference illuminant, suitable allowance having been made for the state of chromatic adaptation.

4.4.5 *CIE 1974 General Colour Rendering Index* (R_a) — Mean of the CIE 1974 special colour rendering indices for a specified set of eight test colour samples.

5 COLORIMETRY

5.1 Colour

a) Perceived Colour — *see* **4.2.2**
b) Psychophysical Colour

A specification of a colour stimulus in terms of operationally defined values, such as three tristimulus values.

NOTE — When the meaning is clear from the context the term colour may be used alone.

5.2 Stimulus

5.2.1 *Colour Stimulus* — Visible radiation entering the eye and producing a sensation of colour, either chromatic or achromatic.

5.2.2 *Achromatic Stimulus* — A stimulus that, under the prevailing conditions of adaptation, gives rise to an achromatic perceived colour.

NOTE — In the colorimetry of object-colours, the colour of the perfect reflecting or transmitting diffuser is usually considered to be an achromatic stimulus for all illuminants, except those whose light sources appear to be highly chromatic.

5.2.3 *Chromatic Stimulus* — A stimulus that, under the prevailing conditions of adaptation, gives rise to a chromatic perceived colour.

NOTE — In the colorimetry or object-colours, stimuli having purities greater than zero are usually considered to be chromatic stimuli.

5.2.4 *Monochromatic Stimulus; Spectral Stimulus* — A stimulus consisting of a monochromatic radiation.

5.2.5 *Complementary Colour Stimuli* — Two colour stimuli are complementary when it is possible to reproduce the tristimulus values of a specified achromatic stimulus by a suitable additive mixture of these two stimuli.

5.3 Illuminants

5.3.1 *Illuminant* — Radiation with a relative spectral power distribution defined over the wavelength range that influences object colour perception.

NOTE — In everyday English this term is not restricted to this sense, but is also used for any kind of light falling on a body or scene.

5.3.2 *Daylight Illuminant* — Illuminant having the same or nearly the same relative spectral power distribution as a phase of daylight.

5.3.3 *CIE Standard Illuminants* — The illuminants A, B, C, D65, and other illuminants D, defined by the CIE in terms of relative spectral power distributions.

NOTE — These illuminants are intended to represent; A, Planckian radiation at a temperature of about 2856K; B, Direct solar radiation (obsolete);
C, average daylight; and
D65, daylight including the ultraviolet region.

5.3.4 *CIE Standard Sources* — Artificial sources specified by the CIE whose radiations approximate CIE standard illuminants A, B, and C

5.4 Trichromatic Systems

5.4.1 *Colour Matching* — Action of making a colour stimulus appear the same in colour as a given colour stimulus.

NOTE — The French and Russian terms apply mainly to the adjustment, of equality of the fields of a visual colorimeter, whereas the English and German terms apply equally well to the selection of two material specimens having the same colour under a given illuminant.

5.4.2 *Trichromatic System* — System for specifying colour stimuli in terms of tristimulus values, based on matching colours by additive mixture of three suitably chosen reference colour stimuli.

5.4.3 *Reference Colour Stimuli* —The set of three colour stimuli on which a trichromatic system is based.

NOTES:

1 These stimuli are either real colour stimuli or theoretical stimuli which are defined by linear combinations of real colour stimuli; the magnitude of each of these three reference colour stimuli is expressed in terms of either photometric or radiometric units, or more commonly by specifying the ratios of their magnitudes or by stating that a specified additive mixture of these three stimuli matches a specified achromatic stimulus; and

2 In the CIE standard colorimetric systems, the reference colour stimuli are represented by the symbols (X), (Y), (Z) and (X10), (Y10), and (Z10).

5.4.4 *Tristimulus Values (of a Colour Stimulus)* — Amounts of the three reference colour stimuli, in a given trichromatic system, required to match the colour of the stimulus considered.

NOTE — In the CIE standard colorimetric systems, the tristimulus values are represented by the symbols X, Y, Z, and [X10], [Y10], [Z10].

5.4.5 *Colour Space* — Geometric representation of colours in space, usually of three dimensions.

5.4.6 *Colour Solid* — That part of a colour space which contains surface colours.

5.4.7 *Standard Colorimetric System (XYZ)* — A system for determining the tristimulus values of any spectral power distribution using the set of reference colour stimuli (X), (Y), (Z) and the three colour- matching functions

$$\bar{x}_{\lambda}, \bar{y}_{\lambda}, \bar{z}_{\lambda}.$$

NOTES

1 $\bar{y}_{\lambda} = V(\lambda)$ and hence the tristimulus value Y is proportional to luminances; and

2 This standard colorimetric system is applicable to centrally-viewed fields of angular size between about 1° and about 4° (0.017 and 0.07 rad).

5.5 Chromaticity

5.5.1 *Chromaticity Coordinates* — Ratio of each of a set of three tristimulus values to their sum.

NOTES

1 As the sum of the three chromaticity coordinates equals 1, two of them are sufficient to define a chromaticity;

2 In the CIE standard colorimetric systems, the chromaticity coordinates are represented by the symbols x, y, z and x10, y10 and z10

5.5.2 *Chromaticity* — Property of a colour stimulus defined by its chromaticity coordinates, or by its dominant or complementary wavelength and purity taken together.

5.5.3 *Chromaticity Diagram* — A plane diagram in which point specified by chromaticity coordinates represent the chromaticities of colour stimuli.

NOTE — In CIE standard colorimeter system y is normally plotted as ordinate and x as abscissa, to obtain an x,y chromaticity diagram.

5.5.4 *Planckian Lous* — The Locus of points in a chromaticity diagram that represents chromaticities of the radiation of Planckian radiators at different temperatures.

5.5.5 *Daylight Locus* — The locus of points in a chromaticity diagram that represents chromaticities of phases of daylight with different correlated colour temperatures.

5.5.6 *Dominant Wavelength (of a Colour Stimulus) (λ_d)* — Wavelength of the monochromatic stimulus that, when additively mixed in suitable proportions with the specified achromatic stimulus, matches the colour stimulus considered.

NOTE — In the case of purple stimuli, the dominant wavelength is replaced by the Complementary wavelength.

5.5.7 *Complementary Wavelength (of a Colour Stimulus) (λ_c)* — Wavelength of the monochromatic stimulus that, when additively mixed in suitable proportions with the colour stimulus considered, matches the specified achromatic stimulus.

5.5.8 *Purity (of a Colour Stimulus)* — A measure of the proportions of the amounts of the monochromatic stimulus and of the specified achromatic stimulus that, when additively mixed, match the colour stimulus considered.

NOTES

1 In the case of purple stimuli, the monochromatic stimulus is replaced by a stimulus whose chromaticity is represented by a point on the purple boundary.

2 The proportions can be measured in various ways.

5.5.9 *Colour Temperature (T_c)*—The temperature of a Planckian radiator whose radiation has the same chromaticity as that of a given stimulus.

Unit K^{-1}

NOTE — The reciprocal colour temperature is also used,

5.5.10 *Correlated Colour Temperature (T_{cp})* — The temperature of the Planckian radiator whose perceived colour most closely resembles that of a given stimulus at the same brightness and under specified viewing conditions.

Unit: Kelvin (K)

NOTES

1 The recommended method of calculating the correlated colour temperature of a stimulus is to determine on a chromaticity diagram the temperature corresponding to the point on the Planckian locus that is intersected by the agreed isotemperature line containing the point representing the stimulus.

2 Reciprocal correlated colour temperature is used rather than reciprocal colour temperature whenever correlated colour temperature is appropriate.

6 EMISSION, OPTICAL PROPERTIES OF MATERIALS

6.1 Emission

6.1.1 *Emission (of Radiation)* — Release of radiant energy.

6.1.2 *Incandescence* — Emission of optical radiation by the process of thermal radiation.

NOTE — In USA, incandescence is restricted to visible radiation

6.1.3 *Energy Level* — Discrete quantum state of energy of an atom, a molecule or an ion.

6.1.4 *Excitation* — Elevation of the energy levels of atoms, molecules or ions to higher energy levels.

6.1.5 *Luminescence* — Emission, by atoms, molecules or ions in a material, of optical radiation which for certain wavelengths or regions of the spectrum is in excess of the radiation due to thermal emission from that material at the same temperature, as a result of these particles being excited by energy other than thermal agitation.

NOTE — In the USA this term sometimes applies to emitted radiation.

6.1.6 *Photoluminescence* — Luminescence caused by absorption of optical radiation.

6.1.7 *Fluorescence* — Photoluminescence in which the emitted optical radiation results from direct transitions from the photo-excited energy level to a lower level, these transitions taking place generally within 10 nano seconds after the excitation.

6.1.8 *Afterglow* — Slowly decaying luminescence persisting after the excitation of the luminescent material has ceased, the duration of which may be from about 100 milliseconds to several minutes.

6.1.9 *Phosphorescence* — Photoluminescence delayed by storage of energy in an intermediate energy level.

NOTES

1 For organic substances, the term phosphorescence applies generally to triplet-singlet transitions;

2 This term is sometimes used as a loose expression to designate other types of luminescence.

6.1.10 *Electroluminescence* — Luminescence caused by the action of an electric field in a gas or in a solid material (Destriau effect, or radiative recombination as in light-emitting diodes).

6.1.11 *Cathodoluminescence* — Luminescence caused by the impact of electrons on certain types of luminescent materials, such as the coating on a television screen.

6.1.12 *Thermally Activated Luminescence: Thermo luminescence* — Luminescence occurring when a previously excited luminescent material is heated.

6.1.13 *(Luminescence) Emission Spectrum* — Spectral distribution of the radiation emitted by a luminescent material for a specified excitation.

6.1.14 *Stimulated Emission* — Process of emission by quantum transition from an excited energy level to a lower level, triggered by incident radiation having the frequency of that transition.

6.1.15 *LASER* — Source emitting coherent optical radiation produced (amplified) by simulated emission of radiation.

6.1.16 *Light Emitting Diode; LED* — Solid state device embodying a p-n junction, emitting optical radiation when excited by an electric current.

6.2 Optical Properties of Materials

6.2.1 *Reflection* — Process by which radiation is returned by a surface or a medium, without change of frequency of its monochromatic components.

NOTES

1 Part of the radiation falling on a medium is reflected at the surface of the medium (surface reflection); another part may be scattered back from the interior of the medium (volume reflection); and

2 The frequency is unchanged only if there is no Doppler effect due to the motion of the materials from which the radiation is returned.

6.2.2 *Transmission* — Passage of radiation through a medium without change of frequency of its monochromatic components.

6.2.3 *Diffusion Scattering* — Process by which the spatial distribution of a beam of radiation is changed when it is deviated in many directions by a surface or by a medium, without change of frequency of its monochromatic components.

NOTE— A distinction is made between selective diffusion and non-selective diffusion according to whether or not the diffusing properties vary with the wavelength of the incident radiation.

6.2.4 *Regular Reflection: Specular Reflection* — Reflection in accordance with the laws of geometrical optics, without diffusion.

6.2.5 *Regular Transmission; Direct Transmission* — Transmission in accordance with the laws of geometrical optics, without diffusion.

6.2.6 *Diffuse Reflection* — Diffusion by reflection in which, on the macroscopic scale, there is no regular reflection.

6.2.7 *Diffuse Transmission* — Diffusion by Transmission in which, on the macroscopic scale, there is no regular transmission.

6.2.8 *Mixed Reflection* — Partly regular and partly diffuse reflection.

6.2.9 *Isotropic Diffuse Reflection* — Diffuse reflection in which the spatial distribution of the reflected radiation is such that the radiance or luminance is the same in all directions in the hemisphere into which the radiation is reflected.

6.2.10 *Isotropic Diffuse Transmission* — Diffuse transmission in which the spatial distribution of the transmitted radiation is such that the radiance or luminance is the same in all directions in the hemisphere into which the radiation is transmitted.

6.2.11 *Diffuser* — Device used to alter the spatial distribution of radiation and depending essentially on the phenomenon of diffusion.

NOTE— If all the radiation reflected or transmitted by the diffuser is diffused with no regular reflection or transmission, the diffuser is said to be completely diffusing; independently of whether or not the reflection or transmission is isotropic.

6.2.12 *Perfect Reflecting Diffuser* — Ideal isotropic diffuser with a reflectance equal to 1.

6.2.13 *Perfect Transmitting Diffuser* — Ideal isotropic diffuser with a transmittance equal to 1.

6.2.14 *Lambert's (Cosine) Law* — For a surface element whose radiance or luminance is the same in all directions of the hemisphere above the surface:

$$I(q) = I_n \, Cosq$$

Where, I(q) and I_n are the radiant or luminous intensities of the surface element in a direction at an angle q from the normal to the surface and in the direction of that normal, respectively.

6.2.15 *Lambertian Surface* — Ideal surface for which the radiation coming from that surface is distributed angularly according to Lambert's cosine law.

NOTE — For a Lambertian surface, $M = \pi L$, where M is the radiant or luminous exitance, and L the radiance or luminance.

Reflectance (for Incident Radiation of Given Spectral Composition Polarization and Geometrical Distribution) (r) — Ratio of the reflected radiant or luminous flux to the incident flux in the given conditions.

Unit : 1

6.2.16 *Diffuse Reflectance (ρ_d)* — Ratio of the diffusely reflected part of the (whole) reflected flux, to the incident flux.

Unit : 1

NOTES

1 $\rho = \rho r + \rho d$

2 The results of the measurements of ρr and ρd depend on the instruments and the measuring techniques used.

6.2.17 Reflectance factor [R] (at a surface element, for the part of the reflected radiation contained in a given cone with apex at the surface element, and for incident radiation of given spectral composition, polarization and geometrical distribution)

Ratio of the radiant or luminous flux reflected in the directions delimited by the given cone to that reflected in the same directions by a perfect reflecting diffuser identically irradiated or illuminated.

NOTES

1 For regularly reflecting surfaces that are irradiated or illuminated by a beam of small solid angle, the reflectance factor may be much larger than 1 if the cone includes the mirror image of the source.

2 If the solid angle of the cone approaches 2n sr, the reflectance factor approaches the reflectance for the same conditions of irradiation.

3 If the solid angle of the cone approaches zero, the reflectance factor approaches the radiance or luminance factor for the same conditions of irradiation.

6.2.18 Transmittance (for incident radiation of given spectral composition, polarization and geometrical distribution) (τ) Ratio of the transmitted radiant or luminous flux to the incident flux in the given conditions.

