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Draft Indian Standard

CODE OF PRACTICE FOR INTERIOR ILLUMINATION PART 1 GENERAL REQUIREMENTS AND RECOMMENDATIONS FOR WORKING INTERIORS

(*Second Revision*)

Illumination Engineering and Luminiaries Sectional Committee ETD 49

Last Date of Comments: 02 August 2024

NATIONAL FOREWORD

This draft Indian Standard (Second Revision) would be adopted by the Bureau of Indian Standards, after the draft finalized by the Illuminating Engineering Sectional Committee had been approved by the Electrotechnical Division Council.

The primary object. of this code is to indicate the factors which should be taken into account to achieve good lighting. It confines itself primarily to the lighting of working interiors, such as factories, workshops, offices, commercial premises, public buildings, hospitals and schools, keeping two objects in mind, namely, to make the task easy to see and to create a good visual environment.

Lighting is good only when it is suitable in both quality and quantity for two purposes; for creating good environmental brightness which is at the same time agreeable and beneficial to the user, and for permitting a high degree of efficiency in seeing whatever is of special interest or importance.

Many of the recommendations hold good whether lighting is artificial, natural or combination of the two and, as far as possible, the lighting of a building is regarded as a service which should be maintained at a high standard whenever the building is occupied.

The conventional methods of planning described herein are still the subject of continual research and in special cases it is felt that planning should be extended to include consideration of the luminance patterns relating to the whole of the visual field.

Provision of a good lighting system calls for co-ordination from the initial stages among the various parties concerned, namely, the architect, the consultants and the illumination engineer. Therefore, it is essential that information regarding lighting should be exchanged between the parties from the stage of planning to installation.

IS 3646 was first published in 1966 in three parts, Part 1 covering principles for good lighting and aspects of design, Part 2 covering schedule of illumination and glare index, and Part 3 covering calculation coefficient of utilization by the BZ method.

Part 1 was subsequently revised in 1992 to cover general requirements and recommendations for working interiors. This revision has been undertaken to include recommendations for lighting in the following areas:

a) Traffic zones inside buildings
b) Logistics and warehouses
c) Industrial activities and crafts
d) Offices
e) Retail premises
f) Places of public
g) Educational premises
h) Health care premises
i) Transportation areas

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2: 2022 ‘Rules for Rounding Off Numerical Values (Second Revision)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

CODE OF PRACTICE FOR INTERIOR ILLUMINATION - GENERAL REQUIREMENTS AND RECOMMENDATIONS FOR WORKING INTERIORS

(*Second Revision*)

1 SCOPE

This code covers the principles and practice governing good lighting in buildings and relates chiefly to the lighting of working area's in industrial, commercial and public buildings, hospitals and schools.

2 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

2.1 Adaptation

The process by which the properties of the organ of vision are modified according to the luminance or the colour stimuli presented to it. The term is also used, usually qualified, to denote the final state of this process. For example, 'Dark adaptation' denotes the state of the visual system when it has become adapted to a very low luminance.

2.2 Candela (cd)

The SI unit of luminous intensity, equal to one lumen/ steradian

2.3 Colour Rendering

A general expression for the appearance of surface colours when illuminated by light from a given source compare consciously or unconsciously, with their appearance under light from some reference source. Good colour rendering' implies similarity of Appearance to that under an acceptable light source, such as daylight.

2.4 Colour Rendering Index (CRI)

A measure of the degree to which the colours of surfaces illuminated by a given light source confirm to those of the same surfaces under a reference illuminant. Suitable allowance having been made for the state of chromatic adaptation.

2.5 Colour Temperature (K)

The temperature of the black body that emits radiation of the same chromaticity as the radiation considered.

2.6 Contrast

A term that is used subjectively and objectively. Subjectively, it describes the difference in appearance of two parts of a visual field seen simultaneously or successively. The difference may be one of brightness or colour, or both. Objectively, the term expresses the luminance difference between the two parts of the field by such relationship as:

$$\text{Contrast} = \frac{L_o - L_b}{L_b}$$

where,

L_b is the dominant or background luminance
L_o is the task luminance.
Quantitatively, the sign of the contrast is ignored.

2.7 Correlated Colour Temperature (Unit: K)

The temperature of a block body which emits radiation having a chromaticity nearest to that of the light source being considered, for example, the colour of a full radiator at 3500 K is the nearest match to that of a 'White' tubular fluorescent lamp.

2.8 Diffuse Reflection

Diffusion by reflection in which, on the macroscopic scale, there is no regular reflection.

2.9 Diffused Lighting

Lighting in which the light on the working plane on an object is not incident predominantly from any particular direction.

2.10 Direct Lighting

Lighting by means of luminaires with a light. Distribution such that 90 to 100 % of the emitted luminous flux reaches the working plane directly, assuming that this plane is unbounded.

2.11 Directional Lighting

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

2.12 Disability Glare

Glare which impairs the vision of objects without necessarily causing discomfort.

2.13 Discomfort Glare

Glare which causes discomfort without necessarily impairing the vision of objects.

2.14 Emergency Lighting

Lighting intended to allow the public to find the exists from a building with ease and certainty in the case of failure of the normal lighting system.

2.15 Flicker

Impression of fluctuating luminance or colour.

2.16 General Lighting

Lighting designed to illuminate the whole of an area uniformly, without provision for special local requirements.

2.17 Glare

Condition of vision in which there is discomfort or a reduction in the ability to see significant objects, or both, due to an unsuitable distribution or range of luminance or to extreme contrasts in space or time.

2.18 Illuminance (E)

At a point of surface, quotient of the luminous flux incident on an element of the surface containing the point by the area of that element. (Unit: Lux, lx).

2.19 Illumination

The application of visible radiation to an object.

2.20 Indirect Lighting

Lighting by means of luminaires with a light distribution such that not more than 10 % of the emitted luminous flux reaches the working plane directly, assuming that this plane is unbounded.

2.21 Light Loss Factor

Ratio of the average illuminance on the working plane after a specified period of use of a lighting installation to the average illuminance obtained under the same conditions for a new installation.

2.22 Local Lighting

Lighting designed to illuminate a particular small area which usually does not extend far beyond the visual task, for example, a desk light.

2.23 Localized Lighting

Lighting designed to illuminate an interior and at the same time to provide higher illuminance over a particular part or parts of the interior.

2.24 Lumen (1m)

Luminous flux emitted within unit solid angle (one steradian) by a point source having a uniform luminous intensity of 1 candela.

2.25 Luminaire

Apparatus that distributes, filters or transforms the light given by a lamp or lamps and which includes all the items necessary for fixing and protecting these lamps and for connecting them to the supply circuit.

2.26 Luminance (L)

In a given direction, at a point on the surface of the source or a recepter or at a point on the path of a beam. Quotient of the luminous flux leaving, arriving at, or passing through an element of surface at this point and propagated in direction defined by an elementary cone containing the given Direction and the product of the solid angle of the cone and the area of the orthogonal projection of the element surface on a plane perpendicular to the given direction (Unit: Candela per square meter, cd/m^2)

2.27 Luminous Efficacy (Unit: lm/W)

The ratio of luminous flux emitted by a lamp to the power consumed by the lamp. When –the power consumed by control gear is taken into account, this term is sometime known as lamp circuit luminous efficacy and is expressed in. lumens/circuit watt.

2.28 Luminous Flux (ø)

The quantity derived from radiant flux by evaluating the radiation according to its action upon a selective receptor, the spectral sensitivity of which is defined by the standard spectral luminous efficiencies. (Unit: lumen).

2.29 Luminous Intensity (I) (of a source in a given direction)

Quotient of the luminous flux leaving the source propagated in an element of solid angle containing the given direction, by the element of solidangle (Unit: candela, cd).

2.30 Lax (1x), Lumen Per Square Meter (SI Unit of Illuminance)

Illuminance produced by a luminous flux- of one lm uniformly distributed over a surface of area one square meter.

2.31 Reflectance (Reflection Factor)

Ratio of the reflected radiant or luminous flux to the incident flux.

2.32 Service Illuminance

The mean illuminance throughout the maintenance cycle of an installation, averaged over the relevant area. The area may be the whole of the working plane or just the area of the visual task and its immediate surround, depending on the lighting approach used.

2.33 Specular Reflection – Regular Reflection

Reflection without diffusion in accordance with the laws of optical reflection as in a mirror.

2.34 Stroboscopic Effect

Apparent change of motion or immobilization of an object, when the object is illuminated by a periodically varying light of appropriate frequency.

2.35 Uniformity Ratio

The ratio of the minimum illuminance to the average illuminance. In some instances, the ratio of the minimum to the maximum illuminance is quoted. The ratio usually applies to values on the working plane over the working area.

2.36 Visual Environment

The environment either indoors or outdoors as seen by an observer.

2.37 Visual Field

The full extent in space of what can be seen when looking in a given direction.

2.38 Activity Area

Area within which a specific activity is carried out.

2.39 Background Area

Area adjacent to the immediate surrounding area.

2.40 Display Screen Equipment DSE

Alphanumeric or graphic display screen, regardless of the display process employed.

NOTE— Adapted from 90/270/EEC.

2.41 Immediate Surrounding Area

Band surrounding the task area within the visual field.

