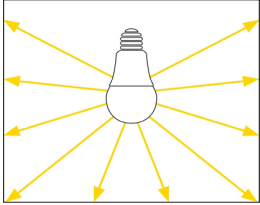


LIGHT TERMINOLOGY

LUMINOUS FLUX Φ (lm)

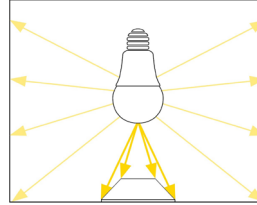
The luminous flux describes the quantity of light emitted by a light source per second.
The luminous efficacy is the ratio of the luminous flux to the electrical power consumed (lm/W). It is a measure of economic efficacy of a light source.



Φ - luminous flux
lm - Lumen

ILLUMINANCE L (lx)

Illuminance describes the amount of luminous flux falling on a surface. Relevant standards specify the required illuminance according to location and activity (EN 12464-1 "Lighting of indoor workplaces", EN 12464-2 "Lighting of outdoor workplaces", EN 12193 "Sports facility lighting")



$$E = \Phi / A \quad lx = lm/m^2$$

E - illuminance
 Φ - luminous flux
A - area, m²
lx - lux

TYPICAL RECOMMENDED LEVELS OF MAINTAINED ILLUMINANCE

OPTIONS	Typical recommended level of maintained illuminance, lx	UGR	U _o	R _a
OFFICES				
Writing, typing, reading, data processing	500	19	0,6	80
Computer work stations	500	19	0,6	80
Technical drawing	750	16	0,7	80
Conference and meeting rooms	500	19	0,6	80
Reception desks	300	22	0,6	80
Filing, copying, etc.	300	19	0,4	80
Archives	200	25	0,4	80
CIRCULATION AREAS WITHIN BUILDINGS				
Circulation areas and corridors	100	28	0,4	40
Stairs, escalators, moving walkways	100	25	0,4	40
Elevators, lifts	100	25	0,4	40
Loading ramps/bays	150	25	0,4	40
REST, SANITATION AND FIRST AID ROOMS				
Canteens, pantries	200	22	0,4	80
Rest rooms	100	22	0,4	80
Rooms for physical exercise	300	22	0,4	80
Cloakrooms, washrooms, bathrooms, toilets	200	25	0,4	80
Sick bays	500	19	0,6	80
Rooms for medical attention	500	16	0,6	90
EDUCATIONAL BUILDINGS				
Classrooms, tutorial rooms	300	19	0,6	80
Classrooms for evening classes and adults education	500	19	0,6	80
Black, green wallboards and whiteboards	500	19	0,6	80
Entrance halls	200	22	0,4	80
Stairs	150	25	0,4	80
Circulation areas, corridors	100	25	0,4	80
Sports halls, gymnasiums, swimming pools (general use)	300	22	0,6	80
STORE ROOMS, FROZEN FOOD STORES				
Store and stockrooms	100	25	0,4	60
Dispatch packing handling areas	300	25	0,6	60

STORAGE RACK AREAS				
Gangways: unmanned	20	-	0,4	40
Gangways: manned	150	22	0,4	60
Control stations	150	22	0,6	80
Front of (high-bay) racks	200	-	0,4	60
FACTORY ASSEMBLY AREAS				
Rough work	300	25	0,6	80
Medium work	500	22	0,6	80
Fine work	750	19	0,7	80
VERY FINE WORK				
Instrument assembly	1000	19	0,7	80
Jewellery assembly/repairs	1500	16	0,7	90
Hospital autopsy tables and dissecting tables	5000	-	-	90
SPORTS FACILITIES				
Aerobics, athletics, dancing, gymnastics, swimming	500	-	-	60
Basketball, football, handball, table tennis, tennis, volleyball, weight lifting	750	-	-	60
School sports	750	-	-	60

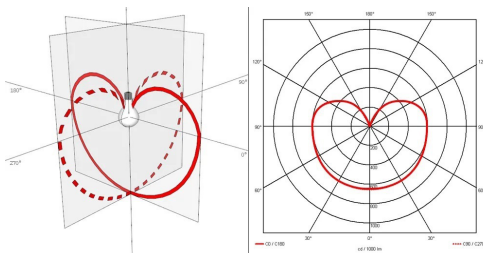
UGR - Unified glare rating serves to define the psychological glare (visual discomfort) of lighting installations in indoor spaces

Uo - Uniformity is the ratio of minimum illuminance to average illuminance on a surface

Ra - Colour rendering index

LUMINOUS INTENSITY I (cd)

The luminous intensity describes the quantity of light emitted in a particular direction per unit solid angle. This is a useful measurement for directive lighting elements such as reflectors. It is represented by the luminous intensity distribution curve.



$$I = \Phi / \Omega \quad \text{cd} = \text{lm} / \text{sr}$$

I - luminous intensity

Φ - luminous flux, lm

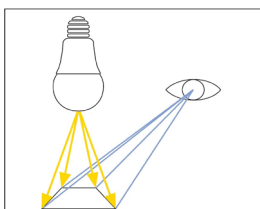
Ω - solid angle into which luminous flux is emitted, sr

cd - Candela

sr - Steradian

LUMINANCE (cd/m²)

The intensity and brilliance of light emitted from an item in a given direction. Luminance is often used to characterize emission or reflection from flat, diffuse surfaces. The luminance indicates how much luminous power will be detected by an eye looking at the surface from a particular angle of view. Luminance is thus an indicator of how bright the surface will appear.