Unit: 1

6.2.19 *Diffuse Transmittance (τd)* — Ratio of the diffusely transmitted part of the (whole) transmitted flux, to the incident flux.

Unit: 1

NOTES

1 $\tau = \tau r + \tau d$

2 The results of the measurements of τr and τd depend on the instruments and the measuring techniques used.

6.2.20 *Gloss (of a Surface)* — The mode of appearance by which reflected highlights of objects are perceived as superimposed on the surface due to the directionally selective properties of that surface.

6.2.21 *Absorption* — Process by which radiant energy is converted to a different form of energy by interaction with matter.

6.2.22 *Reflectivity (of a Material)* — Reflectance of a layer of the material of such a thickness that there is no change of reflectance with increase in thickness.

Unit : 1

6.2.23 *Diffusion Factor (of a Diffusing Surface, by Reflection or by Transmission) (s)* — Ratio of the mean of the values of luminance measured at 20° and 70° (0.35 and 1.22 radian) to the luminance measured at 5° (0.09 radian) from the normal, when the surface considered is illuminated normally.

$$\sigma = \frac{L(20°) + L(70°)}{2L(5°)}$$

NOTES

1 The diffusion factor is intended to give an indication of the spatial distribution of the diffused flux. It is equal to 1 for every isotropic diffuser, whatever the value of the diffuse reflectance or transmittance;

2 This way of defining the diffusion factor may be applied only to materials for which the indicatrix of diffusion does not differ appreciably from that of ordinary opal glasses.

6.2.24 *Retroreflecion* — Reflection in which radiation is returned in directions close to the opposite of the direction from which it came, this property being maintained over wide variations of the direction of the incident rays.

6.2.25 *Retroreflector* — A surface or device from which most of the reflected radiation is retroreflected.

6.2.26 *Observation angle (of a Retroreflector) (α)* — Angle between the direction of observation of the retroreflector and the direction of the incident light.

6.2.27 *Coefficient of Luminous Intensity (of a Retroreflector) [R]* — Quotient of the luminous intensity I of the retroreflector in the direction of observation by the illuminance E⊥ at the retroreflector on a plane perpendicular to the direction of the incident light

R = I/E⊥

Unit: cd/lx

6.2.28 *Coefficient of Retroreflected Luminance (of a Plane Retroreflective Surface) [R_L]*— Quotient of the luminance L of the retroreflective surface in the direction of observation by the illuminance E⊥ at the retroreflector on a plane perpendicular to the direction of the incident light.

RL = L / E⊥

Unit: cd/m² per lux

6.2.29 *Liquid Crystal Display; LCD* — A display device which uses certain liquid crystals whose reflectance or transmittance may be changed by applying an electric field.

6.2.30 *Refraction* — Process by which the direction of a radiation is changed as a result of changes in its velocity of propagation in passing through an optically non-homogeneous medium, or in crossing a surface separating different media.

6.2.31 *Refractive Index (of a Medium, for a Monochromatic Radiation of Wavelength λ in vacuum); n(λ)* — Ratio of the velocity of the electromagnetic waves in vacuum to the phase velocity of the waves of the monochromatic radiation in the medium.

Unit : 1

> NOTE — For isotropic media, this index is equal to the ratio of the sines of the angles of incidence (q_1) and refraction (q_2) of a ray passing through the surface separating vacuum and medium:

$$n(\lambda) = \frac{Sin\theta_1}{Sin\theta_2}$$

6.2.32 *Dispersion*

a) Phenomenon of change in the velocity of propagation of monochromatic radiations in a medium as a function of the frequency of these radiations;
b) Property of a medium giving rise to this phenomenon; and
c) Property of an optical system resulting in the separation of the monochromatic components of a radiation, obtained for example by means of prisms or gratings.

6.2.33 *(Optical) Filter* — Regularly transmitting device used to modify the radiant or luminous flux, the relative spectral distribution, or both, of the radiation passing through it.

> NOTE — A distinction is made between selective filters and non-selective filters or neutral filters or neutral grey filters according as they do or do not alter the relative spectral distribution of the radiation: A selective filter that makes a significant change in the chromaticity of the radiation is called a coloured

filter; one that alters the spectral distribution but, because of metamerism, transmits radiation of nearly the same chromaticity as that of the incident radiation, may be called a grey filter.

6.2.34 *Transparent Medium* — Medium in which the transmission is mainly regular and which usually has a high regular transmittance in the spectral range of interest.

NOTE — Objects may be seen distinctly through a medium which is transparent in the visible region, if the geometric form of the medium is suitable.

6.2.35 *Translucent Medium* — Medium which transmits visible radiation largely by diffuse transmission, so that objects are not seen distinctly through it.

6.2.36 *Opaque medium* — Medium which transmits no radiation in the spectral range of interest.

7 RADIOMETRIC, PHOTOMETRIC AND COLORIMETRIC MEAS UREMENTS, PHYSICAL DETECTORS

7.1 General Terms and Instruments

7.1.1 *Primary Photometric Standard* — Device designed to establish the photometric base unit (candela).

7.1.2 *Secondary Photometric Standard* — Light source or photometer calibrated by reference to a primary photometric standard.

7.1.3 *Working Photometric Standard* — Light source or photometer used, on a day to day basis, for photometric measurements and calibrated by reference to a secondary photometric standard.

7.1.4 *Comparison Lamp* — Light source having a constant but not necessarily known luminous intensity, luminous flux, or luminance, with which a standard lamp and the light source under test are successively compared.

7.1.5 *Photometry* — Measurement of quantities referring to radiation as evaluated according to a given spectral luminous efficiency function, e.g. $V(\lambda)$ or $V'(\lambda)$.

NOTE — In Russian publications, photometry refers only to the evaluation according to $V(\lambda)$. The term photometry is also often used in publications in Russian and in other languages in a broader sense covering the science of optical radiation measurement (radiometry).

7.1.6 *Colorimetry* — Measurement of colours based on a set of conventions.

7.1.7 *Visual Photometry* — Photometry in which the eye is used to make quantitative comparisons between light stimuli.

7.1.8 *Visual Colorimetry* — Colorimetry in which the eye is used to make quantitative comparisons between colour stimuli.

7.1.9 *Physical Photometry* — Photometry in which physical detectors are used to make the measurements.

7.1.10 *Physical Colorimetry* — Colorimetry in which physical detectors are used to make the measurements.

7.1.11 *Photometer* — Instrument for measuring photometric quantities.

7.1.12 *Illuminance Meter* — Instrument for measuring illuminance.

7.1.13 *Luminance Meter* — Instrument for measuring luminance.

7.1.14 *Colorimeter* — Instrument for measuring colorimetric quantities, such as the tristimulus Values of a colour stimulus.

7.1.15 *Flicker Photometer* — Visual photometer in which the observer sees either an undivided field illuminated successively, or two adjacent fields illuminated alternately, by two sources to be compared, the frequency of alternation being conveniently chosen so that it is above the fusion frequency for colours but below the fusion frequency for brightnesses.

7.1.16 *Goniophotometer* — Photometer for measuring the directional light distribution characteristics of sources, luminaires, media or surfaces.

7.1.17 *Integrating Sphere; Ulbricht Sphere* — Hollow sphere whose internal surface is a diffuse reflector, as non-selective as possible.

NOTE — An integrating sphere is used frequently with a radiometer or photometer.

7.1.18 *Integrating Photometer* — Photometer for measuring luminous flux, generally incorporating an integrating sphere.

7.1.19 *Reflectometer* — Instrument for measuring quantities pertaining to reflection.

7.2 Physical Detectors of Optical Radiation

7.2.1 *Photoelectric Detector* — Detector of optical radiation which utilizes the interaction between radiation and matter resulting in absorption of photons and the consequent liberation of electrons from their equilibrium state thereby generating an electric potential or current or can a change in electric resistance excluding phenomenon caused by temperature changes.

7.2.2 *Photo Emissive Cell; Phototube* — Photoelectric detector that utilizes emission of electrons caused by optical radiation.

7.2.3 *Photocathode* — Metallic or semiconducting layer designed for efficient photoemission of electrons and used in a photoelectric detector.

7.2.4 *Photomultiplier* — Photoelectric detector comprising a photocathode, an anode and an electron multiplication device that uses the secondary emission of dynodes or channels between photocathode and anode.

7.2.5 *Photo Resistor; Photoconductive Cell* — Photoelectric device that utilizes the change of electrical conductivity produced by the absorption of optical radiation.

7.2.6 *Photoelement; Photovoltaic Cell* — Photoelectric detector that utilizes the electromotive force produced by the absorption of optical radiation.

7.2.7 *Photodiode* — Photoelectric detector in which a photocurrent is generated by absorption of optical radiation in the neighbourhood of a p-n junction between two semiconductors or a junction between a semiconductor and a metal.

7.2.8 *Phototransistor* — Photoelectric detector that uses semiconductors in which the photoelectric effect is produced in the neighbourhood of a double p-n junction (p-n-p or n-p-n) which possesses amplification properties.

7.2.9 *Photon counter* — Instrument comprising a photoelectric detector and auxiliary electronics with which the electrons emitted by the photocathode can be counted.

7.2.10 *Thermal detector of radiation; thermal (radiation) detector* — Detector of optical radiation in which a measurable physical effect is produced by the heating of the part that absorbs radiation.

7.2.11 *(Radiation) Thermocouple* — Thermal detector of optical radiation in which the electromotive force produced in a single thermoelectric junction is used to measure the heating effect produced by the absorbed radiation.

7.2.12 *(Radiation) Thermopile* — Thermal detector of optical radiation in which the electromotive force produced in several thermoelectric junctions is used to measure the heating effect produced by the absorbed radiation.

7.2.13 *Photocurrent (I_{Ph})* — That part of the output current of a photoelectric detector which is caused by incident radiation.

> NOTE — In photomultipliers a distinction must be made between the cathode photocurrent and the anode photocurrent.

7.2.14 *Dark Current (I_o)* — Output current of a photoelectric detector or of its cathode in the absence of incident radiation.

7.2.15 *Relative Responsivity; Relative Sensitivity (of a Detector) [s_r]* — Ratio of the responsivity s(Z) when the detector is irradiated with radiation Z to the responsivity s(N) when it is irradiated with a reference radiation N.

$$s_r = s\,(Z) / s(N)$$

7.2.16 *Spectral Responsivity; Spectral Sensivity (of a Detector) [s(λ)]* — Quotient of the detector output dY(λ) by the monochromatic detector input dXe(λ) = Xe,λ (λ) • d λ in the wavelength interval d λ as a function of the wavelength λ.

$$S(\lambda) = \frac{dY(\lambda)}{dX_e(\lambda)}$$

7.2.17 *Relative Spectral Responsivity; Relative Spectral Sensitivity (of a Detector) [sr(λ)]* —

Ratio of the spectral responsivity s(2) of the detector at wavelength A to a given reference value sm.

$$sß(2) = s(2)/sm$$

NOTE — The given reference value sm can be an average value, a maximum value or an arbitrarily chosen value of: s (2).

7.2.18 *Response Time (of a Detector)* — Time required for the change of detector output to reach, after a step variation of a steady detector input, a given percentage of its final value.

7.2.19 *Time Constant (of a Detector Whose Output Varies Exponentially With Time)* — Time required for the detector output to vary, after a step variation from a steady input to another steady input, from its initial value by the fraction (1-1/e) of its final change.

7.2.20 *Rise Time (of a Detector)* — Time required for a detector output to rise from a stated low percentage to a stated higher percentage of the maximum value when a steady input is instantaneously applied.

NOTE — It is usual to consider a low percentage of 10% and a high percentage of 90 percent.

7.2.21 *Fall Time (of a Detector)* — Time required for a detector output to fall from a stated high percentage to a stated lower percentage of the maximum value when a steady input is instantaneously removed.

NOTE — It is usual to consider a high percentage of 90 percent and a low percentage of 10 percent.

7.2.22 *Noise Equivalent Input (of a Detector)* — Value of the detector input that produces an output equal to the root mean square (r.m.s.) noise output, for a stated frequency and bandwidth of the measuring instrument.

NOTE — It is usual to consider a 1 Hz bandwidth and this value is implied unless stated otherwise.

7.2.23 *Noise Equivalent Power; (NEP) (of a Detector) (Φ_m)* — Name given to the noise equivalent input when the quantity that the detector is being used to measure or detect is radiant flux.

7.2.24 *Detectivity (of a Detector) [D]* — Reciprocal of the noise equivalent power.

$D = l/\Phi_m$

7.2.25 *Quantum Efficiency (of a Detector) (η)* — Ratio of the number of elementary events (such as release of an electron) contributing to the detector output, to the number of incident photons.

8 LIGHT SOURCES

8.1 General Terms

8.1.1 *Primary Light Source* — Surface or object emitting light produced by a transformation of energy.

8.1.2 *Secondary Light Source* — Surface or object which is not self-emitting but receives light and re-directs it, at least in part, by reflection or transmission.

8.1.3 *Lamp* —Source made in order to produce an optical radiation usually visible.

NOTE — This term is also used for certain types of luminaires.

8.2 Incandescent Lamps

8.2.1 *Incandescent (Electric) Lamp* — Lamp in which light is produced by means of an element heated to incandescence by the passage of an electric current.

8.2.2 *Carbon Filament Lamp* — Incandescent lamp whose luminous element is a filament of carbon. For the shapes of filament, *see* **9.3, 9.4** and **9.5**.

8.2.3 *Metal Filament Lamp* — Incandescent lamp whose luminous element is a filament of metal. For the shapes of filament, *see* **9.3, 9.4** and **9.5**.

8.2.4 *Tungsten Filament Lamp* — Incandescent lamp whose luminous element is a filament of tungsten. For the shapes of filament, *see* **9.3, 9.4** and **9.5**.

8.2.5 *Vacuum (Incandescent) Lamp* — Incandescent lamp in which the luminous element operates in an evacuated bulb.

8.2.6 *Gas-Filled (Incandescent) Lamp* — Incandescent lamp in which the luminous element operates in a bulb filled with an inert gas.

8.2.7 *Tungsten Halogen Lamp* — Gas filled lamp containing halogens or halogen compounds, the filament being of tungsten.

NOTE — Iodine lamps belong to this category.

8.3 Discharge Lamps and Arc Lamps

8.3.1 *Electric Discharge (in a Gas)* — The passage of an electric current through gases and vapours by the production and movements of charge carriers under the influence of an electric field.