2.42 Roof Light (Skylight)

Daylight opening in the roof or a horizontal surface of a building.

2.43 Shielding Angle

Angle between the horizontal plane and the first line of sight at which the luminous parts of the lamps in the luminaire are directly visible.

2.44 Task Area

Area within which the visual task is carried out.

2.45 Visual Task

Visual elements of the activity undertaken.

NOTE— The main visual elements are the size of the structure, its luminance, its contrast against the background and its duration.

2.46 Window

Daylight opening on a vertical or nearly vertical area of a room envelope

2.47 Work Place

Place intended to house work stations on the premises of the undertaking and/or establishment and any other place within the area of undertaking and/or establishment to which the worker has access in the course of his employment.

NOTE— Adapted from 89/654/EEC.

2.48 Work Station

Combination and spatial arrangement of work equipment, surrounded by the work environment under the conditions imposed by the work tasks.

3 FUNCTIONS OF LIGHTING

3.1 The lighting of an interior should fulfill qualititatve and quantitative needs The lighting requirement should satisfy the following:

a) *Visual Performance* — where the occupants are able to perform their tasks, under all conditions and for the required duration
b) *Visual Comfort* — where occupnats feel comfortable in the workspace, have a feeling of well-being, do not feel strained. This contributes to better productivity and higher quality of work
c) *Safety* — where the occupants feels safe in the workspace.

3.2 Lighting affects safety, task performance and the visual environment by changing the extent to and the manner in which different elements of the interior are revealed. Safety is ensured by making any hazards visible. Task performance is facilitated by making the relevant details of the task easy to see. Different visual environments can be created by changing the relative emphasis given to the various objects and surfaces in an interior. Different aspects of lighting influence the appearance of the elements in an interior in different ways. However, it should always be remembered that lighting design involves integrating the various aspects of lighting into a unity appropriate to the design objectives.

4. LIGHTING REQUIREMENTS

4.1 General

4.1.1 *Lighting Criteria*

Lighting requirements are based on the following:

a) Lighting level;
b) Luminance distribution;
c) Glare restriction;
d) Direction of incidence of light and shadow effect;
e) Colour appearance and colour rendering; and
f) Flicker.

A lighting installation can satisfy the requirements laid down, only if all the quality criteria are complied with; one or other quality criterion may be given priority, depending on the nature and difficulty of the visual task or on the type of room.

4.1.2 *Visual Tasks*

The quality requirements of the lighting increase with the difficulty of the visual task.
a) The size of the critical details of the task:
b) Their contrast with the background,
c) The speed at which these details have to
d) be perceived,
e) The desired reliability of recognition, and
f) The duration of the visual work.

4.1.3 *Economic Aspect*

The selection of nominal illuminance for particular activities has to take into account economic aspects too. Although a higher level of lighting involves greater overall costs, these may be more than out-weighed by increased productivity and lower accident rate. A compromise has often to be made between desirable illuminance levels and those which are possible due to the economic climate prevailing. In consequence, it may be necessary to accept a lower standard of. Lighting than that which' would be required from. The point of view of Performance. The overall costs of a lighting installation can be reduced by using lamps having a high luminous efficacy and luminaires having a high efficiency and suitable light distribution.

4.2 Lighting Levels

4.2.1 *Illuminance*

The lighting level produced by a lighting installation is usually qualified by the illuminance produced on a specified plane. In most cases, this plane is the major plane of the tasks in the interior and is commonly called the working plane. The illuminance provided by an installation affects both the performance of the tasks and the appearance of the space.

4.2.2 *Recommendations on Illuminance*

4.2.2.1 *Scale of illuminance*

In order to be able just to discern features of the human face, a luminance of approximately1 cd/m² is necessary. This can be achieved under normal lighting conditions with a horizontal illuminance of approximately 20 lux. So 20 lux is regarded as the minimum illuminance for all non-working

interiors. A factor of approximately 1.5 represents the smallest significant difference in subjective effect of illuminances. Therefore, the following scale of illuminances is recommended:

20-30-50-75-100-150-200-300-500-750-1000-1 500-2 000, etc, lux.

4.2.2.2 *Illuminance ranges*

Because circumstances may be significantly different for different interiors used for the same application or for different conditions for the same kind of activity.

The maintained average illuminance value shall at least meet the requirement as given in Clause 6 ($\bar{E}_{\mathrm{m}}$,required) and shall be used for normal visual conditions taking into account the following factors:

a) psycho-physiological aspects such as visual comfort and well-being;
b) requirements for visual tasks;
c) visual ergonomics.
d) practical experience;
e) contribution to functional safety;
f) economy.

NOTE — Em required is the middle value provided in **6**, for opting lower or higher values of Em one should consider context as per Table 1 and Table 2.

The values given in **6** are maintained average illuminances over the task area or activity area on the reference surface which can be horizontal, vertical or inclined.

For certain indoor areas in which these factors play an important role, a higher level of average lux level is recommended with the provision of lighting controls which not only provides the illuminance for working condition but also helps in regulating the Circadian cycle of the worker exposed to these environments.

Table 1 Context Modifiers for Increase of Maintained Average Illuminance

(*Clause* **4.2.2.2, 5.2.2**)

i)	visual work is critical;
ii)	errors are costly to rectify;
iii)	accuracy, higher productivity or increased concentration is of great importance;
iv)	task details are of unusually small size or low contrast;
v)	the task is undertaken for an unusually long time;
vi)	the task area or activity area has a low daylight provision;
vii)	the visual capacity of the worker is below normal.

NOTES—

1) Retinal illuminance declines with age due to reduced pupil size and increased spectral absorption of the crystalline lens. It is reasonable for lighting practitioners to increase task illuminance to help older people compensate for the age-related losses in retinal illuminance. More information can be found in CIE 227:2017.
2) Daylight provision is considered in **6.5**.
The required mid value $\bar{E}_{\mathrm{m}}$ in **6.3** is minimum average value for normal working conditions.
Decreasing illuminance by one step may be considered when conditions from Table 2 apply.

Table 2 Context Modifiers for Decrease of Required Maintained Average Illuminance

(*Clause* **4.2.2.2, 5.2.2**)

task details are of an unusually large size or high contrast;
the task is undertaken for an unusually short time.

i) Using dimming will accommodate for possible future change in working conditions.

ii) For visually impaired people special requirements can be necessary with regard to illuminances and contrasts.

iii) The size and position of the task or the activity area shall be stated and documented, *see* Figure 1.

iv) For work stations where the size and/or location of the task area or activity area(s) is/are unknown, either:

a) the whole area is treated as the task area; or

b) the whole area is uniformly ($U_{\mathrm{O}} \geq 0{,}40$) lit to an illuminance level specified by the designer; if the task area becomes known, the lighting scheme shall be re-designed to provide the required or modified illuminances.

v) If the type of the task is not known the designer has to make assumptions about the likely tasks and state task requirements.

vi) If the whole area is lit to a given illuminance value, then it is recommended that the lighting is controlled in appropriate zones.

vii) When multiple tasks take place in the area, requirements for all these tasks shall be complied with. This applies also to an activity area.

4.2.2.3 *Illuminance on the immediate surrounding area*

Large spatial variations in illuminance around the task area or activity area can lead to visual stress and discomfort.

The illuminance of the immediate surrounding area shall be related to the illuminance of the task area or activity area and should provide a well-balanced luminance distribution in the visual field.

The immediate surrounding area should be a band with a width of at least 0.5 m around the task area withinthe visual field.

The illuminance of the immediate surrounding area may be lower than the illuminance on the task area but shall be not less than the values given in Table 3.

The size and position of the immediate surrounding area shall be stated and documented.

Table 3 Relationship of Average Illuminances on Immediate Surrounding to the Average Illuminance on theTask Area or Activity Area

(*Clause* **4.2.2.3**)

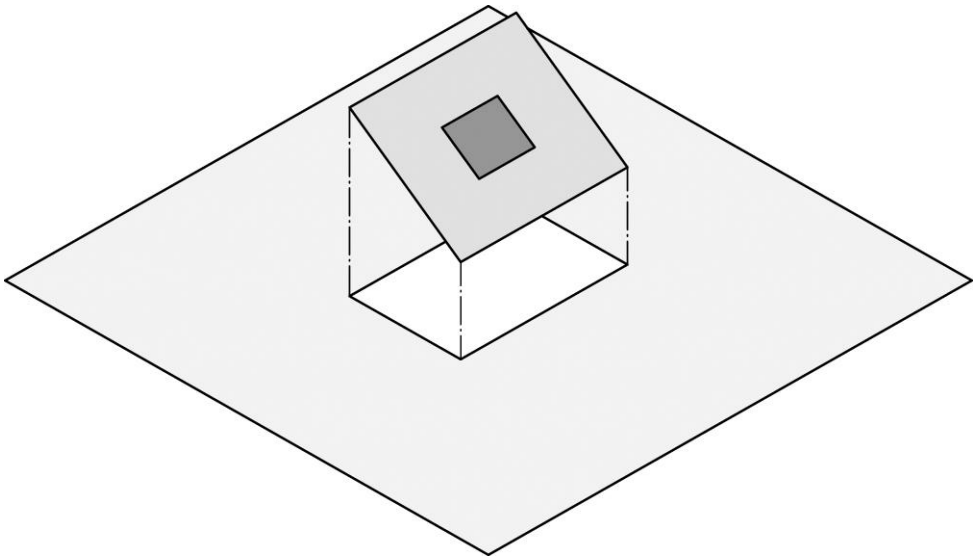
Sl. No.	**Average Illuminance on the Task Area or Activity Area**	**Average Illuminance on Immediate Surrounding Areas**
	$\bar{E}_m$	L_x
	l_x	
(1)	(2)	(3)
i)	≥ 750	500
ii)	500	300
iii)	300	200
iv)	200	150
v)	≤ 150	*equal to task area*

4.2.2.4 *Illuminance on the background area*

In indoor workplaces, particularly those devoid of daylight, a large area outside the immediate surrounding area needs to be illuminated. The background area is a horizontal area on floor level. It is adjacent to the immediate surrounding area within the limits of space and shall be illuminated with a maintained average illuminance of 1/3 of the value of the immediate surrounding area. For larger rooms the band shall be at least 3 m wide.