$$L = I / (A * \cos \epsilon) \quad L = (E * \rho) / \pi$$

where:

Ω - solid angle into which luminous flux is emitted, sr

A - area hit by luminous flux, m²

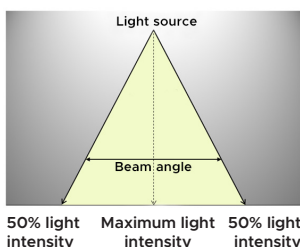
$A * \cos \epsilon$ - visible area from direction ϵ

ρ - reflectance of area (for diffuse surface areas)

π - 3.14

BEAM ANGLE (DEGREE, °)

The Beam Angle is the angle between the two directions opposed to each other over the beam axis for which the luminous intensity is half that of the maximum luminous intensity.



POWER CONSUMPTION (W)

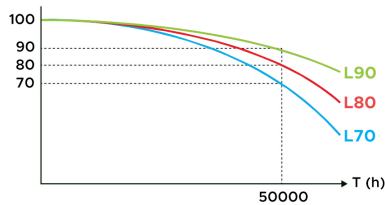
The electrical power used by a luminaire or light source. Usually expressed in watt-hours (power consumed per hour).

ENERGY EFFICACY (lm/W)

The figure gained by dividing the total luminous flux by the power consumed. Used to express the luminous flux (amount of light) gained per watt, the higher the figure the more efficient is the luminaire.

LED LIFETIME (h)

The lifetime of a LED luminaire illustrates the target life expectancy (for example 50 000 hour life expectancy) which is a combination of light output degradation (L80 when the light output has reduced to 80% of its initial level) and source performance expectation (B10 when 10% of the LEDs lumen outputs falls below 80% of the nominal initial value) under specific conditions.

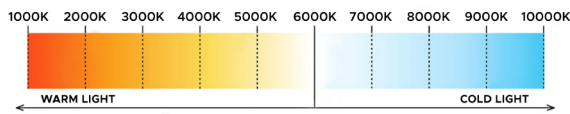


L - Lumen maintenance. L value tells that how many percent of luminous output is still left from the original.

B - Failure fraction. The value B10 means that minimum 90 % of the LED modules will meet the declared L-value and only 10% will have a lower flux level.

COLOUR TEMPERATURE (K)

Used to numerically express the colour of light sources, the redder the colour the lower the number and the bluer the colour the higher the number



- 2700K - extra warm white
- 3000K - warm white
- 4000K - natural white
- 5000K - cool white
- 6500K - day light

K - Kelvin

COLOUR RENDERING INDEX (CRI)

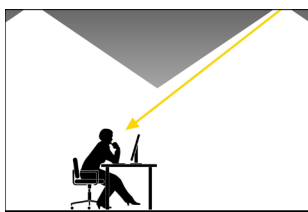
Colour rendering describes how a light source makes the colour of an object appear to human eyes and how well subtle variations in colour shades are revealed. A colour rendering index is a quantitative measure of the ability of a light source to reveal the colours of various objects faithfully in comparison with an ideal or natural light source. The ability of the light source to render colours naturally, without distorting the hues seen under a black full spectrum radiator, like daylight or incandescent lamps. A minimum of 80 CRI is recommended for working areas.



Light sources are divided up into colour rendering levels:
CRI > 90 very good colour rendering
CRI > 80 good colour rendering

UNIFIED GLARE RATING (UGR)

UGR is a method of calculating glare from luminaires. The UGR value is calculated using a complex equation that includes the luminance value of the luminaire, the value of background luminance, the solid angle of the luminaire as seen by the viewer and several other values. Within an office setting, for the luminaire to be classified as "low glare" it must have a UGR below 19 at desk level. Anything above this may cause discomfort – this further enforces the need for high quality interior lighting that is rated UGR<19.



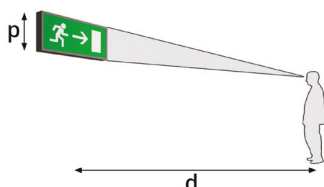
$$UGR = 8 \log \left[\frac{0.25}{L_b} \sum \left(\frac{L_v \omega_v}{P^2} \right) \right]$$

- UGR limits (UGRL) that must not be exceeded:
- ≤ 16 Technical drawing
 - ≤ 19 Reading, writing, training, meetings, computer-based work
 - ≤ 22 Craft and light industries
 - ≤ 25 Heavy industry
 - ≤ 28 Railway platforms, foyers

RECOGNITION DISTANCE (m)

Signs placed at all emergency exits along escape routes should be so illuminated as to indicate the direction to a place of safety in an unambiguous manner (EN1838 Lighting applications. Emergency lighting). Exit and direction signs should be clearly visible from anywhere along the escape route. All signs indicating emergency exits and escape routes should be in the same colour and format, whereas their minimum illuminance should be 2 cd/m².

As people in the building may not be familiar with its layout, internally illuminated, permanently powered safety signs are recommended. Note that internally illuminated safety signs are visible from a greater distance than the same size signs illuminated from the outside.



$$d = s \cdot p$$

d - viewing distance (maximum distance at which a sign is visible and recognizable), m

p - height of sign, m

s - constant value: 100 for externally illuminated signs and 200 for internally illuminated signs