NOTE — The phenomenon results in the emission of electromagnetic radiation which plays an essential part in all its applications in lighting.

8.3.2 *Glow Discharge* — Electric discharge in which the secondary emission from the cathode is much greater than the thermionic emission.

NOTE — This discharge is characterized by a considerable cathode fall (typically 70 V or more) and by low current density at the cathode (some 10 A. m^{-2}).

8.3.3 *Arc Discharge; Electric Arc (in a Gas or in a Vapour)* — Electric discharge characterized by a cathode fall which is small compared with that in a glow discharge.

NOTE — The emission of the cathode results from various causes (thermionic emission, field emission, etc.) acting simultaneously or separately, but secondary emission plays only a small part.

8.3.4 *Discharge Lamp* — Lamp in which the light is produced, directly or indirectly, by an electric discharge through a gas, a metal vapour or a mixture of several gases and vapours.

NOTE — According as the light is mainly produced in a gas or in a metal vapour, one distinguishes between gaseous discharge lamps, for example xenon, neon, helium, nitrogen, carbon dioxide lamp, and metal vapour lamps, such as the mercury vapour lamp and the sodium vapour lamp.

8.3.5 *High Intensity Discharge Lamp; HID Lamp* - An electric discharge lamp in which the light-producing arc is stabilized by wall temperature and the arc has a bulb wall loading in excess of 3 watts per square centimetre.

NOTE — HID lamps include groups of lamps known as high pressure mercury metal halide and high pressure sodium lamps.

8.3.6 *High Pressure Mercury (Vapour) Lamp* — A high intensity discharge lamp in which the major portion of the light is produced, directly or indirectly, by radiation from mercury operating at a partial pressure in excess of 100 kilopascals.

NOTE — This term covers clear, phosphor coated (mercury fluorescent) and blended lamps. In a fluorescent mercury discharge lamp, the light is produced partly by the mercury vapour and partly by a layer of phosphors excited by the ultraviolet radiation of the discharge.

8.3.7 *Blended Lamp; Self-Ballasted Mercury Lamp (USA)* — Lamp containing in the same bulb a mercury vapour lamp and an incandescent lamp filament connected in series.

NOTE — The bulb may be diffusing or coated with phosphors.

8.3.8 *Low Pressure Mercury (Vapour) Lamp* — A discharge lamp of the mercury vapour type, with or without a coating of phosphors, in which during operation the partial pressure of the vapour does not exceed 100 pascals.

8.3.9 *High Pressure Sodium (Vapour) Lamp* — A high intensity discharge lamp in which the light is produced mainly by radiation from sodium vapour operating at a partial pressure of the order of 10 kilopascals.

NOTE — The term covers lamps with clear or diffusing bulb.

8.3.10 *Low Pressure Sodium (Vapour) Lamp* — A discharge lamp in which the light is produced by radiation from sodium vapour operating at a partial pressure of 0.1 to 1.5 Pascal.

8.3.11 *Metal Halide Lamp* — A high intensity discharge lamp in which the major portion of the light is produced from a mixture of a metallic vapour and the products of the dissociation of halides.

NOTE — The term covers clear and phosphor-coated lamps.

8.3.12 *Fluorescent Lamp* — A discharge lamp of the low pressure mercury type in which most of the light is emitted by one or several layers of phosphors excited by the ultraviolet radiation from the discharge.

NOTE — These lamps are frequently tubular and, in the UK, are then usually called fluorescent tubes.

8.3.13 *Cold Cathode Lamp* — A discharge lamp in which the light is produced by the positive column of a glow discharge.

NOTE — Such a lamp is generally fed from a device providing sufficient voltage to initiate starting without special means.

8.3.14 *Hot Cathode Lamp* — A discharge lamp in which the light is produced by the positive column of an arc discharge.

NOTE — Such a lamp generally requires a special starting device or circuit.

8.3.15 *Cold-Start Lamp; Instant-Start Lamp* — A discharge lamp designed to start without preheating of the electrodes.

8.3.16 *Preheat Lamp; Hot-Start Lamp* — A hot cathode lamp which requires preheating of the electrodes for starting.

8.3.17 *Switch-Start Fluorescent Lamp* — A fluorescent lamp designed to operate in a circuit requiring a starter for the preheating of the electrodes.

8.3.18 *Starterless Fluorescent Lamp* — A fluorescent lamp of cold or hot start type designed to operate with an auxiliary equipment which enables it, when switched on, to start rather quickly without the intervention of a starter.

8.3.19 *Arc Lamp* — A discharge lamp in which the light is emitted by an arc discharge and / or by its electrodes.

NOTE — The electrodes may be either of carbon (operating in air) or of metal.

8.3.20 *Short-Arc Lamp; Compact-Source Arc Discharge Lamp* — An arc lamp, generally of very high pressure, in which the distance between the electrodes is of the order of 1 to 10 millimeters.

NOTE — Certain mercury vapour or xenon lamps belong to this type.

8.3.21 *Long-Arc Lamp* — An arc lamp, generally of high pressure, in which the distance between the electrodes is large, the arc filling the discharge tube and being therefore, stabilized.

8.4 Lamps of Special Types or for Special Purposes

8.4.1 *Prefocus Lamp* — Incandescent lamp in which, during manufacture, the luminous element is accurately adjusted to a specified position with respect to locating devices that form part of the cap.

8.4.2 *Reflector Lamp* — Incandescent or discharge lamp in which part of the bulb, of suitable shape, is coated with a reflecting material so as to control the light.

8.4.3 *Pressed Glass Lamp* — A reflector lamp, the bulb of which consists of two glass parts fused together, namely a metallized reflecting bowl and a patterned cover forming an optical system.

8.4.4 *Sealed Beam Lamp* — A pressed glass lamp designed to give a closely controlled beam of light.

8.4.5 *Projector Lamp* — Lamp in which the luminous element is so mounted that the lamp may be used with an optical system projecting the light in chosen directions.

NOTE — This term includes various types of lamp such as floodlight lamps, spotlight lamps, studio lamps, etc.

8.4.6 *Projection Lamp* — Lamp in which the luminous element is of relatively concentrated form and is so mounted that the lamp may be used with an optical system for the projection of either still or motion pictures on a screen.

8.4.7 *Photoflood Lamp* — Incandescent lamp of especially high colour temperature, often of the reflector type, for lighting objects to be photographed.

8.4.8 *Photoflash Lamp* — Lamp emitting, by combustion within a bulb, a large quantity of light in a single flash of very short duration, for lighting objects to be photographed.

8.4.9 *Flash Tube: Electronic Flash Lamp* — Discharge lamp to be operated with an electronic equipment in order to give a high light output for a very brief period, capable of repetition.

NOTE — This type of lamp may be used for lighting objects to be photographed, for stroboscopic observation or for signalling purposes.

8.4.10 *Daylight Lamp* —Lamp giving light with a spectral energy distribution approximating that of a specified daylight.

8.4.11 *Black Light Lamp; Wood's Glass Lamp* — Lamp designed to emit ultraviolet-A radiation and very little visible radiation.

NOTE — Such a lamp is generally mercury discharge or fluorescent.

8.4.12 *Tungsten Ribbon Lamp; Strip Lamp* — Incandescent lamp in which the luminous element is a tungsten ribbon.

NOTE — This type of lamp is particularly used as a standard in pyrometry and spectral radiometry.

8.4.13 *Infrared Lamp* — Lamp which radiates especially strongly in the infrared, the visible radiation produced, if any, not being of direct interest.

8.4.14 *Ultraviolet Lamp* — Lamp which radiates especially strongly in the ultraviolet, the visible radiation produced, if any, not being of direct interest.

NOTE — There are several types of such lamp used for photo biological, photochemical and biomedical purposes.

8.4.15 *Bactericidal Lamp; Germicidal Lamp* — Low pressure mercury vapour lamp camp with a bulb which transmits the bactericidal ultraviolet-C radiation.

8.4.16 *Spectroscopic Lamp* — Discharge lamp which gives a well-defined line spectrum and which, in combination with filters, may be used to obtain monochromatic radiation.

8.4.17 *Reference Lamp* — A discharge lamp selected for the purpose of testing ballasts and which, when associated with a reference ballast under specified condition, has electrical values which are close to the objective values given in a relevant specification.

8.4.18 *Secondary Standard Lamp* — Lamp intended to be used as a secondary photometric standard.

8.4.19 *Working Standard Lamp* — Lamp intended to be used as a working photometric standard.

8.5 Operational Conditions and Characteristics of Lamps

8.5.1 *Rating (of a Lamp)* — The set of rated values and operating conditions of a lamp which serve to characterize and designate it.

8.5.2 *Rated Luminous Flux (of a Type of Lamp)* — The value of the initial luminous flux of a given type of lamp declared by the manufacturer or the responsible vendor, the lamp being operated under specified conditions.

Unit: lm

NOTES

1 The initial luminous flux is the luminous flux of a lamp after a short ageing period as specified in the relevant lamp standard.

2 The rated luminous flux is sometimes marked on the lamp.

8.5.3 *Rated Power (of a Type of Lamp)* — The value of the power of a given type of lamp declared by the manufacturer or the responsible vendor the lamp being operated under specified conditions.

Unit : W

NOTE — The rated power is usually marked on the lamp;

8.5.4 *Life (of a Lamp)* — The total time for which a lamp has been operated before it becomes useless, or is considered to be so according to specified criteria.

NOTE — Lamp life is usually expressed in hours.

8.5.5 *Life Test* — Test in which lamps are operated under specified conditions for a specified time or to the end of life and during which photometric and electrical measurements may be made at specified intervals.

8.5.6 *Life to X % Failures* — The length of time during which X percent of the lamps subjected to a life test reach the end of their lives, the lamps being operated under specified conditions and the end of life judged according to specified criteria.

8.5.7 *Average Life* — The average of the individual lives of the lamps subjected to a life test, the lamps being operated under specified conditions and the end of life judged according to specified criteria.

8.5.8 *Luminous Flux Maintenance Factor; Lumen Maintenance (of a Lamp)* — Ratio of the luminous flux of a lamp at a given time in its life to its initial luminous flux, the lamp being operated under specified conditions.

NOTE — This ratio is generally expressed in per cent.

8.5.9 *Amplitude of Fluctuation of the Luminous Flux (of a Source run on Alternating current)* — Relative amplitude of the periodic fluctuation of the luminous flux as measured by the ratio of the difference between the maximum and the minimum luminous flux to the sum of both these values:

$$\frac{\Phi_{max} + \Phi_{min}}{\Phi_{max} - \Phi_{min}}$$

NOTES

1 This ratio is usually expressed in percent and is then known under the expression percent flicker which, however, should be depreciated.

2 Another means sometimes used by the lighting industry to characterize the fluctuation in light output is flicker index, which is defined by the ratio of two areas deduced from the diagram representing the variation of the instantaneous flux over a period of time; the area of the diagram above the average value is divided by the total area under the curve (this total area is the product of the average value and the given period of time).

8.5.10 *Starting voltage (of a discharge lamp)* — The voltage between the electrodes which is needed to start the discharge in the lamp.

8.5.11 *Lamp Voltage (of a Discharge Lamp)* — The voltage between the electrodes of the lamp during stable operating conditions (the root mean square value in the case of a (alternating current).

8.5.12 *Starting Time (of an Arc Discharge Lamp)* — The time required for an arc discharge lamp to develop an electrically stable arc discharge, the lamp being operated under specified conditions and the time being measured from the moment its circuit is energized.

NOTE — There is a time delay in the starting device between the time when power is applied to this device and the time when power is applied to the lamp electrodes. The starting time is measured from the latter moment.

8.5.13 *Series Cathode Heating (of a Discharge Lamp)* — Type of heating of the electrodes of a discharge lamp in which the heating current flows through the electrodes in series.

8.5.14 *Series Cathode Preheating (of a Discharge Lamp)* — Type of preheating of the electrodes of a discharge lamp in which the preheating current flows through the electrodes in series.

8.5.15 *Parallel Cathode Heating (of a Discharge Lamp)* — Type of heating of the electrodes of a discharge lamp in which these electrodes are fed by separate circuits.

NOTE — Each electrode is usually connected across a low voltage winding which may be part of the ballast and provides the heating current. In certain circuits, this low voltage is automatically decreased after the arc has struck.

8.5.16 *Parallel Cathode Preheating (of a Discharge Lamp)* — Type of preheating of the electrodes of a discharge lamp in which these electrodes are fed by separate circuits.

NOTE — Each electrode is usually connected across a low voltage wining which may be part of the ballast and provides the preheating current. In certain circuits, this low voltage is automatically decreased after the arc has struck.

9 COMPONENTS OF LAMPS AND AUXILIARY APPARATUS

9.1 Luminous Element

The part of a lamp which emits light.

9.2 Filament

Threadlike conductor, usually of tungsten, which is heated to incandescence by the passage of an electric current.

9.3 Straight Filament

Filament which is uncoiled and straight or which consists of uncoiled straight portions.

9.4 Single-Coil Filament

Filament wound in the form of a helix.

9.5 Coiled-Coil Filament

Helical filament wound into a larger helix.

9.6 Bulb

Transparent or translucent gas-tight envelope enclosing the luminous element (s).

9.7 Clear Bulb

Bulb which is transparent to visible radiation.

9.8 Frosted Bulb

Bulb which is made diffusing by roughening its inner or outer surface.

9.9 Opal Bulb

Bulb in which all, or a layer, of the material diffuses the light.

9.10 Coated Bulb

Bulb coated internally or externally with a thin diffusing layer.

9.11 Reflectorized Bulb

Bulb having part of its interior or exterior surface coated to form a reflecting surface to enhance the light in particular directions.

NOTE — Such surfaces may remain transparent to certain radiations, in particular to the infrared.

9.12 Enamelled Bulb

Bulb coated with a layer of translucent enamel.

9.13 Coloured Bulb

Bulb made of glass coloured in the mass, or of clear glass coated internally or externally with a coloured layer which may be transparent or diffusing.

9.14 Hard Glass Bulb

Bulb made of glass with a high softening temperature and consistent to thermal shock.

9.15 Cap; Base

That part of a lamp which provides connection to the electrical supply by means of a lamp holder or lamp connector and, in most cases, also serves to retain the lamp in the lamp holder.

NOTE — In USA the cap of a lamp and its corresponding holder are generally identified by one or more letters followed by a number which indicates approximately the principal dimension (generally the diameter) of the cap in millimeters. The standard code is to be found in IS.