The size and position of the background area shall be stated and documented.

Below Fig. 1 illustrates the minimum dimension of background area in relation to task and immediate surrounding area.



task area or activity area (not true to scale) in a specified size and position

immediate surrounding area (band with a width of at least 0,5 m around the task area or activity area within the visual field)

background area (band with a width of at least 3 m adjacent to the immediate surrounding area or up to the limits of the space for smaller rooms) horizontal on floor level

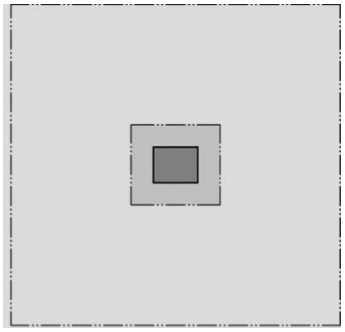


Fig. 1 Minimum Dimensions of Immediate Surrounding Area and Background Area in Relation to Task and Activity Area (Figure is Not True to Scale)

4.2.2.5 *Illuminance uniformity*

In the task area or activity area, the illuminance uniformity (U_O) shall be not less than the minimum uniformity values given in the tables below

Uniformity in the immediate surrounding area shall be $U_o \geq 0.40$.

On the background area, the walls and the ceiling the uniformity shall be $U_o \geq 0.10$. These uniformity levels shall only be applied with electric lighting.

Illuminance uniformity levels when daylight is available are not applicable because light intensity and distribution changes continuously due to weather conditions and outdoor context. Additional benefits of daylight can compensate for the lack of uniformity.

4.2.2.6 *Illuminance grid*

Grid systems shall be created to indicate the points at which the illuminance values are calculated and verified for the task and activity area(s), immediate surrounding area(s) and background area(s).

Grid cells approximating to a square are preferred, the ratio of length to width of a grid cell shall be kept between 0.5 and 2 (*see* also EN 12193 and EN 12464-2). The maximum grid size shall be:

$$p = 0.2 \bullet 5 \log^{10}(d)$$

where

$p \leq 10$ m

d is the longer dimension of the calculation area (m), however if the ratio of the longer to the shorter side is 2 or more then *d* becomes the shorter dimension of the area, and

p is the maximum grid cell size (m).

The number of points in the relevant dimension is given by the nearest whole number of *d/p*.

The resulting spacing between the grid points is used to calculate the nearest whole number of gridpoints in the other dimension. This will give a ratio of length to width of a grid cell close to 1

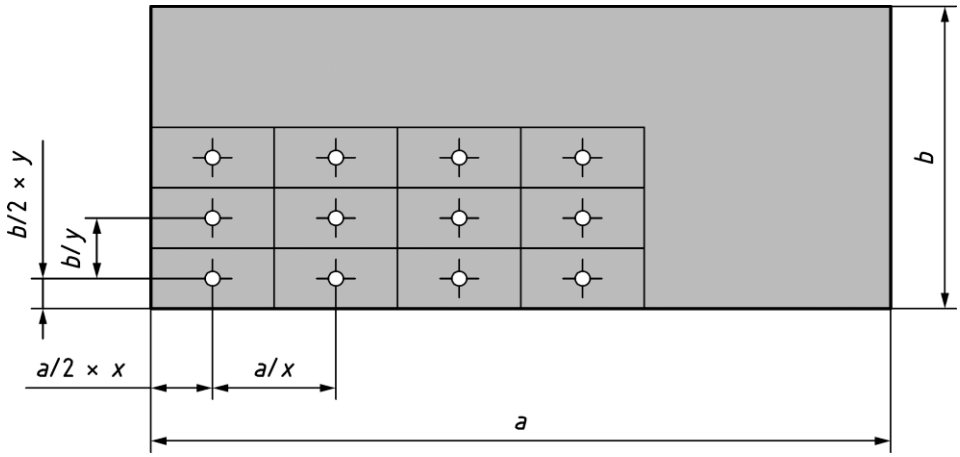
NOTE— Formula (1) (coming from CIE x005-1992) has been derived under the assumption that *p* is proportional to log(*d)*, where:

p = 0.2 m for *d* = 1 m;

p = 1 m for *d* = 10 m;

p = 5 m for d =100 m

The illuminance values are calculated and measured at the center point of grid rectangles. A typical grid is shown in Fig. 2.



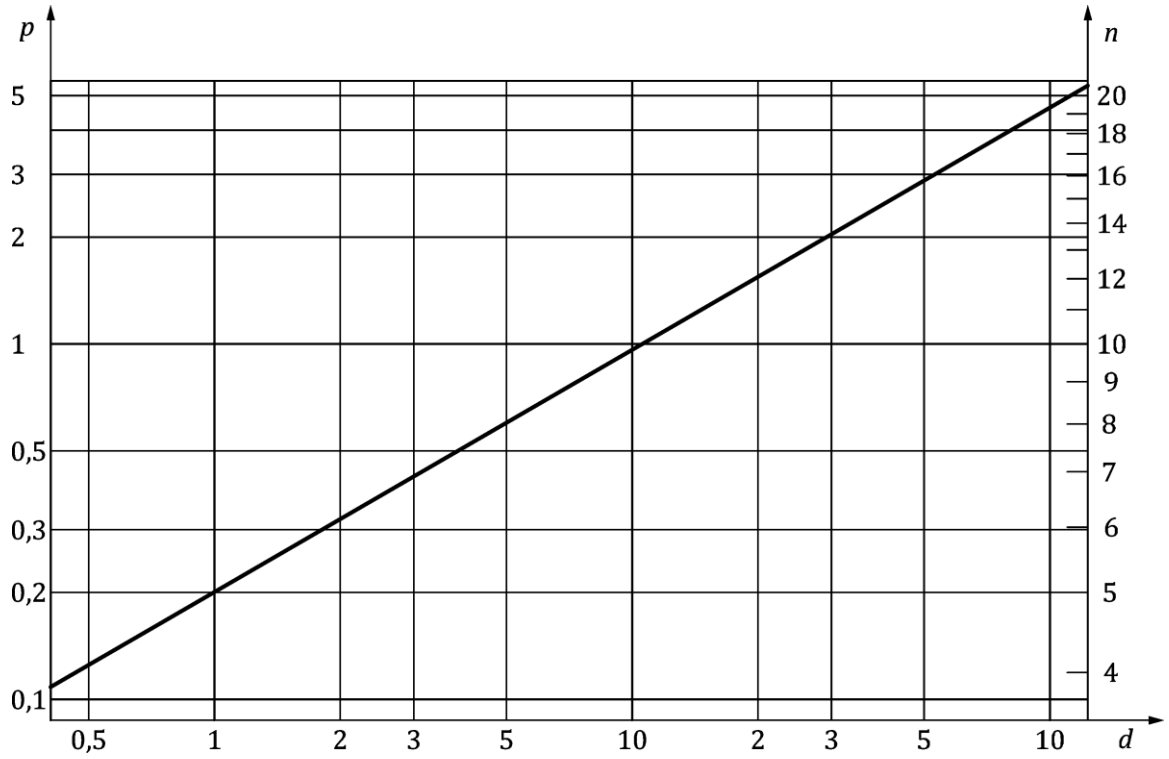
Key

- *a* dimension of the longer side of the calculation area/verification area
- *b* dimension of the shorter side of the calculation area/verification area
- *x* number of points along the longer side
- *y* number of points along the shorter side

Fig. 2 Typical Grid

To avoid high impact on uniformity from calculation points near the wall, a band next to the wall can be excluded from the calculation except when the task area is in or extends into this border area. The width of this band is specified as 15 % of the smallest dimension of the area under consideration or 0.5 m, whichever of the two is smaller.

The grid cell size as function of calculation/measurement area dimension is shown in Fig. 3.



d longer dimension of the calculation area (m), however if the ratio of the longer to the shorter side is 2 or more then *d* becomes the shorter dimension of the area
p maximum grid cell size (m)
n number of points in relevant dimension

Fig. 3 Grid Cell Size as Function of Calculation/ Measurement Area Dimension

An appropriate grid size shall be applied to walls and ceiling and a band of 0.5 m may be applied also. The grid point spacing should not coincide with the luminaire spacing.

NOTE— A separate grid for the calculation of daylight provision is specified in Annex B to EN 17037: 2018. This grid is not applicable for electric lighting

4.2.2.7 *Glare*

Glare is the unpleasant sensation produced by bright areas within the visual field, such as lit surfaces, parts of the luminaires, windows and/or roof lights. Glare shall be limited to avoid errors, fatigue and accidents. Glare can be experienced either as discomfort glare or as disability glare.

Glare caused by reflections in specular surfaces is usually known as veiling reflections or reflected glare. Glare shall be avoided:

a) By shielding the light source and/or by limiting the luminance of the luminous surfaces (according to **4.2.2.7.1**); and

b) By limiting the discomfort glare. For luminaires the UGR method shall be applied where valid (according to **4.2.2.7.2**).

NOTE— Special care is needed to avoid glare when the direction of view is significantly above the horizontal viewing direction, e.g. cases where a regular aspect of the work is looking high up/into the luminaires such as the storage racks, etc.

4.2.2.7.1 *Limiting luminaire luminance*

Bright sources of light can cause glare and can impair the vision of objects. It shall be avoided for example by suitable shielding of light sources or suitable shading from bright light through daylight openings.

For luminaires where the light source is directly visible, the minimum shielding angles (*see* Fig. 4) in the visual field given in Table 4 shall be applied for the specified light source luminance.

For luminaires where a direct view of the light source is obscured via optics, the maximum average luminaire luminance for the values of vertical photometric angle given in Table 5 shall be applied (*see* Fig. 4).

The values given in Table 4 and Table 5 do not apply to luminaires with an upward component only, mounted above normal eye level or to luminaires with a downward component only, mounted below normal eye level.

Table 4 Minimum Shielding Angles at Specified Light Source Luminance

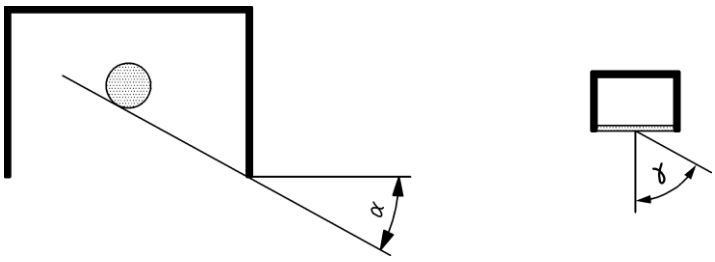
(*Clause* **4.2.2.7.1**)

Sl. No.	**Light Source Luminance**	**Minimum Shielding Angle**
	kcd m^{-2}	α
(1)	(2)	(3)
i)	20 to < 50	15°
ii)	50 to < 500	20°
iii)	≥ 500	30°

Table 5 Maximum Average Luminance of a Luminous Optical Element at Specified Vertical Photometric Angles

(*Clause* **4.2.2.7.1**)

Sl. No.	Vertical Photometric Angle γ	Maximum Average Luminance of a Luminous Optical Element kcd m^{-2}
(1)	(2)	(3)
i)	$75° \leq \gamma < 90°$	≤ 20
ii)	$70° \leq \gamma < 75°$	≤ 50
iii)	$60° \leq \gamma < 70°$	≤ 500



Key

α shielding angle
γ vertical photometric angle

NOTE— Left figure shows a cross section

of a conventional luminaire with a separate light source. Right picture shows a cross section of a luminous part of the optical element, e.g. a part of a LED luminaire.

Fig. 4 Shielding Angle and Vertical Photometric Angle

4.2.2.7.2 *Discomfort glare*

a) Discomfort glare from daylight

In areas with daylight access, glare from daylight openings can occur, either by direct sunlight entering and/or when the luminance in the field of view seen through daylight openings is too high compared to the adaptation levels for which the occupant is adapted

at a given time.

b) Discomfort glare from electric light — application of UGR tabular method

To select a luminaire suitable for the lighting installation of a given space the rating of discomfort glare caused directly from the luminaires shall be determined using the CIE Unified Glare Rating (UGR) tabular method.

NOTE— The UGR tabular method is detailed in CIE 117-1995 and in CIE 190:2010.

This UGR value determined using the UGR tabular method shall not exceed the R_{UG} limit value (R_{UGL}) given in **6**.

All assumptions made concerning luminaire, room dimensions, room surface reflectance's and spacing to height ratio in the determination of the R_{UGL} (formerly: UGR) shall be stated in the scheme documentation.

The tabular method is based on applying Formula (2) to a set of standard conditions (observer position, room dimensions and reflection factors).

$$R_{UG} = 8\log_{10}\left(\frac{0.25}{L_B}\Sigma\frac{L_\omega^2}{\rho 2}\right)\ldots\ldots\ldots \text{[(Formula (2)]}$$

Where,

R_{UG} *is* the value of the Unified Glare Rating (UGR),

LB is the background luminance in cd·m-2, calculated as $E_{ind} \cdot \pi\text{-}1$, in which E_{ind} is the vertical indirect illuminance at the observer's eye,

L is the luminance in $cd \cdot m^{-2}$ of the luminous parts of each luminaire in the direction of the observer's eye,

ω is the solid angle in steradian of the luminous parts of each luminaire at the observer's eye,

p is the Guth position index for each individual luminaire which relates to its displacement from the line of sight.

NOTES—

1) For more information on discomfort caused by glare from luminaires with a non-uniform source luminance, refer to CIE 232:2019.
2) The limiting values of the R_{UGL} form a series whose steps indicate noticeable changes in glare. This series of R_{UGL} is: 16, 19, 22, 25, 28 where a low value means “little likelihood of discomfort glare” and a high value means “significant possibility of discomfort glare”.
3) For a tabular UGR value a variation of ± can also be given. This variation of UGR within the room can be determined using the comprehensive tables for different observer positions, as detailed in CIE 117-1995. A high variation indicates that even small changes in the observer position can result in larger changes in glare. The compliance of the indoor lighting installation is not considering any variation in the CIE Unified Glare Rating (*UGR*) tabular method.

The boundary conditions for the determination of the UGR value by the tabular method include having one type of luminaire only in a rectangular space, a regular luminaire grid, same installation height, same orientation (C and γ angles).

The UGR tabular method does also not apply to following luminaires:

a) wall washers;
b) totally indirect;
c) asymmetric and double asymmetric;
d) adjustable spots; and
e) very small or very large luminous surfaces (*see* **A.2.1**).

This limits the application of the methodology to some extent but does not exclude its use. To maximize the applicability of the tabular method, **A.2** covers recommended practices when the above boundary conditions are not met.

4.2.3 *Determination by UGR formula*

If the tabular method is not applicable and the observer position and the viewing directions are known the UGR value can be determined by using the UGR Formula (2) from 4.2.2.7.2. However, the limits given in **6** have to be considered as benchmarks and not mandatory limits.

Account should be taken of possible variations in observer position and viewing direction, up to the expected displacement/rotation of the head of a person.

> NOTE— UGR values calculated by the formula are also suitable for making decision on optimal position(s) of the observer in the room.

All assumptions made concerning the calculation shall be stated in the scheme documentation.

4.3 Lighting in The Interior Space

4.3.1 *General*

In addition to lighting of the task and the activity areas the volume of space occupied by people should be lit. This light is required to highlight objects, reveal texture and improve the appearance of people within the space. The terms “average cylindrical illuminance”, "modelling" and “directional lighting” describe the lighting conditions.

4.3.2 *Cylindrical Illuminance Requirement in the Activity Space*

Good visual communication and recognition of objects within a space require that the volume of space in which people move or work shall be illuminated. This is fulfilled by providing adequate average cylindrical illuminance, $\bar{E}_z$, in the space.

The required maintained average cylindrical illuminance ($\bar{E}_{m,z}$) to be determined on a horizontal plane in the room and space (as in Table 8) is given in **6** for each type of task or activity. The uniformity of the average cylindrical illuminance shall be $U_o \geq 0.10$. The height of the horizontal plane shall be 1.2 m for seated people and 1.6 m for standing people above the floor.

Special attention is given to those spaces where visual recognition and communication is of higher importance.

When the complete space is treated as the task area or activity area and is used for the calculation of the required horizontal average illuminance, $\bar{E}_m$, the maintained average cylindrical illuminance, $\bar{E}_{m,z}$, shall be calculated for the same area size and position. When the task area and activity area / immediate surrounding area / background area are defined separately, the cylindrical illuminance requirement given in the tables in **6.3** shall be calculated and fulfilled for the space including task area and activity area and the immediate surrounding area.

NOTE— As an approximation for the cylindrical illuminance, the average value of four vertical illuminances orthogonal to one another can be used.

4.3.3 *Modelling*

The general appearance of an interior is enhanced when its structural features, the people and objects within it are lit so that form and texture are revealed clearly and pleasingly.

The lighting should not be too directional or it will produce harsh shadows, neither should it be too diffuse or the modelling effect will be lost entirely, resulting in a very dull luminous environment. Multiple shadows caused by directional lighting from more than one position should be avoided as this can result in a confused visual effect.

Modelling describes the balance between diffuse and directed light and should be considered.
The ratio of cylindrical to horizontal illuminance at a point is an indicator of modelling. The grid points for cylindrical and horizontal illuminances shall coincide in x, y and z.