9.16 Screw Cap

Cap (international designation) having its shell in the form of a screw thread which engages the lamp holder.

9.17 Bayonet Cap

Cap (international designation B) with bayonet pins on its shell which engage in slots in a lamp holder.

9.18 Shell Cap

Cap (international designation S) having a smooth cylindrical shell.

9.19 Pin Cap

Cap (international designation F for a single pin, G for two or more pins) which has one or more pins.

9.20 Prefocus Cap

Cap (international designation P) which enables the luminous element to be brought into a specified position relative to the cap during manufacture of the lamp so that reproducible positioning may be assured when the lamp is inserted in a suitable lamp holder.

9.21 Bayonet Pin

Small piece of metal which projects from the shell of a cap, particularly a bayonet cap, and which engages in a slot in a lamp holder to fix the cap.

9.22 Contact Plate

Piece of metal, insulated from the shell of the cap, which is connected to one of the lead-in wires and provides connection to the electric supply.

9.23 Pin; Post

Piece of metal, usually of cylindrical shape, fixed at the end of the cap so as to engage in the corresponding hole in a lamp holder for fixing the cap and/or for making contact.

NOTE — The pin and post generally indicate a difference in size, a pin being smaller than a post.

9.24 Lamp Holder

A device which holds the lamp in position, usually by having the cap inserted in it, in which case it also provides the means of connecting the lamp to the electric supply.

NOTE — The term socket or, when the context is clear, the abbreviation holder are commonly used instead of lamp holder.

9.25 (Lamp) Connector

A device consisting of electrical contacts, with appropriate insulation and mounted on flexible conductors, which provides for connection of the lamp to the electric supply but does not support the lamp.

9.26 Main Electrode (of a Discharge Lamp)

Electrode through which the discharge current passes after the discharge has been stabilized.

9.27 Starting Electrode (of a Discharge Lamp)

Auxiliary electrode for starting the discharge in a lamp.

9.28 Arc Tube

The enclosure in which the arc of the lamp is confined.

9.29 Emissive Material

Material deposited on a metal electrode to promote the emission of electrons.

9.30 Starting Strip

Narrow conducting strip placed longitudinally on the internal or external wall of a tubular discharge lamp for assisting in starting.

NOTE —The strip may be connected to one or both of the shells of the caps or, possibly, to an electrode.

9.31 Starting Device

Apparatus which provides, by itself or in combination with other components in the circuit, the appropriate electrical conditions needed to start a discharge lamp.

9.32 Starter

A starting device, usually for fluorescent lamps, which provides for the necessary preheating of the electrodes and, in combination with the series impedance of the ballast, causes a surge in the voltage applied to the lamp.

9.33 Ignitor

A device intended, either by itself or in combination with other components, to generate voltage pulses to start a discharge lamp without providing for the preheating the electrodes.

9.34 Ballast

A device connected between the supply and one or more discharge lamps which serves mainly to limit the current of the lamp (s) to the required value.

NOTE — A ballast may also include means for transforming the supply voltage, correcting the power factor and, either alone or in combination with a starting device, provide the necessary conditions for starting the lamp (s).

9.35 Semiconductor Ballast

A unit comprising semiconductor devices and stabilizing elements for the operation under ac power of one or more discharge lamps and energized by a dc or an ac source.

9.36 Reference Ballast

A device in the electric circuit for varying the luminous flux from lamps in a lighting installation. A special inductive type ballast designed for the purpose of providing comparison standards for use in testing regular production lamp under standardized condition.

9.37 Dimmer

A device in the electric circuit for varying the luminous flux from lamps in a lighting installation.

10 LIGHTING TECHNOLOGY, DAYLIGHTING

Comparison standards for use in testing ballast for the selection of reference lamp and for testing regular production lamp under standardized condition.

10.1 General Terms

10.1.1 *Lighting: Illumination* — Application of light to a scene, objects or their surroundings so that they may be seen.

NOTE — This term is also used colloquially with the meaning “lighting system” or “lighting installation”.

10.1.2 *Lighting Technology: Illuminating Engineering* — Applications of lighting considered under their various aspects.

10.1.3 *Luminous Environment* — Lighting considered in relation to its physiological and psychological effects.

10.1.4 *Visual Performance* — Performance of the visual system as measured for instance by the speed and accuracy with which a visual task is performed.

10.1.5 *Equivalent Contrast (of a Task)* — Luminance contrast of a visibility reference task having equal visibility at the same luminance level as that of the task considered.

10.2 Types of Lighting

10.2.1 *General Lighting* — Substantially uniform lighting of an area without provision for special local requirements.

10.2.2 *Local Lighting* — Lighting for a specific visual task, additional to and controlled separately from the general lighting.

10.2.3 *Localised Lighting* — Lighting designed to illuminate an area with a higher illuminance at certain specified positions, for instance those at which work is carried out.

10.2.4 *Permanent Supplementary Artificial Lighting (in Interiors)* — Permanent artificial lighting intended to supplement the natural lighting of premises, when the natural lighting is insufficient or objectionable if used alone.

NOTE — This type of lighting is generally denoted in brief by the initial letters PSALI of the words of the English term.

10.2.5 *Emergency Lighting* — Lighting provided for use when the supply to the normal lighting fails.

10.2.6 *Escape Lighting* — That part of emergency lighting provided to ensure that an escape route may be effectively identified and used.

10.2.7 *Safety Lighting* — That part of emergency lighting provided to ensure the safety of people involved in a potentially hazardous process.

10.2.8 *Stand by Lighting* — That part of emergency lighting provided to enable normal activities to continue substantially unchanged.

10.2.9 *Direct Lighting* — Lighting by means of luminaires having a distribution of luminous intensity such that the fraction of the emitted luminous flux directly reaching the working plane, assumed to be unbounded, is 90 percent to 100 percent.

10.2.10 *Semi-Direct Lighting* — Lighting of means of luminaires having a distribution of luminous intensity such that the fraction of the emitted luminous flux directly reaching the working plane, assumed to be unbounded, is 60 percent to 90 percent.

10.2.11 *General Diffused Lighting* — Lighting by means of luminaires having a distribution of luminous intensity such that the fraction of the emitted luminous flux directly reaching the working plane, assumed to be unbounded, is 40 percent to 60 percent.

10.2.12 *Semi-Indirect Lighting* — Lighting by means of luminaries having a distribution of luminous intensity such that the fraction of the emitted luminous flux directly reaching the working plane, assumed to be unbounded, is 10 percent to 40 percent.

10.2.13 *Indirect Lighting* — Lighting by means of luminaires having a distribution of luminous intensity such that the fraction of the emitted luminous flux directly reaching the working plane, assumed to be unbounded, is 0 percent to 10 percent.

10.2.14 *Directional Lighting* — Lighting in which the light on the working plane or on an object is incident predominantly from a particular direction.

10.2.15 *Diffused Lighting* — Lighting in which the light on the working plane or on an object is not incident predominantly from a particular direction.

10.2.16 *Floodlighting* — Lighting of a scene or object, usually by projectors, in order to increase considerably its illuminance relative to its surroundings.

10.2.17 *Spotlighting* — Lighting designed to increase considerably the illuminance of a limited area or of an object relative to the surroundings, with minimum diffused lighting.

10.3 Terms Used in Lighting Calculations

10.3.1 *Illuminance Vector (at a Point)* — Vector quantity equal to the maximum difference between the illuminances on opposite sides of an element of surface through the point considered, that vector being normal to and away from the side with the greater illuminance.

10.3.2 *(Spatial) Distribution of Luminous Intensity (of a Source)* — Display, by means of curves or tables, of the value of the luminous intensity of the source as a function of direction in space.

10.3.3 *Symmetrical Luminous Intensity Distribution (of a Source)* — Distribution of luminous intensity having an axis of symmetry or at least one plane of symmetry.

NOTE — Sometimes this term is used in the sense of term 845-09-26. This usage is to be discouraged.

10.3.4 *Rotationally Symmetrical Luminous Intensity Distribution (of a Source)* — Distribution of luminous intensity which may be represented by rotating around an axis a polar luminous intensity distribution curve in a plane containing that axis.

10.3.5 *Mean Spherical Luminous Intensity (of a Source)* — Average value of the luminous intensity of the source in all directions, equal to the quotient of its luminous flux by the solid angle 4π Steradian.

10.3.6 *ISO-intensity Curve: ISO-intensity Line: ISO candela Curve or Line (Depreciated) (for a Source)* — Curve traced on a sphere that has its center at the light center of the source, joining all the points corresponding to those directions in which the luminous intensity is the same, or a plane projection of that curve.

10.3.7 *ISO-intensity Diagram: ISO candela Diagram (Deprecated*) — Array of ISO-intensity curves.

10.3.8 *Half-Peak Divergence; One-Half-Peak Spread (of a Projector, in a Specified Plane)* — Angular extent of all the radius vectors of the polar curve of luminous intensity in the specified plane having lengths greater than 50% of the maximum.

NOTE — In British practice beam spread relates to the total angle within which the illuminance on a plane normal to the axis of the beam exceeds 10% of the maximum.

10.3.9 *Cumulative flux (of a Source, for a Solid Angle)* — Luminous flux emitted by the source under operating conditions, within a cone having a vertically downward axis and enclosing the solid angle.

10.3.10 *Zonal Flux (of a Source, for a Zone)* — Difference of the cumulative fluxes of the source for the solid angles subtended by the upper and lower boundaries of the zone.

10.3.11 *Total flux (of a Source)* — Cumulative flux of the source for the solid angle 4π Steradian.

10.3.12 *Downward flux (of a Source)* — Cumulative flux of the source for the solid angle 2π Steradian, below the horizontal plane passing through the source.

10.3.13 *Upward Flux (of a Source)* — Difference of total and downward fluxes.

10.3.14 *Optical Light Output Ratio (of a Luminaries)* — Ratio of the total flux of the luminaire, measured under specified conditions, to the sum of the individual luminous fluxes of the lamps when inside the luminaire.

NOTE — For luminaires using incandescent lamps only, the optical light output ratio and the light output ratio are the same in practice.

10.3.15 *Light Output Ratio (of a Luminaire): Luminaire Efficiency*— Ratio of the total flux of the luminaire, measured under specified practical conditions with its own lamps and equipment, to the sum of the individual luminous fluxes of the same lamps when operated outside the luminaire with the same equipment, under specified conditions.

10.3.16 *Downward Light Output Ratio (of a Luminaire)* — Ratio of the downward flux of the luminaire, measured under specified practical conditions with its own lamps and equipment, to the sum of the individual luminous fluxes of the same lamps when operated outside the luminaire with the same equipment, under specified conditions.

10.3.17 *Downward Flux Fraction (of a Luminaire)* — Ratio of the downward flux to the total flux of the luminaire.

10.3.18 *Magnification Ratio (of a Luminaire)* — Ratio of the maximum luminous intensity of the luminaire, generally a projector, to the mean spherical luminous intensity of its lamp.

NOTE — In certain countries, the definition of the magnification ratio varies according to the types of luminaires or lamps.

10.3.19 *Direct Flux (on a Surface)* — Luminous flux received by the surface directly from a lighting installation.

10.3.20 *Indirect Flux (on a Surface)* — Luminous flux received by the surface from a lighting installation, after reflection from other surfaces.

10.3.21 *Direct Ratio (of an Interior Lighting Installation)* — Ratio of the direct flux on the working plane to the downward flux of the installation.

10.3.22 *Installed Lamp Flux Density (for an Interior Lighting)* — Quotient of the sum of the individual rated fluxes of the lamps of an installation, by the floor area.

unit : lm . m^{-2}

10.3.23 *Installation Flux Density (for an Interior Lighting)* — Quotient of the sum of the individual total fluxes of the luminaires of an installation, by the floor area.

unit: lm. m^{-2}

10.3.24 *Reference Surface* — Surface on which illuminance is measured or specified.

10.3.25 *Work Plane: Working Plane* —Reference surface defined as the plane at which work is usually done.

NOTE — In interior lighting and unless otherwise indicated, this plane is assumed to be a horizontal plane 0.85 m above the floor and limited by the walls of the room.

10.3.26 *Utilization Factor: Coefficient of Utilization (of an Installation, for a Reference Surface)* — Ratio of the luminous flux received by the reference surface to the sum of the individual fluxes of the lamps of the installation.

10.3.27 *Utilance (of an Installation, for a Reference Surface) [U]* — Ratio of the luminous flux received by the reference surface to the sum of the individual total fluxes of the luminaires of the installation.

10.3.28 *Room Index: Installation Index (K)* — Number representative of the geometry of the room between the working plane and the plane of the luminaires, used in calculation of utilization factor or utilance.

NOTES

1 Unless otherwise indicated, the room index (K) is given by the formula:

$$K = \frac{ab}{h(a+b)}$$

in which a and b are the dimensions of the sides of the room and h the mounting height, that is the distance between the working place and the plane of the luminaires.

2 In British practice, the ceiling cavity index is calculated from the same formula except that h is the distance from ceiling to luminaires.

3 In the USA, the term room cavity ratio is currently used. This is equal to five times the reciprocal of the room index defined by the formula in Note 1. Two supplementary terms are used: ceiling cavity ratio and floor cavity ratio which are derived in the same way as the room cavity ratio except that h is respectively the distance from ceiling to luminaires and from floor to working plane.

10.3.29 *ISO-Luminance Curve* — Locus of points on a surface at which the luminance is the same, for given positions of the observer and of the source or sources in relation to the surface.

10.3.30 *ISO-Illuminance Curve; ISO-Illuminance Line; ISO Lux Curve or Line (Deprecated)* — Locus of points on a surface where the illuminance has the same value.

10.3.31 *Uniformity Ratio of Illuminance (on a given Plane)* — Ratio of the minimum illuminance to the average illuminance on the plane.

NOTE — Use is made also of a) the ratio of the minimum to the maximum illuminance and b) the inverse of either of these two ratios.

10.3.32 *Light Loss Factor: Maintenance Factor (Obsolete)* — Ratio of the average illuminance on the working place after a certain period of use of a lighting installation to the average illuminance obtained under the same conditions of the installation considered conventionally as new.

NOTES

1 The term depreciation factor has been formerly used to designate the reciprocal of the above ratio.

2 The light losses take into account dirt accumulation on luminaire and room surfaces and lamp depreciation.

10.3.33 *Service Illuminance (of an Area)* — Mean illuminance during one maintenance cycle of an installation averaged over the relevant area.