NOTES—
1) For uniform arrangement of luminaires or roof lights a ratio of cylindrical to horizontal illuminance between 0.30 and 0.60 is an indicator of good modelling.
2) Daylight from vertical openings has a large impact on modelling. For this reason, the additional benefits of daylight (*see* **6.5**) can compensate for the above indicator of modelling.

4.3.4 *Directional Lighting of Visual Tasks*

Lighting from a specific direction can reveal details within a visual task, increase their visibility and making the task easier to perform. Unintended veiling reflections and reflected glare should be avoided, *see* **5.5.4**.

Harsh shadows that interfere with the visual task should be avoided. But some shadows help to increase the visibility of the task.

4.4 Colour Aspects

4.4.1 *General*

The colour qualities of a near-white

light source or transmitted daylight are characterized by two attributes:

a) the colour appearance of the light;
b) its colour rendering capabilities.

These two attributes shall be considered separately.

4.4.2 *Colour Appearance of the Light*

The colour appearance of a light source refers to the apparent colour (chromaticity) of the light emitted. It is quantified by its correlated colour temperature (*CCT*), *see* Table 6.

Table 6 Light Source Colour Appearance Groups
(*Clause* **4.4.2**)

Sl. No.	**Colour Appearance**	**Correlated Colour Temperature,** *CCT*
(1)	(2)	(3)
i)	warm	below 3000 K
ii)	neutral	3000 K to 5700 K
iii)	cool	above 5700 K

The choice of colour appearance of the light is a matter of psychology, aesthetics and what is preferred. The choice will depend on illuminance level, colours of the room and furniture, surrounding climate and the application. Additionally, dynamic colour temperature can be considered for increased personalization.

For further information on the physiological impact of spectral distribution and colour temperature change *see* Annex B. Careful consideration is necessary, especially in the case of night shift work.

In **6**, for specific applications a restricted band of suitable colour temperatures is given. These are applicable for daylighting as well as electric lighting.

4.4.3 *Colour Rendering*

For visual performance and the feeling of comfort and well-being colours in the environment, of objects and of human skin, shall be rendered with sufficient accuracy according to the task requirements given in **6**.

To provide an objective indication of the colour rendering properties of a light source the general colour rendering index R_a is used. The maximum value of R_a is 100.

The minimum value of colour rendering index for distinct types of task and activity areas within a space are given in **6**.

Safety colours according to ISO 3864-1 shall always be identifiable as such.

Colour rendering properties of light from luminaires can be influenced by optics, glazing and coloured surfaces.

NOTES—

1) Colour rendering properties for an observer in a space are affected by the reflectance properties of all surfaces.
2) If coloured light is used, the colour rendering requirements given in **6** are not applicable. For accurate rendition of colours of objects and human skin the appropriate special colour rendering index (R_i) should be considered. A colour rendering index below 80 should not be accepted in areas where people work permanently.

4.5 Flicker and Stroboscopic Effects

4.5.1 *General*

Flicker and stroboscopic effect (also called temporal light artefacts - TLA) can lead to undesired effects such as reducing visual comfort and reducing task performance and can lead to physiological effects such as fatigue or headaches.

Stroboscopic effects can also lead to dangerous situations by changing the perceived motion of rotating or reciprocating machinery. This is, however, outside of the scope of this document.

Lighting systems should be designed to avoid the negative effects of flicker and stroboscopic effect throughout the full dimming range (this includes light sources and control gears). Background information and methods to objectively quantify these effects can be found in CIE TN 006:2016.

4.5.2 *Flicker*

Flicker is specified by using the IEC short-term flicker indicator (*P*stLM) and test method as described in IEC TR 61547-1:2020.

4.5.3 *Stroboscopic Effect*

Stroboscopic effect perceived by individuals in indoor work places executing typical tasks, can be objectively quantified using the Stroboscopic Visibility Measure (SVM). The SVM can be used to quantify the visibility of this effect for applications where human motion is dominant and $\bar{E} > 100$ lx. Limits for this measure are application dependent and currently under consideration. The test method is described in IEC TR 63158:2018.

NOTE— SVM is not suitable to quantify the effects of lighting on health and rotating or reciprocating machinery as described in **5.8.1**.

4.6 Lighting of Work Stations with Display Screen Equipment (DSE)

4.6.1 *General*

The lighting for DSE work stations shall be appropriate for all tasks performed at the work station, e.g. reading from the screen, reading printed text, writing on paper, keyboard work.

For these areas the lighting criteria and system shall be chosen in accordance with type of task area or activity area, from the schedule in **6**.

Reflections in DSE and, in some circumstances, reflections from the keyboard can cause disability and discomfort glare. It is therefore necessary to select, locate and arrange the luminaires to avoid high brightness reflections.

The luminance of the background wall should be balanced to the brightness of the screen.

The designer shall determine the offending mounting zone and shall choose equipment and plan mounting positions which will cause no disturbing reflections.

4.6.2 *Luminaire Luminance Limits with Downward Flux*

Light can lower the contrast of the presentation on DSE by:

a) veiling reflection caused by the illuminance on the display surface and
b) luminances from luminaires and bright surfaces reflecting in the display.

EN ISO 9241-307 gives recommendations for the visual qualities of displays concerning unwanted reflections.

This subclause describes luminance limits for luminaires which can be reflected in DSE for normal viewing directions.

Table 7 gives the limits of the average luminaire luminance at elevation angles of 65° and above from the downward vertical, radially around the luminaires, for work stations where display screens which are vertical or inclined up to 15° tilt angle are used.

Table 7 Limits for The Average Luminance of Luminaires, which can be Reflected in Flat Screens

(*Clause* **4.6.2**)

Sl. No.	**Screen high state luminance**	**High luminance screen** $L > 200\ cd \cdot m^{-2}$	**Medium luminance screen** $L \leq 200\ cd \cdot m^{-2}$

(1)	(2)	(3)	(4)
i)	Case A (positive polarity and normal requirements concerning colour and details of the shown information, as used in office, education, etc.)	≤ 3 000 $cd \cdot m^{-2}$	≤ 1 500 $cd \cdot m^{-2}$
ii)	Case B (negative polarity and/or higher requirements concerning colour and details of the shown information, as used for CAD, colour inspection, etc.)	≤ 1 500 $cd \cdot m^{-2}$	≤ 1 000 $cd \cdot m^{-2}$

NOTE— Screen high state luminance (*see* EN ISO 9241-302) describes the maximum luminance of the white part of the screen and this value is available from the manufacturer of the screen.

Luminance criteria chosen to the luminaires of the space.

If a high luminance screen is intended to be operated at luminances below 200 $cd \cdot m^{-2}$ the conditions specified for a medium luminance screen shall be considered.

Some tasks, activities or display screen technologies require different lighting treatment (e.g. lower luminance limits, special shading, individual dimming, etc.).

In areas of industrial activities and crafts screens are sometimes protected by additional front glasses. The unwanted reflections on these protection glasses have to be reduced by suitable methods (such as anti-reflection treatment, tilting of the protection glass or by shutters).

5 LIGHTING DESIGN CONSIDERATIONS

5.1 General

To apply the lighting design criteria from **4**, the following aspects should be taken into account for the lighting design:

a) recommended illuminance requirements, *see* **5.2**;
b) operation of the lighting system;
c) energy efficiency requirements, *see* **5.4**;
d) variability of light, *see* **5.2.4**.

Verification procedure can be found in **7**.

5.2 Illuminance Requirements and Recommendations

5.2.1 *General*

To allow for a larger variety in application requirements, **6** provides maintained average illuminances $\bar{E}_{\mathrm{m}}$ in steps according to the scale of illuminances in **5.3.2** from required to modified values.

5.2.2 *Lighting of The Task Area or Activity Area and Its Immediate Surrounding Area* (*see* **4.2.2**)

The following steps shall be followed in selecting the appropriate lighting criteria for the task area or activity area and immediate surrounding area:

a) Define the task area and activity areas in the space.
b) Determine the appropriate type of task or activity based on the visual tasks executed in that area.The task area or activity area may be horizontal, vertical or inclined, and multiple tasks or activities may take place in the same area (consult **4.3.3** for guidance).
c) Select the "task or activity related requirements" from the tables in **6.3** ($\bar{E}_{\mathrm{m}}$, U_{o}, $\mathrm{R_a}$, R_{UGL}). For activity areas with multiple tasks the most onerous requirements shall be used for design (*see* **4.2.2**).
d) Select the adequate maintained average illuminance $\bar{E}_{\mathrm{m}}$ in steps using the scale of illuminance in **4.2.2.1** starting from the required value for the actual working condition according to the specific context modifiers as specified in **4.2.2.2** (Table 1 and Table 2).
It is recommended to design higher illuminances by up to two steps than the required (minimum average) maintained value on the task area or activity area ($\bar{E}$m) to allow adjustment of the illuminance on the task to cater for higher visual performance. To ensure satisfaction during different times of operation dimmable lighting can be used. When the task or activity is not being performed, or an activity of less visual difficulty is being performed, lower light levels can be employed using dimming or switching if appropriate.
e) Select the appropriate illuminance requirements for the immediate surrounding area and background area based upon the $\bar{E}_{\mathrm{m}}$ selection in step 3 and Table 3 (*see* **4.2.2.3** and **4.2.2.4**)

5.2.3 *Lighting of The Space*

To enhance the visual appearance and brightness impression of the room and space and good visual communication and recognition of objects, the following steps shall be followed:

a) Determine the relevant room surfaces around the workplaces (the walls and ceiling). The surfaces to be illuminated are at least those that contribute to the perception of room brightness. For example, in high industrial halls the upper part of the wall and the ceiling may be excluded.
b) Select the requirements for "objects and people" and for "room brightness" from the tables in **6.3** ($\bar{E}_{\mathrm{m,z}}$, $\bar{E}_{\mathrm{m,wall}}$, $\bar{E}_{\mathrm{m,ceiling}}$) based on all selected tasks and activities in **5.2.2** steps 1 and 2. If different requirements apply select the highest requirements to respect all specified tasks and activities within the space.
c) In areas with high distance to the ceiling, a lower ceiling illuminance can be accepted. E.g. in industrial premises or other areas with only direct lighting and lower reflectance than

the recommended values in **4.2.2**, or areas where illumination of the ceiling is not appropriate.

The R_{UGL} determined by the task or activity requirements needs to be fulfilled by luminaires in the field of view within the space.

If in step 3 of **5.2.2** higher values have been selected for $\bar{E}_m$ on the task area or activity area, the wall, ceiling and cylindrical illuminance values should also be increased by up to the same number of steps.

5.2.4 *Adjustability of the Lighting System*

A lighting installation can be adjusted by dimming and/or controlling. Dimming increases or decreases the lumen output from a luminaire. Controlling can have additional functionality to modify the operation of the luminaire(s) in an installation, for example variation in colour temperature or different lighting scenes or according to daylight provision.

Lighting should be adjustable to the actual user needs. The system should ensure that illuminances can be achieved that meet or exceed the recommended maintained average illuminance level using only the electric lighting (assuming a worst case scenario without daylight contribution). Illuminance can be achieved by both daylight and electric lighting or any combination of the two.

An adjustable system ensures that

a) the benefit of available daylight is maximized;
b) occupancy of the space can be taken into account;
c) changes of visual tasks can be catered for;
d) changes of occupants, occupant preferences or needs can be catered for.

This document recommends the use of the higher maintained average illuminance $\bar{E}_m$ to give the user the full use of the lit environment. Designing a basic lighting installation only fulfilling the minimum criteria limits the possible benefits of good lighting quality.

5.3 Maintenance Factor

The lighting scheme shall be designed taking into account an overall maintenance factor (f_m) calculated for the selected lighting equipment, environment and specified maintenance schedule for the task area or activity area according to ISO/CIE TS 22012.

The illuminance requirements for each task as specified in **6** are given as maintained average illuminance ($\bar{E}_m$) values. The initial illuminance $\bar{E}_i$ can be calculated from $\bar{E}_m$ as follows:

$$\bar{E}_i = \frac{\bar{E}_m}{f_m}$$

Where,

$\bar{E}_m$ is maintained average illuminance

$\bar{E}_i$ is initial illuminance
f_m is maintenance factor

The designer shall:

a) state the f_m and list all assumptions made in the derivation of the value;
b) specify lighting equipment suitable for the application environment; and
c) prepare a maintenance schedule to include e.g. frequency of light source replacement, luminaire and room cleaning intervals.

The maintenance factor f_m has a large impact on energy efficiency. The assumptions made in the derivation of the f_m shall be both realistically achievable and optimized in a way that leads to a high value.

NOTES—

1) Guidance on the determination of the maintenance factor can be found in ISO/CIE TS 22012 and further information on the erivation of f_m for electric indoor lighting systems can be found in CIE 97.
2) For daylight calculations, reduction of transmittance of daylight openings due to dirt deposition has an influence on daylight supply.

5.4 Energy Efficiency Requirements

Lighting should be designed to meet the lighting requirements of a particular task, activity or space in an energy efficient manner. It is important not to compromise the visual aspects of a lighting installation simply to reduce energy consumption. The required minimum illuminance values as set in this document are minimum values and shall be maintained over time (*see* **6.3**). Energy savings can be made by harvesting daylight, responding to occupancy patterns, improving maintenance characteristics of the installation, and making full use of controls.

Daylight can supply all or part of the light needed for visual tasks or activities, and therefore offers potential energy savings. The amount of daylight indoors depends firstly on the availability of daylight outside (i.e. the prevailing climate at the site) and, thereafter, the environment surrounding the building, the components immediately around the daylight opening and the configuration of the interior spaces. With a near vertical daylight opening in the façade, the daylight availability decreases rapidly with the distance from the façade. Supplementary lighting (e.g. electric light or additional daylight openings) can be needed to ensure the required illuminance levels at the work station are achieved and to balance the luminance distribution within the room. Controls can be used to ensure appropriate integration between electric lighting and daylight.

5.5 Additional Benefits of Daylight

Daylight can provide significant quantities of light indoors, with high colour rendering and variability in illuminance, direction and spectral composition throughout the day and season. Daylight openings in a vertical, inclined or horizontal surface are strongly favoured in work places for the light they deliver, and for the visual contact they provide with the outside environment. Additionally, daylight provides variable modelling and luminance patterns, which is also perceived as being beneficial for people in indoor working environments. For any space with daylight

openings, it is recommended to provide shading devices to reduce risk of glare or thermal discomfort. Direct view of the sun or to a reflection of the sun should be avoided. For a more comprehensive method EN 17037 defines metrics, gives principles of calculation and verification, with respect to using daylight to provide lighting within interiors.

5.6 Variability of Light

Light is important to people's health and well-being. Light affects the mood, emotion and mental alertness of people. It can also support and adjust the circadian rhythms and influence people's physiological and psychological state. Varying illuminances in time and season (with values higher or temporarily lower than specified in this document) and varying in colour temperature or spectrum can enhance people's well-being. Up to date research indicates that these phenomena, in addition to the lighting design criteria defined in this document, can be provided by the so-called "non-image forming" illuminances and colour appearance of light, as described in CEN/TR 16791 and in CIE S 026. The non-image-forming effects will depend on quantity and time of light exposure, spectral power distribution, duration of exposure, and individual parameters like circadian phase, light history, and others. These objectives can be achieved with daylight and electric lighting solutions. More information about non-image forming aspects can be found in Annex B. When varying lighting (e.g. using personal control) it is possible that lighting requirements (as stated in the tables in **6.3**) are no longer met. However, the values listed in the tables in 6.3 shall remain achievable.

> NOTE— Variability of light is important in spaces that are occupied for extended periods. Examples are classrooms, healthcare, offices and productions spaces.

5.7 Room Brightness

An indication of perceived room brightness in spaces where visual tasks or activities are carried out is obtained by a combination of reflectances and illuminances on walls and the ceiling. Additional indications of perceived room brightness are explained in Annex B. A well balanced adaptation luminance is needed to increase visual acuity (sharpness of vision); contrast sensitivity (discrimination of small relative luminance differences); efficiency of the ocular functions (such as accommodation, convergence, pupillary contraction, eye movements, etc.). The luminance distribution in the visual field also affects visual comfort. The following should be avoided for the reasons given:

a) Too high luminances which can give rise to glare;
b) Too high luminance contrasts which will cause fatigue because of constant re-adaptation of the eyes;
c) Too low luminances and too low luminance contrasts which result in a dull and non-stimulating working environment.

To create a well-balanced luminance distribution the luminances of all surfaces shall be taken into consideration and will be determined by the reflectance and the illuminance on the surfaces. To avoid gloom and to raise adaptation levels and comfort of people in buildings, it is highly desirable to have bright interior surfaces particularly the walls and ceiling

Recommended reflectance for the major interior diffusely reflecting surfaces are:

a) Ceiling: 0.7 to 0.9;
b) Walls: 0.5 to 0.8;
c) Floor: 0.2 to 0.4.

NOTE— The reflectance of major objects (like furniture, machinery, etc.) should be in the range of 0.2 to 0.7.

6 SCHEDULE OF SPECIFIC LIGHTING REQUIREMENTS

6.1 Composition of The Tables

For the application of the tables in 6.3, *see* **6**.

Column 1 lists the reference number for each task area or activity area.

Column 2 lists those tasks areas or activities areas, for which specific requirements are given. If the particular task or activity is not listed, the values given for a similar, comparable situation should be adopted. Task areas or activity areas can also be a room, e.g. a corridor or resting room.

Column 3 gives the required maintained average illuminance $\bar{E}_m$ on the reference surface (*see* **6.3**) for the interior (area) in which the task or activity from Column 2 is performed.

Column 4 gives the minimum illuminance uniformity U_o on the reference surface for the maintained average illuminance $\bar{E}_m$ chosen according to **5**.

Column 5 gives the minimum colour rendering indices (R_a) (*see* **4.4.3**) for the situation listed in Column 2.

Column 6 gives the UGR limits (Unified Glare Rating limit, R_{UGL}) that are applicable to the situation listed in Column 2 (*see* **4.2.2.7**).