NOTE — The area may be either the whole area of the working plane in an interior or the working areas.

10.3.34 *Ballast Lumen Factor* — Ratio of the luminous flux emitted by a reference lamp when operated with a particular production ballast to the luminous flux emitted by the same lamp when operated with its reference ballast.

10.4 Terms relating to Distance Measurements

10.4.1 *Light Center (of a Source)* — Point used as origin for photometric measurements and calculations.

10.4.2 *Test Distance (for Photometric Measurements)* — Distance from the light center to the surface of the detector.

10.4.3 *Spacing (in an Installation)* — Distance between the light centers of adjacent luminaires of the installation.

10.4.4 *Proximity (in an installation in an interior)* — Distance between a wall and the light centers of the luminaires of the nearest row.

10.4.5 *Suspension Length (of a Luminaire in an Interior)* — Distance between the ceiling and the light center of the luminaire.

10.5 Terms Relating to Inter-reflection

10.5.1 *Inter Reflection* — General effect of the reflections of radiation between several reflecting surfaces.

10.5.2 *Configuration Factor (Between Two Surfaces S_i and S_j) (c_{ij})* — Ratio of irradiance or illuminance(E) at a point on surface Si due to the flux received from the surface S_j, to the radiant or luminous exitance (M_j) of surface S_j.

$$c_{ij} = \frac{E_j}{M_j}$$

10.5.3 *Form Factor (Between Two Surfaces S_i and S_j) (f_{ij})* — Ratio of the average radiant or luminous flux density (φ_i) received over surface Si of area Ai from surface S_j to the radiant or luminous exitance (M_j) of surface S_j.

$$f_{ij} = \frac{\phi_i}{A_i M_j}$$

10.6 Day lighting

10.6.1 *Solar Radiation* — Electromagnetic radiation from the Sun.

10.6.2 *Extraterrestrial Solar Radiation* — Solar radiation incident on the outer limit of the Earth's atmosphere.

10.6.3 *Solar Constant (E_e, o)* — Radiance produced by the extraterrestrial solar radiation on a surface perpendicular to the Sun's rays at mean Sun-Earth distance.

10.6.4 *Direct Solar Radiation* — That part of extraterrestrial solar radiation which as a collimated beam reaches the Earth's surface after selective attenuation by the atmosphere.

10.6.5 *Diffuse Sky Radiation* — That part of solar radiation which reaches the Earth as a result of being scattered by the air molecules, aerosol particles, cloud particles or other particles.

10.6.6 *Global Solar Radiation* — Combined direct solar radiation and diffuse sky radiation.

10.6.7 *Sunlight* —Visible part of direct solar radiation.

10.6.8 *Skylight* — Visible part of diffuse sky radiation.

10.6.9 *Daylight* — Visible part of global solar radiation.

10.6.10 *Reflected (Global) Solar Radiation* — Radiation that results from reflection of the global solar radiation by the surface of the Earth and by any surface intercepting that radiation.

10.6.11 *Optical Thickness of the Atmosphere [δ(ε)]* — Quantity defined by the formula

$\delta(\varepsilon) = -\ln(\Phi'_e / \Phi_e)$

Where Φ_e is the radiant flux of a collimated beam entering the upper limit layers of the atmosphere at an angle *e* to the vertical, and Φ_e the attenuated radiant flux of that beam reaching the surface of the Earth.

unit : 1

NOTES

1 *see* also **10.6.5**

2 In English, the term optical depth is sometimes used instead of optical thickness.

10.6.12 *Total Turbidity Factor (According to Linke) [T]* — Ratio of the vertical optical thickness of a turbid atmosphere to the vertical optical thickness of the pure and dry atmosphere (Rayleigh atmosphere), related to the whole solar spectrum.

$$T = \frac{\delta_R + \delta_A + \delta_Z + \delta_W}{\delta_R}$$

Where δ_R is the optical thickness with respect to Rayleigh scattering at the air molecules, δ_A , δ_Z , δ_W are the optical thicknesses with respect to Mie scattering and absorption at the aerosol particles, to ozone absorption, and to water vapour absorption respectively.

10.6.13 *Relative Optical Air Mass [m]* — Ratio of the slant optical thickness, δ(ε), to the vertical optical thickness, δ (0), of the atmosphere.

$m = \delta(\varepsilon) / \delta(0)$ unit : 1

NOTE — When the curvature of the atmosphere and atmospheric refraction are neglected, $m = 1/\cos \varepsilon$

10.6.14 *Global Illuminance (E_g)* — Illuminance produced by daylight on a horizontal surface on the earth.

10.6.15 *CIE Standard Overcast Sky* — Completely overcast sky for which the ratio of its luminance L y in the direction at an angle y above the horizon to its luminance L_z at the zenith is given by the relation

$Ly = Lz (1 + 2 \sin \gamma)/3$.

10.6.16 *CIE Standard Clear Sky* — Cloudless sky for which the relative luminance distribution is described in CIE publication No. 22 (I 973).

10.6.17 *Sunshine Duration [S]* — Sum of time intervals within a given time period (hour, day, month, year) during which the irradiance from direct solar radiation on a plane normal to the sun direction is equal to or greater than 200 watts per square meter.

10.6.18 *Astronomical Sunshine Duration* — Sum of the time intervals within a given time period during which the sun is above an even, unobscured horizon.

10.6.19 *Possible Sunshine Duration (at a Particular Location)* — Sum of the time intervals within a given time period during which the sun is above the real horizon, which may be obscured by mountains, buildings, trees, etc.

10.6.20 *Relative Sunshine Duration* — Ratio of sunshine duration to possible sunshine duration within the same time period.

10.6.21 *Daylight Factor (D)* — Ratio of the illuminance at a point on a given plane due to the light received directly or indirectly from a sky of assumed or known luminance distribution, to the illuminance on a horizontal plane due to an unobstructed hemisphere of this sky. The contribution of direct sunlight to both illuminances is excluded.

NOTES

1 Glazing, dirt effects, etc., are included.

2 When calculating the lighting of interiors, the contribution of direct sunlight shall be considered separately.

10.6.22 *Sky Component of Daylight Factor (D_s)* — Ratio of that part of the illuminance at a point of a given plane which is received directly (or through clear glass) from a sky of assumed or known luminance distribution, to the illuminance on a horizontal plane due to an unobstructed hemisphere of this sky. The contribution of direct sunlight to both illuminances is excluded.

NOTE — When dealing with actinic effects of optical radiations, this term is commonly used for radiations extending beyond the visible region of the spectrum.

10.6.23 *Externally reflected Component of Daylight Factor [D_e]* — Ratio of that part of the illuminance at a point on a given plane in an interior which is received directly from external reflecting surfaces illuminated directly or indirectly by a sky of assumed or known luminance distribution, to the illuminance on a horizontal plane due to an unobstructed hemisphere of this sky. The contribution of direct sunlight to both illuminances is excluded.

NOTE — *see* note to **10.6.21.**

10.6.24 *Internally Reflected Component of Daylight Factor [D_i]* — Ratio of that part of the illuminance at a point on a given plane in an interior which is received directly from internal reflecting surfaces illuminated directly or indirectly by a sky of assumed or known luminance distribution, to the illuminance on a horizontal plane due to an unobstructed hemisphere of this sky. The contribution of direct sunlight to both illuminances is excluded.

NOTE — *see* note to **10.6.21**.

10.6.25 *Obstruction* — Anything outside a building which prevents the direct view of part of the sky.

10.6.26 *Daylight Opening* — Area, glazed or unglazed, that is capable of admitting daylight to an interior.

10.6.27 *Window* — Daylight opening on a vertical or nearly vertical area of a room envelope.

10.6.28 *Roof Light: Skylight* — Daylight opening on the roof or on a horizontal surface of a building.

10.6.29 *Shading* — Device designed to obstruct, reduce or diffuse solar radiation.

11 LUMINAIRES AND THEIR COMPONENTS

11.1 Luminaire

Apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all the parts necessary for fixing and protecting the lamps and, were necessary, circuit auxiliaries together with the means for connecting them to the electric supply.

NOTE — The term lighting fittings is deprecated.

11.2 Symmetrical (Asymmetrical) Luminaire

Luminaire with a symmetrical (asymmetrical) luminous intensity distribution.

11.3 Wide Angle Luminaire

Luminaire which distributes the light over a comparatively wide solid angle.

11.4 Ordinary Luminaire

Luminaire without special protection against dust or moisture.

11.5 Protected Luminaire

Luminaire with special protection against ingress of dust, moisture or water.

11.6 Flameproof Luminaire (Explosion Proof Luminaire)

Luminaire which satisfies the appropriate regulation applicable to equipment with explosion-proof enclosure, for use in situations where there is a risk of explosion.

11.7 Adjustable Luminaire

Luminaire of which the main part may be turned or moved by means of appropriate devices.

NOTE — An adjustable luminaire may be fixed or portable.

11.8 Portable Luminaire

Luminaire which can easily be moved from one place to another even while connected to the electric supply.

11.9 Pendant Luminaire (Suspended Luminaire)

Luminaire provided with a cord, chain tube, etc, which permits it to be suspended from a ceiling or a wall support.

11.10 Recessed Luminaire

Luminaire suitable to be fully or partly recessed into a mounting surface.

11.11 Troffer

Long recessed luminaire usually installed with the opening flush with the ceiling.

11.12 Downlight

Small luminaire concentrating the light, usually recessed in the ceiling.

11.13 Bulkhead Luminaire

Protected luminaire of compact design intended to be fixed directly on a vertical or horizontal surface.

11.14 Cove Lighting

Lighting system comprising light sources shielded by a ledge or recess, and distributing light over the ceiling and upper wall.

11.15 Table Lamp

Portable luminaire intended for standing on furniture.

11.16 Hand-Lamp

Portable luminaire with a handle and a flexible cord for its supply.

11.17 Torch (Flashlight)

Portable luminaire fed by a built-in source, usually a dry battery or an accumulator, sometimes a manual generator.

NOTE — In French, the term “lampe torche” refers to a torch with a cylindrical container.

11.18 Lighting Chain

Set of lamps arranged along a cable and connected in series or parallel.

11.19 Projector

Luninaire using reflection and/or refraction to increase the luminous intensity within a limited solid angle.

11.20 Searchlight

A high intensity projector having an aperture usually greater than 0.2 m and giving an approximately parallel beam of light.

11.21 Spotlight

A projector having an aperture usually smaller than 0.2 m and giving a concentrated beam of light of usually not more than 0.35 radian (20°) divergence.

11.22 Floodlight

Projector designed for floodlighting, usually capable of being pointed in any direction.

11.23 Cut Off

Technical used for concealing lamps and surfaces of high luminance from direct view in order to reduce glare.

NOTE — In public lighting, distinction is made between full-cut-off luminaires, semi cut-off luminaires and non-cut-off luminaires.

11.24 Cut-Off Angle (of a Luminaire)

Angle, measured up from nadir, between the vertical axis and the first line of slight at which the lamps and the surfaces of high luminance are not visible.

11.25 Shielding Angle

The complementary angle of the cut-off angle.

11.26 Refractor

Device used to alter the spatial distribution of the luminous flux from a source and depending essentially on the phenomenon of refraction.

11.27 Reflector

Device used to alter the spatial distribution of the luminous flux from a source and depending essentially on the phenomenon of reflection.

11.28 Diffuser

Device used to alter the spatial distribution of the luminous flux from a source and depending essentially on the phenomenon of diffusion.

11.29 Bowl

Diffuser, refractor or reflector in the form of a bowl, intended to be placed below the lamp.

11.30 Globe

Envelope of transparent or diffusing material, intended to protect the lamp, to diffuse the light, or to change the colour of the light.

11.31 Shade

Screen which may be made of opaque or diffusing material and which is designed to prevent a lamp from being directly visible.

11.32 Louver (Spill Shield)

Screen made of translucent or opaque components and geometrically disposed to prevent lamps from being directly visible over a given angle.

11.33 Protective Glass

Transparent or translucent part of an open or closed luminaire designed to protect the lamp (s) from dust or dirt, or to prevent their contact with liquids, vapours or gases and to render from inaccessible.

11.34 Luminaire Guard

Device, shaped as a grid, used to shield the protective glass of the luminaire against mechanical shocks.

11.35 Studio Floodlight

Lighting device with a half-peak divergence exceeding 1.74 radian (100°) and with a total divergence not less than 3.14 radians (180°).

11.36 Special Studio Floodlight

Lighting device with a specified half-peak divergence, less than 1.74° radian (100°) and a specified total divergence.

11.37 Reflector Spotlight

Projector with simple reflector and sometimes capable of adjustment of divergence by relative movement of lamp and mirror.

11.38 Lens Spotlight

Projector with simple lens, with or without reflector, sometimes capable of adjustment of divergence by relative movement of lamp and lens.

11.39 Fresnel Spotlight

Lens spotlight but with a stepped lens.

11.40 Profile Spotlight

Projector giving a hard-edged beam of light which may be varied in outline by diaphragms, shutters or silhouette cut-off masks.

11.41 Effects projector

Projection apparatus with optics designed to give even field illumination of slides and, with a suitable objective lens, well defined projection of detail.

NOTE — Slides can be of stationary or moving-effects type.

11.42 Soft Light

Lighting device of sufficient size to produce diffused lighting with indefinite shadow boundaries.

12 LUMINAIRES FOR MINE LIGHTING

12.1 Mine Luminaire

Luminaire comprising a casing and sometimes an accumulator, provided for illumination in all areas of an underground mine.

12.2 Miner's (Personal) Lamp

Mine luminaire with integral energy source, required for each person entering an underground mine.

12.3 Cap Lamp

Miner's personal lamp designed to be attached to a miner's helmet.

12.4 Headpiece

Part of a cap lamp, containing a light source or sources, designed to be attached to a miner's helmet.

12.5 Mine Safety Lamp

Flame lamp used for detection of methane and oxygen deficiency in mine air.

12.6 Portable Mine Luminaire

Mine luminaire with integral or mains-operated power source, which may supply light while being moved.

12.7 Mine Rescue Luminaire

Portable mine luminaire with integral power source designed for rescue operations.

12.8 Air-Turbo Lamp; Compressed Air Luminaire

Luminaire energized by an alternator driven by compressed air.

12.9 Face Luminaire

Mine luminaire portable or otherwise, providing illumination in working face areas.

12.10 Permissible Luminaire

Mine luminaire designed and tested for use in areas where explosive methane gas or coal dust may be present.

12.11 Intrinsically Safe Luminaire

Mine luminaire whose safety results from the use of intrinsically safe electrical circuits.

12.12 Paddy Lamp; Trip Lamp

Battery-powered portable mine luminaire showing a red light, designed for mounting at the rear of a train of cars.

13 VISUAL SIGNALLING

13.1 General Terms

13.1.1 *Visual Signal* — Visible phenomenon intended to convey information.

13.1.2 *Light Signal* — Visual signal that emanates from a light source.

NOTES

1 The term is sometimes used for an object or apparatus that emits a light signal, but this usage is not recommended (*see* **13.1.5**).

2 In German, the term "Lichtsignal" refers to a signal that stimulates visual perception; and the term "Signallicht" refers to the visible radiation that conveys a signal.

13.1.3 *Sign* — Device that provides a visual signal by virtue of its situation, shape, colour or pattern, and sometimes by the use of symbols or alphanumeric characters. It may be internally illuminated.

NOTE — In French, the term "panneau de signalisation" refers more particularly to a panel that contains a visual signal.

13.1.4 *Matrix Sign* — Sign designed to display a variable message by means of an array of elementary units, each of which can be individually illuminated or otherwise altered in appearance.

13.1.5 *Signal Light* — Object or apparatus designed to emit a light signal.

13.1.6 *(Navigation) Mark* — Natural or artificial object that provides navigational information by virtue of both its situation and its distinctive appearance.

13.1.7 *Beacon* —

a) Fixed artificial navigation mark. It may carry a signal light.
b) Signal light used to indicate a designated geographical location.

NOTE — In French, the term "balise" refers also to an artificial object that is used to regulate vehicular or pedestrian traffic.

13.2 Appearance of a Light

13.2.1 *Character (of a Light Signal); Characteristic (of a Light Signal)* — Distinctive rhythm and colour, or colours, of a light signal that provide the identification or a message.

13.2.2 *Fixed Light* — Signal light that shows continuously, in any given direction, with constant luminous intensity and colour.

13.2.3 *Rhythmic Light* — Signal light that shows intermittently, in a given direction, with a regular periodicity.

13.2.4 *Flashing Light* — Rhythmic light in which every appearance of light (flash) is of the same duration, and, except possibly for rhythms with rapid rates of flashing, the total duration of light in a period is clearly shorter than the total duration of darkness.

NOTE — The term eclipse is used for the interval of darkness between two successive appearances of light.

13.2.5 *ISO Phase Light* — Rhythmic light in which all the durations of light and darkness are intended to be perceived as equal.

NOTE — In French and in terminology of road traffic, an isophase light is also called "feu clignotant".

13.2.6 *Alternating Light* — Signal light that shows different colours in a regularly repeated sequence.

13.2.7 *Reciprocating Lights* — Pair of isophase lights that are arranged to show light alternately.

13.2.8 *Sun Phantom* — False light signal created by radiation from the sun striking a signal light.

13.2.9 *Effective Intensity (of a Flashing Light)* — Luminous intensity of a fixed light, of the same relative spectral distribution as the flashing light, which would have the same luminous range (or visual range in aviation terminology) as the flashing light under identical conditions of observation.

NOTE— For practical purposes, a conventional effective intensity may be evaluated for a flashing light from photometric data by an agreed method.

13.3 Visibility

13.3.1 *Atmospheric Transmissivity [T_i]* — Regular luminous transmittance of the atmosphere over a path of a specified length do.

NOTE — In German, the terms "Transmissions factor" and "Sichtwert" refer respectively to lengths of one kilometer and one nautical mile.

13.3.2 *Visual Contrast Threshold* — Smallest contrast, produced at the eye of an observer by a given object, which renders the object perceptible against a given background.

NOTE — For meteorological observations, the object must be rendered recognizable, and hence a higher threshold is to be expected. The value of 0.05 has been adopted as the basis for the measurement of meteorological optical range.

13.3.3 *Visual Range* — Greatest distance at which a given object can be recognized in any particular circumstances, as limited only by the atmospheric transmissivity and by the visual contrast threshold.

NOTES

1 In aviation terminology, the term is also used for the luminous range of a signal light.

2 In aviation terminology, the runway visual range of a runway at an aerodrome is the greatest distance at which the runway surface markings, or the runway center-line lights, or the runway edge lights, can be seen from a given height above the center line of the runway.

13.3.4 *Geographical Range; Geographic Range (of an Object or a Light Source)* — Greatest distance at which an object or a light source could be seen under conditions of perfect visibility, as limited only by the curvature of the Earth, by refraction in the atmosphere, and by the heights of the observer and the object or light source.

13.3.5 *Point Vision* — Mode of vision, of an apparently small source of light, in which the luminous sensation is determined only by the illuminance that is produced by the source at the eye of the observer.

13.3.6 *Threshold of Illuminance; Visual Threshold (in Point Vision)* — Smallest illuminance (point brilliance), produced at the eye of an observer by a light source seen in point vision, which renders the source perceptible against a background of given luminance; the illuminance is considered on a surface element that is normal to the incident rays at the eye.

NOTE — For visual signaling, the light source must be rendered recognizable, and hence a higher threshold of illuminance is to be expected.

13.3.7 *Luminous Range* — Greatest distance at which a given signal light can be recognized in any particular circumstances, as limited only by the atmospheric transmissivity and by the threshold of illuminance at the eye of the observer.

13.3.8 *Nominal Range* — Luminous range of a maritime signal light in a homogeneous atmosphere having a meteorological optical range of 10 nautical miles.

13.3.9 *Conspicuity* — Quality of an object or a light source to appear prominent in the surroundings.

13.4 Maritime and Waterway Traffic and Lights on Vessels

13.4.1 *Light House* — Tower, or substantial building or structure, erected at a designated geographical location to carry a signal light and to assist maritime navigation.

13.4.2 *Direction Light* — Signal light designed to show a signal of one character over a narrow arc of the horizon, and used to indicate a particular direction. It may also indicate an arc of the horizon to each side by dissimilar characters.

NOTE — In French, the term "feu de guidage" refers to a direction light in which a very narrow arc of the horizon is used to indicate a particular.

13.4.3 *Light Vessel; Lightship* — Vessel designed to carry a signal light of high luminous intensity, and moored or anchored at a designated geographical location to assist maritime navigation.

13.4.4 *Buoy* — Floating, and moored, artificial navigation mark.

13.4.5 *Lighted Buoy* — Buoy that carries a signal light.

13.4.6 *Cardinal Mark [Cardinal Light]* — Artificial mark [signal light] used to indicate, with reference to the cardinal points of the compass, where navigable water may be found.

13.4.7 *Navigation Light (of A Vessel)* — Signal light, one of a set, carried on a vessel to indicate the presence and aspect, and sometimes the particular occupation and ability to maneuver, of the vessel.

13.4.8 *Mast-Head Light* — Navigation light positioned above the longitudinal axis of a vessel, and designed to show a fixed white light forwards and to the sides of the vessel.

13.5 Air Traffic and Lights on Aircraft

13.5.1 *Aeronautical Ground Light* — Signal light provided on land or water to assist the navigation of aircraft.

13.5.2 *Obstacle Light; Obstruction Light (Deprecated in this Sense)* — Aeronautical ground light used to indicate the presence of a fixed or mobile hazard to the permitted movement of aircraft on the ground or in the air.

13.5.3 *Identification Beacon* — Aeronautical ground light that shows a coded signal to indicate a designated geographical location.

13.5.4 *Aerodrome Beacon* — Aeronautical ground light used to indicate the location of an aerodrome.

13.5.5 *Barrette* — Line of closely spaced aeronautical ground lights which is designed to appear from a distance as a short bar of light orthogonal to the center line of an aerodrome runway.

13.5.6 *Runway Lights* — Aeronautical ground lights positioned on, or very close to, a runway of an aerodrome to indicate the part of the runway intended for the landing or take-off of aircraft.

> NOTE — Runway center-line lights and runway edge lights indicate respectively the center line and the edges of a runway. Runway threshold lights and runway end lights indicate respectively the beginning and the end of the part of the runway intended for the landing of aircraft. Runway touchdown zone lights are barrettes arranged in pairs symmetrically about the center line of a runway, and between the two lines of runway edge lights, to indicate the portion of the runway where aircraft should first make contact on landing.

13.5.7 *Approach Lighting System* — System of aeronautical ground lights which is sited in front of the threshold of an aerodrome runway and designed to provide guidance to aircraft making an approach to land on the runway.

13.5.8 *Cross Bar (of Lights)* — Line of lights in an approach lighting system which is arranged orthogonal to, and symmetrically disposed about, the center line of the system and the runway.

13.5.9 *Wing Bar* — Barrette positioned at the side of an aerodrome runway, outside the line of the runway edge lights. It may be paired symmetrically with another one on the opposite side of the runway.

13.5.10 *Visual Approach Slope Indicator* — Aeronautical ground light, or system of lights, designed to indicate the correct angle of descent to an aircraft making an approach to land.

13.5.11 *Navigation Light (of an Aircraft)* — Signal light, one of a set, carried on an aircraft to indicate the presence and aspect of the aircraft.

13.5.12 *Anti-Collision Light* — Signal light carried on an aircraft to indicate the presence of the aircraft.

13.5.13 *Landing Light* — Projector carried on an aircraft for illuminating the ground in front of the aircraft while it 'is landing or taking-off. The projector may also be used to provide a highly conspicuous light while the aircraft is making an approach to land.

13.5.14 *Taxiing Light* — Projector carried on an aircraft for illuminating the ground in front of the aircraft while it is maneuvering on the ground.

13.6 Road Traffic and Lights on Vehicles

13.6.1 *Traffic Sign* — Authorised sign that conveys, to vehicular and pedestrian traffic, a prohibition, restriction, requirement or warning, or information.

> NOTE— In French, the term "panneau de signalisation (routière) " refers only to a panel that contains a sign, and it may in some cases be equivalent to the English term sign plate or sign panel.

13.6.2 *Traffic Light; Traffic Signal (Deprecated)* — Signal light used for regulating traffic.

> NOTE — A three-colour set, with red, yellow (amber) and green lights, is the common arrangement for the regulation of vehicular traffic. In French, the term "feu tricolore" is used for such a three-colour set.

13.6.3 *(Traffic) Bollard* — Post used to indicate an obstruction or to regulate traffic. It may be internally illuminated and may incorporate a regulatory traffic sign.

13.6.4 *Marker Post* — Post erected at the edge of a carriageway to indicate a hazard or the line of the edge. It may incorporate a retroreflector.

13.6.5 *Road Marking* — Mark, line, pattern, symbol or alphanumeric character applied to the surface of a road to regulate, or inform, vehicular or pedestrian traffic. A road marking may incorporate retro-reflecting material.

13.6.6 *Road Stud; Raised Pavement Marker* — Small device secured to, and projecting slightly above, a road marking. It may incorporate a retroreflector.

13.6.7 *Headlight; Headlamp* — Projector carried on a vehicle for illuminating the way or scene in front of the vehicle.

13.6.8 *Main-Beam Headlight*; High-Beam Headlight** — Headlight designed to illuminate for a considerable distance ahead of the vehicle carrying it.

13.6.9 *Dipped-Beam Headlight*; Low-Beam Headlight** — Headlight designed to illuminate without causing undue glare to people in front of the vehicle carrying it, particularly to the drivers of approaching vehicles.

NOTE— The two kinds of headlight as defined in **13.6.8** and **13.6.9** are commonly provided by a single lighting device.

13.6.10 *Front Fog Light** — Projector carved on a vehicle for illuminating the way ahead in poor visibility, and usually positioned so as to moderate the amount of light returned by scattering to the driver.

13.6.11 *Front Position Light* [Rear Position Light*; Tail Light*]* — Signal light carried on a vehicle to indicate forwards [rearwards] the presence of the vehicle. It may also, particularly if paired with an identical light, provide an indication of the width of the vehicle.

NOTE — The terms sidelight* (UK) and side-marker light* (USA) are commonly used for one of a pair of front position lights.

13.6.12 *Parking Light** — Signal light carried on a vehicle to indicate the presence of the vehicle in a parking place.

NOTE — A front position light or a rear position light may sometimes be used as a front parking light or a rear parking light respectively.

13.6.13 *Rear fog Light** — Signal light carried on a vehicle to indicate rearwards the presence of the vehicle in poor visibility. It is supplementary to a rear position light.

13.6.14 *Reversing Light*; Backup Light**—Signal light carried on a vehicle to indicate rearwards an intended, or actual, backward movement by the vehicle. It may also be designed to illuminate the way behind the vehicle.

13.6.15 *Brake Light*; Stop Light** — Signal light carried on a vehicle to indicate rearwards that a brake is being applied to the vehicle.

13.6.16 *Direction Indicator Light*; Turn-Signal Light** — Signal light, one of a set, canied on a vehicle to indicate an intended, or actual, movement by the vehicle to the left or the right.

13.6.17 *Hazard Warning Signal (on a Vehicle)* — Light signal provided by the simultaneous operation of all the direction indicator lights on a. vehicle, and used to indicate that the vehicle constitutes a special hazard to other moving vehicles.

13.6.18 *Number-Plate Light*; Rear Registration-Plate Light*; License-Plate Light** — Lighting device carried on a vehicle to illuminate the number plate, or registration plate, or license plate, at the rear of the vehicle.

NOTE — * In this term, lamp is sometimes used instead of light.

14 LIGHT EMITTING DIODE (LED) PRODUCTS AND RELATED EQUIPMENT

14.1 Ageing

Preconditioning period of the LED light source before initial values are taken.

14.2 Angular Subtense (α)

angle subtended by an apparent source as viewed from a point in space.

NOTES

1 Angular subtense is expressed in radians (rad).

2 The angle extension is determined by the observation distance, but at no distance smaller than the minimum distance of accommodation of the eye.

3 The location and angular subtense of the apparent source depends on the viewing position in the beam.

4 The angular subtense of an apparent source is only applicable in the wavelength range from 380 nm to1400 nm.

14.3 Apparent Source

for a given evaluation location of the retinal hazard, the real or virtual object that forms the smallest possible retinal image (considering the accommodation range of the human eye)

NOTES

1 The accommodation range of the eye is assumed to be variable from 100 mm to infinity. The location of the apparent source for a given viewing position in the beam is that location to which the eye accommodates to produce the most hazardous retinal irradiance condition.