Column 7 gives the maintained cylindrical illuminance $\bar{E}_{m,z}$ for the recognition of object and people as described in **4.3.2**

Column 8 gives the maintained average illuminance on walls $\bar{E}_m$, wall as described in **5.2.3.**

Column 9 gives the maintained average illuminance on ceilings $\bar{E}_m$, ceiling as described in **5.2.3.**

6.2 Schedule of Task and Activity Areas

Table 9 — Traffic zones inside buildings
Table 10 — General areas inside buildings – Rest, sanitation and first aid rooms
Table 11 — General areas inside buildings – Control rooms
Table 12 — General areas inside buildings – Store rooms, cold stores

Table 59 — Health care premises – Autopsy rooms and mortuaries
Table 60 — Transportation areas – Airports
Table 61 — Transportation areas – Railway installations

6.3 Lighting Requirements for Task Areas, Activity Areas, Room and Space Brightness

The requirements for task areas and activity areas are given in Table 8 to Table 60. The columns are understood as shown in Table 8. The requirements for the specific tasks and activities are given by $\bar{E}_{m}$, U_{o}, R_{a} and R_{UGL}. The requirements for the space in which the task(s) or activities are carried out are given by $\bar{E}_{m,z}$ for the perception of objects and people within this space and $\bar{E}_{m}$,wall and $\bar{E}_{m}$,ceiling for room brightness. The latter are used for designing the room and the space including *R*UGL. Glare (by *R*UGL) is dedicated to the space in which a task is carried out. The first four columns are used for of task area or activity area design and more than one of these areas can occur within one space.

This applies to column 3 to column 10 in all tables in **6.3**.

Table 8 Assignment of Columns to Requirements
(*Clause* **4.3.2**)

Sl. No.	**Task area or activity area design**				**Room or space design requirements**		
(1)	(2)				(3)		
i)	Task or activity related requirements				Brightness appearance of rooms (**5.2.2**/**5.2.3**)		
ii)	$\bar{E}_{m}$ lux	U_{o}	R_{a}	*RUGL*	$\bar{E}_{m,z}$ lux	$\bar{E}_{m}$,*wall* lux	$\bar{E}_{m}$,*ceiling* lux

Where,

$\bar{E}m$ - Minimum Average Illuminance Level at defined area

U_{o} - Uniformity Ratio (Minimum Illuminance / Average Illuminance)

R_a - Colour rendering properties of a light source

R_{UGL} - Unified Glare Rating Limit Value

$\bar{E}_{m,z}$ - maintained average cylindrical illuminance

$\bar{E}_m$,*wall –Average Illuminance level at wall(s)*

$\bar{E}_m$,*ceiling – Average Illuminance level at ceiling*

In all enclosed places the maintained illuminances on the major surfaces shall have the following values, unless specified in the table.

Table 9 Areas Inside Buildings
(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ **l_x**	$\bar{E}_m$**,wall l_x**	$\bar{E}_m$**,ceiling l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	9.1	Corridors and circulation areas	75– 100 - 150	0.40	70	28			
ii)	9.2	Stairs, escalators, travelators	75 – 100 - 150	0.40	70	25			
iii)	9.3	Elevators, lifts	75 – 100 - 150	0.40	70	25			
iv)	9.4	Area in front of lifts, elevators and escalators	150-200-300	0.40	70	25			
v)	9.5	Loading ramps/bays	100–150 -200	0.40	70	25			
vi)	9.6	Building entrance with canopy	20 -30- 50	0.40	-	-			
vii)	9.7	Gangways: manned	100 -150-200	0.40	70	25			

Table 10 General Areas Inside Buildings – Rest, Sanitation and First Aid Rooms

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(L_x)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ **l_x**	$\bar{E}_{m,wall}$ **l_x**	$\bar{E}_{m,ceiling}$ **l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	10.1	Canteens and break areas	150- 200- 300	0.40	80	22			
ii)	10.2	Resting rooms	75 -100- 150	0.40	80	22			
iii)	10.3	Rooms for physical exercise	200-300-500	0.40	80	22			
iv)	10.4	Cloakroom (area), washrooms, bathrooms, dressing-, lockers-, shower-, sink- and toiletareas	150 -200- 300	0.40	80	25			
v)	10.5	Facial lighting in front of mirrors	150- 200- 300	0.40	80	-			
vi)	10.6	Sick bay	300- 500- 750	0.60	80	19			
vii)	10.7	Rooms for medic	300- 500- 750	0.60	90	19			

		al attenti on							
viii)	10.8	General cleaning	75-100-150	0.40	-	-			

Table 11 General Areas Inside Buildings – Control Rooms

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(L_x)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	11.1	Plant rooms, switch gear rooms	150 -200-300	0.40	80	25	50	50	
ii)	11.2	Post sorting, switchboard	300 -500-750	0.60	80	19	150	150	
iii)	11.3	Surveillance station	200-300-500	0.60	80	19	100	100	

Table 12 General Areas Inside Buildings – Store Rooms, Cold Stores

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(L_x)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	12.1	Store and stockrooms	75 -100 - 150	0.40	80	25			
ii)	12.2	Dispatch packing handling areas	200–300- 500	0.60	80	25			
iii)	12.3	Larder	150–200 -300	0.40	80	25			

Table 13 Logistics and Warehouses
(*Clause* **6.2**)

Sl. No	Ref. no.	Type of task/activity area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	13.1	Unloading/ loading area	150 -200 -300	0.40	80	25	50		
ii)	13.2	Packing/ grouping area	200- 300-500	0.50	80	25	100		
iii)	13.3	Configuration and rehandling	500 -750- 1000	0.60	80	22	150		
iv)	13.4	Open goods storage	150 -200-300	0.40	80	25	50		
v)	13.5	Rack storage - floor	100 – 150- 200	0.50	80	25			
vi)	13.6	Rack storage - rack face	50 – 75 - 100	0.40	80	–	-		
vii)	13.7	Central logistics corridor (heavy traffic)	200 – 300- 500	0.60	80	25	100		
viii)	13.8	Automated zones (unmanned)	50 – 75 - 100	0.40	80	25			

Table 14 Industrial Activities and Crafts – Agriculture

(*Clause* **6.2**)

Sl. No	Ref. no.	Type of task/activity area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	14.1	Loading and operating of goods, handling equipment and machinery	150 -200- 300	0.40	80	25			
ii)	14.2	Buildings for livestock	30 -50- 75	0.40	70	-			
iii)	14.3	Sick animal pens; calving stalls	150 -200- 300	0.60	80	25			
iv)	14.4	Feed preparation ; dairy; utensil washing	150 -200- 300	0.60	80	25			

Table 15 Industrial Activities and Crafts – Bakeries

(*Clause* **6.2**)

Sl. No	Ref. no.	Type of task/activity area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	15.1	Preparation and baking	200 – 300- 500	0.60	80	22	75		
ii)	15.2	Finishing, glazing, decorating	300 – 500 -750	0.70	80	22	100		

Table 16 Industrial Activities and Crafts – Cement, Cement Goods, Concrete, Bricks

(*Clause* **6.2**)

Sl. No	Ref. no.	Type of task/activity area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	16.1	Drying	30-50 -75	0.40	70	28	-		
ii)	16.2	Preparation of materials; work on kilns and mixers	150 -200-300	0.40	70	28	50		
iii)	16.3	General machine work	200 – 300 – 500	0.60	80	25	100		

iv)	16.4	Rough forms	200 – 300 - 500	0.60	80	25	100		

Table 17 Industrial Activities And Crafts – Ceramics, Tiles, Glass, Glassware

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_m$**,wall** l_x	$\bar{E}_m$**,ceiling** l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	17.1	Drying	30 -50- 75	0.40	70	28	-		
ii)	17.2	Preparation, general machine work	200 -300-500	0.60	80	25	100		
iii)	17.3	Enamelling, rolling, pressing, shaping simple parts, glazing, glass blowing	200 -300-500	0.60	80	25	100		
iv)	17.4	Grinding, engraving, glass polishing, shaping precision parts, manufacture of glass instruments	500 – 750- 1000	0.70	80	19	150	75	50
v)	17.5	Grinding of optical glass, crystal, hand grinding and engraving	500–750- 1000	0.70	80	19	150	75	50

vi)	17.6	Precision work, e.g. decorative grinding, hand painting	750–1000-1000	0.70	90	19	150	75	50
vii)	17.7	Manufacture of synthetic precious stones	1000-1500-2000	0.70	90	19	150	75	50

Table 18 Industrial Activities and Crafts – Chemical, Plastics and Rubber Industry

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ **l**$_x$	$\bar{E}_m$**,wall l**$_x$	$\bar{E}_m$**,ceiling l**$_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	18.1	Remote-operated processing installations	30 -50 - 75	0.40	70	-	-		
ii)	18.2	Processing installations with limited manual intervention	100 – 150- 200	0.40	70	28	50		
iii)	18.3	Constantly manned work stations in processing installations	200 – 300 – 500	0.60	80	25	100		
iv)	18.4	Precision measuring rooms, laboratories	300 – 500 -750	0.60	80	19	150	75	50

v)	18.5	Pharmaceutical production	300 – 500 -750	0.60	80	22	150		
vi)	18.6	Tyre production	300 – 500 -750	0.60	80	22	150		
vii)	18.7	Colour inspection	750 – 1000- 1500	0.70	90	19	150	75	50
viii)	18.8	Cutting, finishing, inspection	500 – 750- 1000	0.70	80	19	150	75	50