2 This definition is used to determine, for a given evaluation position, the location of the apparent origin of laser radiation in the wavelength range of 380 nm to 1400 nm. In the limit of vanishing divergence, i.e. in the case of a well collimated beam, the location of the apparent source goes to infinity.

14.4 Beam Angle

angle between two imaginary lines in a plane through the optical beam axis, such that these lines pass through the centre of the front face of the lamp and through points at which the luminous intensity is 50 percent of the centre beam intensity

NOTES

1 Beam angle is expressed in degrees (°).

2 This angle is a full angle measure, not a half angle measure.

14.5 Bin

Restricted range of LED performance characteristics used to delimit a subset of LED dies or LED packages near a nominal LED performance as identified by chromaticity, photometric, radiometric and/or electrical characteristics

14.6 Control Gear

14.6.1 *Control Gear for LED Module (LED Control Gear)* — unit inserted between the electrical supply and one or more LED modules, which serves to supply the LED module(s) with its (their) rated voltage or rated current, and may consist of one or more separate components and may include means for dimming, correcting the power factor and suppressing radio interference, and further control functions

NOTES

1 The control gear consists of a power supply and a control unit.

2 The control gear may be partly or totally integrated in the LED module.

3 When no confusion is expected like when used in a LED standard for example, "controlgear" may also be used. Both terms "control gear" or "control gear" are acceptable.

14.6.2 *Power Supply of the Control Gear* — electronic device, being part of the controlgear, capable of controlling current, voltage or power within design limits, containing no additional LED control capabilities

NOTES

1 For LEDsi modules, the power supply of the control gear is separate from the LED module on a distant location.

2 The energy source of a power supply can be either a battery or the electrical supply system.

14.6.3 *Control Unit of the Control Gear* — electronic device, being part of the controlgear, responsible for controlling the electrical energy to the LED light sources as well as colour mixing, response to depreciating luminous flux and further performance features

NOTE — In LEDs modules, the control unit of the controlgear is on board of the LED module and separate from the power supply of the controlgear.

14.7 Dominant Wavelength (of a Colour Stimulus) (λ_d)

wavelength of the monochromatic stimulus that, when additively mixed in suitable proportions with the specified achromatic stimulus, matches the colour stimulus considered in the CIE 1931 x,y chromaticity diagram

NOTES

1 Dominant wavelength is expressed in nanometres (nm).

2 In the case of purple stimuli, the dominant wavelength is replaced by the complementary wavelength.

3 For characterising LED light sources the reference achromatic stimulus should be illuminant E which has the chromaticity coordinates x_E = 0. 3333, y_E = 0.3333.

4 A value for dominant wavelength should only be stated for LED light sources emitting coloured light. For LED light sources emitting white light no meaningful value for dominant wavelength can be given.

5 Deviating from the peak wavelength, the dominant wavelength determines perceived colour.

14.8 Failure

Termination of the ability of an item to perform a required function

NOTES

1 After failure the item has a fault.

2 "Failure" is an event, as distinguished from "fault", which is a state.

3 This concept as defined does not apply to items consisting of software only.

14.9 Failure Fraction (F)

Fraction of the population that lost the ability to perform a required function in a specified time interval

NOTE — Failure fraction is dimensionless.

14.10 Failure fraction at rated life (F_y)

Ratio y of failed LED products of the same type at their rated life to the test quantity

NOTES

1 The ratio is expressed in percent.
2 This failure fraction expresses the combined effect of all components of a LED product including mechanical, as far as the light output is concerned. The effect of the LED could either be less light than claimed or no light at all.
3 For LED products normally a failure fraction of 10% or/and 50% are being applied, indicated as F10 and/or F50.

14.11 Family

Group of LED light sources or LED luminaires, having the same characteristics and method of control (integrated, semi-integrated, nonintegrated), the groups are distinguished by common features of materials, components, and/or method of processing.

14.12 Forward direction

Direction of current that results when the P-type semiconductor region connected to one terminal is at positive potential relative to the N-type region connected to the other terminal

NOTE —If temperature compensation diodes are included, these are ignored in the determination of forward direction.

14.13 Forward voltage (U_F)

potential difference pertaining to the forward direction, dependent on the forward current at a given temperature

NOTES
1 Forward voltage is expressed in Volts (V).
2 Forward voltage for LED die is measured normally at 25 °C ambient temperature.

14.14 Heat output to the luminaire (P_d)

Power to be transferred to the luminaire by means of heat-conduction in order to stay below the t_c or t_p temperature

NOTES
1 Heat output is expressed in Watts (W).
2 P_d is below the rated power of a LED module.
3 For LED modules which do not need heat-conduction to the luminaire for keeping t_c, P_d is equal to zero.
4 A measurement method is under consideration.

14.15 LED lamp

Electric lamp based on LED technology

NOTES
1 An LED lamp can be integrated (LEDi lamp) or semi-integrated (LEDsi lamp) or non- integrated (LEDni lamp).
2 An LED lamp can include at least one LED module.

14.15.1 *Integrated LED Lamp (LEDi lamp)* — LED lamp, incorporating controlgear, and any additional elements necessary for stable operation of the light source, designed for direct connection to the supply voltage.

14.15.2 *Non-Integrated LED Lamp (LEDni lamp)* — LED lamp which needs a separate controlgear to operate.

14.15.3 *Retrofit LED Lamp* — LED lamp intended as a replacement of a non-LED lamp without requiring internal modification of the luminaire.

14.15.4 *Semi-Integrated LED Lamp (LEDsi Lamp)* — LED lamp which carries the control unit of the controlgear, and is operated by the separated power supply of the controlgear.

14.16 LED Light Source

Electrical light source based on LED technology

NOTES
1 A luminaire may include LED light sources but is not considered itself as a light source.
2 LED light source(s) for a LED luminaire represents one or more LED lamp(s) or LED module(s).

14.17 LED Luminaire

A complete lighting unit consisting of light emitting diode (LED)- based light emitting elements and a matched driver together with parts to distribute light, to position and the light emitting elements, and to connect the unit to a branch circuit. The LED- based light emitting elements may take the form of LED packages (components), LED arrays (modules), an LED light engine, or LED lamps. The LED luminaire is intended to connect directly to a branch circuit.

14.18 Non-Repairable, Factory Sealed LED Luminaire

Luminaire which cannot be dismantled without being permanently damaged, and incorporating LED light source(s) and any additional elements necessary for starting and stable operation of the light source

14.19 Led Array or Module

An assembly of light emitting diode (LED) packages (components), or dies on a printed circuit board or substrate, possible with optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of an LED driver. Power source and ANSI standard base are not incorporated into the device. The device cannot be connected directly to the branch circuit.

NOTES

1 A LED module can be integrated (LEDi module, Type 1) or semi-integrated (LEDsi module, Type 2) or non-integrated (LEDni module, Type 3).

2 An LED module is usually designed to be part of an LED lamp or an LED luminaire.

3 An LED module can include one or more of the following: electric, optical, mechanical, and thermal components, interfaces and controlgear.

14.19.1 *Built-in LED module* — LED module, generally designed to form a replaceable part to be built into a luminaire, a box, an enclosure or the like and not intended to be mounted outside a luminaire, etc. without special precautions

14.19.2 *Independent LED module* — LED module designed for mounting or placing separately from a luminaire, from an additional box or enclosure or the like

NOTES

1 The independent LED module provides all the necessary protection with regard to safety according to its classification and marking.

2 An example of an independent LED module is a system where the LED module is connected via a glass fibre with the luminaire head.

14.19.3 *Integral LED module* — LED module, generally designed to form a non-replaceable part of a luminaire.

14.19.4 *Integrated LED module* — LEDi module LED module, incorporating controlgear and any additional elements necessary for stable operation of the light source, designed for direct connection to the supply voltage

NOTE — LEDi modules are designated “Type 1”.

14.19.5 *Non-Integrated LED Module (LEDni Module)* — LED module which needs a separate control circuitry or controlgear to operate.

NOTE— LEDni modules are designated “Type 3”. regarded as a LED array. No further components are included like electrical, optical, mechanical, and thermal.

14.19.6 *Semi-Integrated LED Module (LEDsi Module)* — LED module which carries the control unit of the controlgear, and is operated by the separated power supply of the controlgear

NOTE — LED modules with control unit are designated “Type 2”.

14.20 LED Package

Single electric component comprising principally at least one LED die

NOTES

1 The LED package does not include the control unit of the controlgear, does not include a cap, is not connected directly to the supply voltage and does not include active electronic components.

2 An LED package is a discrete component and part of the LED module or LED lamp.

3 An LED package can include one or more of the following:
a) Optical elements;
b) Light converters (phosphors);
c) Thermal, mechanical, and electric interfaces;
d) Components to address ESD concerns.

14.21 LED Die

A small block of light-emitting semiconducting material on which a functional light emitting diode (LED) circuit is fabricated.

14.22 Luminous Life Time of LED Package ($L_x(t_j)$)

Time period at a specified junction temperature and forward current, determined by a minimum level of x % of the measured initial luminous flux

NOTES

1 Luminous life time of LED package is expressed in hours (h).

2 t_j relates to LED die, but luminous life time of LED package are given with reference to t_j.

14.23 Luminous Life Time of LED Module Related to t_p Temperature [$L_x(t_p)$]

Time period at a specified performance temperature at which x % of the measured initial luminous flux value is reached

NOTES

1 Luminous life time of LED module is expressed in hours (h).

2 The use of forced cooling to achieve the specified tp temperature should be stated.

14.24 Light Colour Designation

Three-digit number, the first digit representing the first digit of the general colour rendering index Ra and the second and third digit representing the first two digits (thousands and hundreds) of the CCT of the light source

14.25 Light Emitting Diode (LED)

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

NOTES

1 This definition is independent from the existence of enclosure(s) and of terminals.

2 The output 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 LED term normally represents the LED die (or chip), or LED package. It is also used as a generic term representing the technology.

4 LED term should not be used for reporting product performance (for example luminous flux, colour rendering, life time etc.) instead use for example “luminous flux of the LED module”

14.26 LED Lamp, Integrated

An integrated assembly composed of light emitting diode (LED) packages (components) or LED arrays (modules), as well as an LED driver, base, and other components such as optical, thermal, mechanical and electrical. The device is intended to connect directly to the branch circuit through a corresponding lamp-holder (socket).

14.27 LED Package

An assembly of one or more light emitting diode (LED) dies that includes wire bond or other type of electrical connections, possibly with an optical element and thermal, mechanical, and electrical interfaces. Power source and ANSI standardized base are not incorporated into the device. The device cannot be connected directly to the branch circuit.

14.28 Live Part

Conductive part which may cause an electric shock in normal use.

14.29 Luminous Efficacy (of a Source) [ηV, η]

Quotient obtained when the emitted luminous flux is divided by the power consumed by the source.

NOTES

1 Luminous efficacy is expressed in $lm.W^{-1}$

2 For LED applications, the source may be a LED package, module, lamp, luminaire etc.

14.30 Luminous Flux (Φ_V, Φ)

Quantity derived from radiant flux Φ_e by evaluating the radiation according to its action upon the (CIE) standard photometric observer.

NOTES

1 Luminous flux is expressed in lumen (lm).

$$\Phi_V = K_m \int_{360}^{830} (d\Phi_e(\lambda)/d\lambda) \times V(\lambda) d\lambda$$

2 For photopic vision

where, $(d\phi_e(\lambda)/ d\lambda)$ is the spectral distribution of the radiant flux and V (λ) is the spectral luminous efficiency.

3 The luminous flux of LED dies is usually expressed in groups into which they are sorted.

14.31 Luminous Flux Maintenance Factor / Lumen Maintenance Factor

Ratio of the luminous flux emitted by the light source at a given time in its life to its initial luminous flux emitted, the light source being operated under specified conditions

NOTES

1 This ratio is generally expressed in percent.

2 The lumen maintenance factor of a LED light source is the effect of decrease of the luminous flux output of the LED package or a combination of this with failure(s) of LED package if the LED light source contains more than one LED package

14.32 Luminous Intensity (of a Source, in a Given Direction) [IV; I]

Quotient of the luminous flux $d\Phi_V$ leaving the source and propagated in the element of solid angle $d\Omega$ containing the given direction, by the element of solid angle.

$IV = d\Phi_V/d\Omega$

NOTES

1 Luminous intensity is expressed in candela, cd=lm·sr–1

2 The definition holds strictly only for a point source.

14.33 Peak Wavelength (λ_p)

Wavelength of radiation at the highest intensity of the spectral distribution

NOTE— Peak wavelength is expressed in nanometres (nm).

14.34 Rated Life

Length of time during which a population of LED light sources provides at least the claim for maintained luminous flux percentage and at most the claim for failure fraction percentage Fy, as declared by the manufacturer or responsible vendor

NOTE— Rated life is expressed in hours (h).

14.35 Rated Value

Value of a quantity used for specification purposes, established under standard test conditions as declared by the manufacturer or responsible vendor.

NOTE— The standard test conditions are given in the relevant standard.

14.36 Rated Emergency Lighting Charging Power

Electrical power from the mains supply consumed by the charging circuit of emergency luminaires

NOTE— Rated emergency lighting charging power is measured in Watts (W).

14.37 Stabilization Time

Time that is required for the LED light source or LED luminaire to obtain stable photometric output and electrical power consumption with constant electrical input.

14.38 Standby Power (of the Luminaire)

Electrical power consumed by the luminaire during the period when the light source(s) is (are) not operating.

NOTES

1 Standby power is expressed in Watts (W).

2 For emergency lighting luminaires, this does not include the emergency lighting charging power.

14.39 Supply Voltage

Voltage applied to the complete unit of LED light source or LED luminaire.

14.40 Temperature

14.40.1 *Ambient Temperature* (t_{amb}) — Temperature of air or another medium in the vicinity of the product under test.

NOTES

1 Ambient temperature is expressed in degrees Celsius (°C).

2 During the measurement of the ambient temperature, the measuring instrument/probe should be shielded from draughts and radiant heating.

14.40.2 *Ambient Performance Temperature* — Ambient temperature related to the performance of the LED light source or LED luminaire

NOTE— Ambient performance temperature is expressed in degrees Celsius (°C).

14.40.3 *Board Temperature (t_b)* — Temperature of LED package or LED module between the printed circuit board and the thermal interface

NOTE — Board temperature is expressed in degrees Celsius (°C).

14.40.4 *Heat Transfer Temperature (t_d)* — Temperature occurring on a relevant part of the LED module (or any heat-conducting foil or paste provided as for insertion if delivered with the LED module) (at the indicated position if marked) which is intended for the passing of heat to the lamp holder or to other parts of the luminaire under normal operating conditions and at the rated voltage/current/power or the maximum of the rated voltage/current/power range

NOTES

1 The temperature measured at the specified point gives information on the interface in which the heat is to be transferred to the luminaire. An improper designed LED module does not pass the heat to the surface where it should be transferred to the luminaire. As a result, the t_c point will not stay below its maximum level and the t_d point in the interface area remains cold.

2 A measurement method is under consideration.

14.40.5 *Junction Temperature (t_j)* — Temperature at the p-n junction

NOTE— Junction temperature is expressed in degrees Celsius (°C).

14.40.6 *Performance Temperature (t_p)* — Temperature related to performance of the LED module.

NOTES

1 Performance temperature is expressed in degrees Celsius (°C).

2 Temperature is measured at a given location t_p-point.

14.40.7 *Rated Maximum Performance Ambient Temperature (t_q,nn)* — Highest ambient temperature around the luminaire related to a rated performance of the luminaire under normal operating conditions, both as declared by the manufacturer or responsible vendor

NOTES

1 Rated maximum performance ambient temperature is expressed in degrees Celsius (°C).

2 For a given life time, the t_q,nn temperature is a fixed value, not a variable, where nn, the number in the suffix indicates the related lifetime claim in khours, example; t_p,60 where nn = 60 represent 60 000 h lifetime claim.

3 There can be more than one tq,nn temperature, depending on the life time claim.

14.40.8 *Rated Maximum Performance Temperature (t_p,nn)* — Highest temperature at t_p point, related to a rated performance of the LED module, both as declared by the manufacturer or responsible vendor

NOTES

1 Rated maximum performance temperature is expressed in degrees Celsius (°C).

2 The location of t_p and t_c can be different.

3 For a given performance, the t_p,nn temperature is a fixed value, not a variable, where nn, the number in the suffix indicates the related lifetime claim in k hours, example; t_p,60 where nn = 60 represent 60 000 h lifetime claim.

4 There can be more than one t_p,nn, depending on the performance claim.

14.40.9 *Rated Maximum Temperature (t_c)* — Highest permissible safety related temperature which may occur on the outer surface of the component (LED module or controlgear) (at the indicated position, if marked) under normal operating conditions and at the rated voltage/current/power or the maximum of the rated voltage/current/power range

NOTE— Rated maximum temperature is expressed in degrees Celsius (°C).

14.40.10 *Storage Temperature Range* — Ambient temperature range within which a non-operated LED light source or LED luminaire can be stored, when the claims of the specification are maintained.

NOTE — Storage temperature range is expressed in degrees Celsius (°C).

14.40.11 *Temperature Coefficient of the Forward Voltage (kFV)* — Change in forward voltage at a fixed current as a function of the junction temperature.

NOTE— Temperature coefficient of the forward voltage is expressed in $mV \cdot K^{-1}$

14.41 Thermal Resistance of A LED Module

Thermodynamic temperature difference divided by the corresponding heat flow rate from the LED module to the heat sink.

NOTES

1 Thermal resistance of a LED module is expressed in °C/W

2 Measurement points should be at the junction, board or ambient, the location of which is to be determined by the manufacturer or responsible vendor.

14.42 Type

LED product representative of the production.

14.43 Type Test

Conformity test on one or more LED product(s) representative of the production.

14.44 Type Test Sample

One or more LED product(s) submitted by the manufacturer or responsible vendor for the purpose of the type test.

14.45 Printed Circuit Board Cap (PCB Cap)

Cap intended for use with printed circuit boards.

15 SOLAR RADIATION SIMULATOR

A device designed to produce a beam of collimated radiation having a spectrum, flux density, and geometric characteristics similar to those of the Sun outside Earth's atmosphere.

16 COVE LIGHTING

Lighting comprising light sources shielded by a ledge or horizontal recess, and distributing light over the ceiling and upper wall.

17 PHOTOBIOLOGICAL (HUMAN) HAZARD FUNCTION

The term "photobiological hazard function" refers to a mathematical representation of the potential harm caused by exposure to light, particularly in the context of its effects on living organisms, including humans. This concept is commonly associated with assessing the safety of exposure to optical radiation, such as ultraviolet (UV) or visible light. The photobiological hazard function is typically derived from experimental data on the biological effects of light at different wavelengths and intensities. The function describes the relationship between the dose of optical radiation (usually expressed in terms of radiant exposure or irradiance) and the likelihood or severity of biological damage. It is crucial in determining exposure limits to prevent adverse effects on human health, especially regarding the eyes and skin.

18 LIGHTING EFFECTIVENESS FACTOR (LEF)

The ratio of equivalent sphere illumination to measured or calculated task illuminance.

19 ERYTHEMA

The abnormal redness due to an over-accumulation of blood in the capillaries of the skin. Ultraviolet-induced erythema is due to actinic action and is delayed effect occurring several hours after exposure. This differs from infrared-induced erythema, a thermal effect occurring only for the duration of time that the skin temperature is elevated.

20 OCCUPANCY SENSOR

An occupancy sensor is an electronic sensor, used for different purposes like to improve the security of the office as well as home, reduces the energy utilization for lights in empty spaces. Generally, this sensor unites a motion detector using a timer as well as a light switch to activate and deactivate the lights as they are not required. Also called a chromaticity diagram one in which the x and y chromaticity coordinates are plotted in rectangular coordinates.* A plot of chromaticity coordinates for the physical colours forms a 'chromaticity diagram'. Fig. 1 shows the chromaticity coordinates (r_0,g_0) and (x,y).

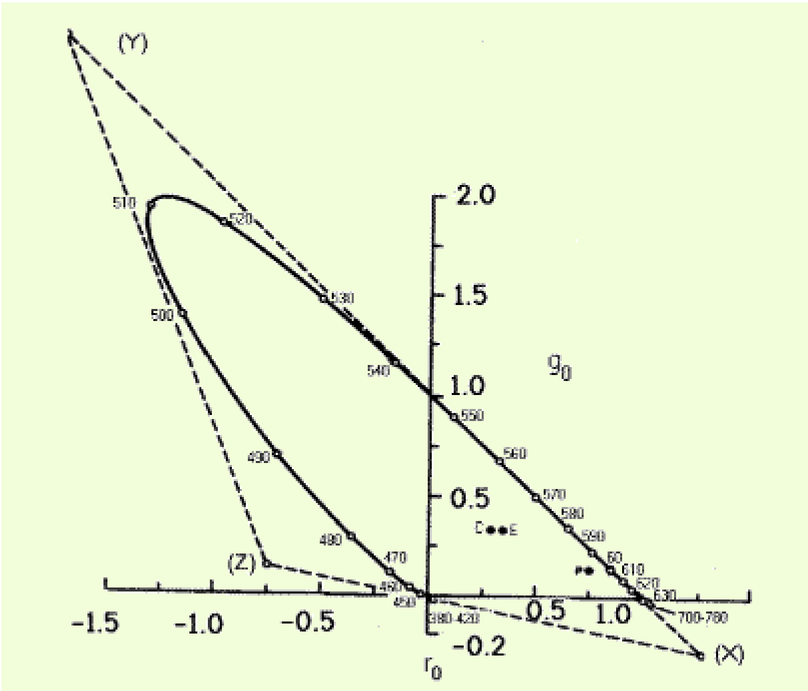

Fig. 1 The (r_0, g_0) Chromaticity Diagram for the Standard Observer

NOTES

1 The diagram may be based on the CIE 1931 Standard Observer or on the CIE 1964 supplementary Standard Observer. (See note to colour matching functions [spectral tristimulus values].)

2 CIE Technical Report 15.2, Colormetry, 2nd ed.,Vienna, Austria: International Commission on Illumination; 1986.

21 GERMICIDAL ACTION SPECTRUM

The relative spectral effectiveness in producing germicidal efficiency of various wavelengths of radiant flux is given in Table 1.

Table 1 Relative Spectral Effectiveness of Various Wavelengths of Radiant Flux
(*Clause* 21)

Sl. No	UVC Range	Specifications
(1)	(2)	(3)
i)	UVC (100-280 nm):	UVC light is highly effective for germicidal purposes, with wavelengths around 254 nm being particularly efficient at deactivating microorganisms.
ii)	UVB (280-315 nm):	UVB light is less effective than UVC but can still contribute to germicidal efficiency, especially at shorter wavelengths closer to the UVC range.
iii)	UVA (315-400 nm):	UVA light is the least effective for germicidal purposes, with minimal impact on microbial deactivation.

Unless otherwise indicated, the values used for spectral luminous efficiency in photopic vision are the values agree upon internationally in 1924 by the CIE, completed by interpolation and extrapolation, and recommended by the CIPM in 1972.

*CIE No. 86, CIE 1988 2° Spectral Luminous Efficiency Function for Photopic Vision. Vienna, Austria: international Commission on Illumination; 1990.

22 MOUNTING HEIGHT, MH (INTERIOR)

The distance from a reference plane (e.g. floor or work plane) to a luminaire, or to the plane of the ceiling for recessed luminaires. The default reference plane is the work plane. The luminaire reference location should be stated (e.g. bottom or light center) to avoid ambiguities.

23 LIFE OF A TEST LAMP

The actual operating time of the lamp until failure, expressed in hours, and which shall not include any off time.

24 MOUNTING HEIGHT, MH (ROADWAY)

The vertical distance between the roadway and the center of the apparent light source of a luminaire.

25 GRAYBODY

A temperature radiator whose spectral emissivity is less than unity and the same at all wavelengths.

26 LIGHT CENTER LENGTH (LCL)

The distance from the light center to a specified reference point on the lamp.

27 LOUVER SHIELDING, ANGLE θ

The angle between the horizontal plane of the baffles or louver grid and the plane at which the louver conceals all objects above Fig. 2 shows louver shielding angles θ and θ'.

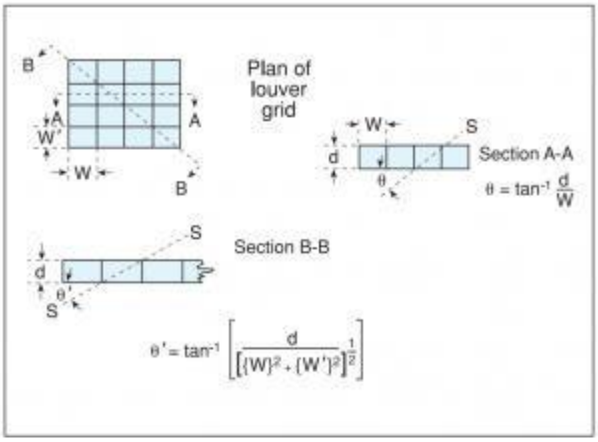

Fig. 2 Louver Shielding Angles (θ and θ')

28 TIME CLOCK

A clock-operated switch programmed to turn lighting on and off for selected periods.

29 HEAVY DUTY FLOODLIGHT, HD

A weatherproof unit having a substantially constructed metal housing into which is placed a separate and removable reflector. A weatherproof hinged door with cover glass enclosed the assembly but provides an unobstructed light opening at least equal to the effective diameter of the reflector.

30 COSINE LAW

A law stating that the illuminance on any surface varies as the cosine of the angle of incidence. The angle of incidence is the angle between the normal to the surface and the director of the incident light. The inverse-square law and the cosine law can be combined as:

$$E= \frac{(I\ cos\theta\ )}{d^2}$$

31 AERONAUTICAL LIGHT

Any luminous sign or signal that is specially provided as an aid to air navigation.

32 CHROMATICITY DIFFERENCE THRESHOLDS

The smallest difference in chromaticity between two colours of the same luminance that make them perceptibly different. The difference may be in hue, saturation, or a combination of the two.

33 ANTI-COLLISION LIGHT

In aeronautical lighting: A flashing aircraft aeronautical light or system of lights designed to provide a red signal throughout 360 degrees of azimuth for the purpose of giving long-range indication of an aircraft's location to pilots of other aircraft.

34 CIRCADIAN

Variations with a cycle of approximately 24 hours.

35 CHROMATICITY OF A COLOUR

The dominant or complementary wavelength and purity aspects of the colour taken together, or of the aspects specified by the chromaticity coordinates of the colour taken together.

36 BALLAST FACTOR

The fractional lumens of a fluorescent lamp(s) operated on a ballast compared to the lumens when operated on the standard (reference) ballasting specified for rating lamp lumens.

NOTE— The lamp(s) are specified ambient temperature conditions for photometric testing.

37 CHROMATIC ADAPTATION

The process by which the chromatic properties of the visual system are modified by the observation of stimuli of various chromaticities and luminance.

38 AERONAUTICAL GROUND LIGHT

Any light, other than a light displayed on an aircraft that is specially provided as an aid to air navigation.

The spectral luminous efficiency function for scotopic vision, adopted by the International Commission on Illumination (CIE) in 1951, is represented by the symbol $V'(\lambda)$. This function describes the sensitivity of the human eye under low-light conditions, particularly during nighttime or under dim lighting. Scotopic vision is associated with the activity of rod cells in the retina, which are more sensitive to shorter wavelengths of light.

39 AERODROME BEACON

An aeronautical beacon used to indicate the location of an aerodrome.

> NOTE — An aerodrome is any defined area on land or water – including any buildings, installations, and equipment-intended to be used either wholly or in part for the arrival, departure and movement of aircraft.

40 HEAVY DURTY FLOODLIGHT, HD

A weatherproof unit having a substantially constructed metal housing into which is placed a separate and removable reflector. A weatherproof hinged door with cover glass encloses the assembly but provides an unobstructed light opening at least equal to the effective diameter of the reflector.

41 ASTRONOMICAL TIME CLOCK

A time clock with automatic compensation for the annual change in length of day such that the switching operation is coordinated with daylight conditions.

42 BLUE-LIGHT HAZARD

Potential for photo chemically induced injury to the retina of the eye resulting from radiant exposure at wavelengths principally between 400 nm and 500 nm.

> NOTE— For non-laser sources, it is primarily due to fixating on the source with high radiance in this spectral band. Such injury commonly leads to retinal damage and potential long-term effects, as blue light exposure can contribute to the risk of age-related macular degeneration (AMD) and other retinal disorders.