Table 19 Industrial Activities and Crafts – Electrical and Electronic Industry

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(L_x)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ **l_x**	$\bar{E}_{m,wall}$ **l_x**	$\bar{E}_{m,ceiling}$ **l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	19.1	Cable and wire manufacture	200 -300- 500	0.60	80	25	100		
ii)	19.2.1	Winding - large coils	200 -300- 500	0.60	80	25	100		
iii)	19.2.2	Winding - medium-sized coils	300 – 500- 750	0.60	80	22	150		
iv)	19.2.3	Winding - small coils	500–750-1000	0.70	80	19	150	75	50
v)	19.3	Coil impregnating	200 -300- 500	0.60	80	25	100		
vi)	19.4	Galvanising	200 -300- 500	0.60	80	25	100		
vii)	19.5.1	Assembly work:- rough,	200 -300- 500	0.60	80	25	100		

		e.g. large transformers							
viii	19.5.2	Assembly work:- medium, e.g. switchboards	300 – 500- 750	0.60	80	22	150		
ix)	19.5.3	Assembly work:- fine, e.g. telephones, radios, IT equipment (computers)	500–750-1000	0.70	80	19	150	75	50
x)	19.5.4	Assembly work:- precision, e.g. measuring equipment, printed circuit boards	750-1000-1500	0.70	80	19	150	75	50
xi)	19.6	Electronic workshops, testing, adjusting	1000-1500-2000	0.70	80	19	150	75	50

Table 20 Industrial Activities and Crafts – Food Stuffs and Luxury Food Industry

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	20.1	Work stations	150 – 200-300	0.40	80	25	50		

ii)	20.2	Sorting and washing of products, milling, mixing, packing	200 – 300- 500	0.60	80	25	100		
iii)	20.3	Work stations and critical zones in slaughter houses, butchers, dairies mills, on filtering floor in sugar refineries	300 – 500- 750	0.60	80	25	150		
iv)	20.4	Cutting and sorting of fruit and vegetables	200 – 300- 500	0.60	80	25	100		
v)	20.5	Manufacture of delicatessen foods,	300 – 500- 750	0.60	80	22	150		
vi)	20.6	Inspection of glasses and bottles, product control, trimming, sorting, decoration	300 – 500- 750	0.60	80	22	150		
vii)	20.7	Laboratories	300 – 500- 750	0.60	80	19	150	75	50
viii)	20.8	Colour inspection	750-1000-1500	0.70	90	19	150	75	50

Table 21 Industrial Activities and Crafts – Foundries and Metal Casting

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_m$**,wall** l_x	$\bar{E}_m$**,ceiling** l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

i)	21.1	Man-size underfloor tunnels, cellars, etc.	30 -50- 75	0.40	70	-	-
ii)	21.2	Platforms	75 – 100 – 150	0.40	70	25	50
iii)	21.3	Sand preparation	150 -200- 300	0.40	80	25	50
iv)	21.4	Dressing	150 -200- 300	0.40	80	25	50
v)	21.5	Work stations at cupola and mixer	150 -200-300	0.40	80	25	50
vi)	21.6	Casting bay	150 -200- 300	0.40	80	25	50
vii)	21.7	Shake out areas	150 -200- 300	0.40	80	25	50
viii)	21.8	Machine moulding	150 -200- 300	0.40	80	25	50
ix)	21.9	Hand and core moulding	200– 300- 500	0.60	80	25	100
x)	21.10	Die casting	200– 300- 500	0.60	80	25	100
xi)	21.11	Model building	300–500-750	0.60	80	22	150

Table 22 Industrial Activities and Crafts – Hairdressers

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	22.1	Hairdressing	300 – 500 - 750	0.60	90	19	150	75	50

Table 23 Industrial Activities and Crafts – Jewellery Manufacturing

(*Clause* **6.2**)

Sl. No	Ref. no.	Type of task/activity area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	23.1	Working with precious stones	1000 -1500 – 2000	0.70	90	19	150	75	50
ii)	23.2	Manufacture of jewellery	750 – 1000- 1500	0.70	90	19	150	75	50
iii)	23.3	Watch making (manual)	1000-1500- 2000	0.70	80	19	150	75	50
iv)	23.4	Watch making (automatic)	300 – 500 - 750	0.60	80	19	150	75	50

Table 24 Industrial Activities and Crafts – Laundries and Dry Cleaning

(*Clause* **6.2**)

Sl. No	Ref. no.	Type of task/activity area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

i)	24.1	Goods in, marking and sorting	200 – 300- 500	0.60	80	25	100			
ii)	24.2	Washing and dry cleaning	200 – 300- 500	0.60	80	25	100			
iii)	24.3	Ironing, pressing	200 – 300- 500	0.60	80	25	100			
iv)	24.4	Inspection and repairs	500 – 750 - 1000	0.70	80	19	150	75		50

Table 25 Industrial Activities and Crafts – Leather and Leather Goods

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(L_x)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ **l_x**	$\bar{E}_{m,wall}$ **l_x**	$\bar{E}_{m,ceiling}$ **l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	25.1	Work on vats, barrels, pits	150 -200- 300	0.40	80	25	75		
ii)	25.2	Fleshing, skiving, rubbing, tumbling of skins	200 – 300 – 500	0.40	80	25	100		
iii)	25.3	Saddlery work, shoe manufacture: stitching, sewing, polishing, shaping, cutting, punching	300 – 500 - 750	0.60	80	22	150		
iv)	25.4	Sorting	300 – 500 - 750	0.60	90	22	150		
v)	25.5	Leather dyeing (machine)	300 – 500 - 750	0.60	80	22	150		
vi)	25.6	Quality control	750 – 1000- 1500	0.70	80	19	150	75	50
vii)	25.7	Colour inspection	750 – 1000- 1500	0.70	90	19	150	75	50
viii	25.8	Shoe making	300 – 500 - 750	0.60	80	22	150		

ix)	25.9	Glove making	300 – 500 - 750	0.60	80	22	150		

Table 26 Industrial Activities and Crafts – Metal Working and Processing

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	26.1	Open die forging	150 -200- 300	0.60	80	25	50		
ii)	26.2	Drop forging	200 – 300 – 500	0.60	80	25	75		
iii)	26.3	Welding	200 – 300 – 500	0.60	80	25	75		
iv)	26.4	Rough and average machining: tolerances ≥ 0,1 mm	200 – 300 – 500	0.60	80	22	75		
v)	26.5	Precision machining; grinding: tolerances < 0,1 mm	300 – 500 - 750	0.70	80	19	150	75	50
vi)	26.6	Scribing; inspection	500 – 750 - 1000	0.70	80	19	150	75	50
vii)	26.7	Wire and pipe drawing shops; cold forming	200 – 300 – 500	0.60	80	25	75		
viii)	26.8	Plate machining: thickness ≥ 5 mm	150 -200- 300	0.60	80	25	50		
ix)	26.9	Sheet metalwork:	200 – 300 – 500	0.60	80	22	75		

		thickness < 5 mm								
x)	26.10	Tool making; cutting equipment manufacture	500 – 750 - 1000	0.70	80	19	150			
xi)	26.11	Assembly:								
xii)	26.11.1	- rough	150 -200- 300	0.60	60	25	50			
xiii)	26.11.2	- medium	200 – 300 – 500	0.60	80	25	75			
xiv)	26.11.3	- fine	300 – 500 - 750	0.60	80	22	150			
xv)	26.11.4	- precision	500 – 750 - 1000	0.70	80	19	150	75		50
xvi)	26.12	Galvanizing	200 – 300 – 500	0.60	80	25	75			
xvii)	26.13	Surface preparation and painting	500 – 750 - 1000	0.70	80	25	150			
xviii	26.14	Tool, template and jig making, precision mechanics, micro-mechanics	750 – 1000 - 1500	0.70	80	19	150	75		50

Table 27 Industrial Activities and Crafts – Paper and Paper Goods

(*Clause* **6.2**)

Sl. No	Ref. no.	Type of task/activity area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	27.1	Edge runners, pulp mills	150 -200- 300	0.40	80	25	50		
ii)	27.2	Paper manufacture and processing, paper and corrugating machines, cardboard manufacture	200 – 300 – 500	0.60	80	25	75		
iii)	27.3	Standard bookbinding work, e.g. folding, sorting, gluing, cutting, embossing, sewing	300 – 500 - 750	0.60	80	22	150		

Table 28 Industrial Activities and Crafts – Power Stations

(*Clause* **6.2**)

Sl. No	Ref. no.	Type of task/activity area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	28.1	Fuel supply plant	30 – 50 – 75	0.40	70	-	-	-	-
ii)	28.2	Boiler house	75 – 100 – 150	0.40	70	28	50		
iii)	28.3	Machine halls	150 -200- 300	0.40	80	25	50		

iv)	28.4	Side rooms, e.g. pump rooms, condenser rooms, etc.; switchboards (inside buildings)	150 -200- 300	0.40	80	25	50		
v)	28.5	Control rooms	300 – 500 - 750	0.70	80	19	150	75	50

Table 29 Industrial Activities and Crafts – Printers

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	29.1	Cutting, gilding, embossing, block engraving, work on stones and	300 – 500 - 750	0.60	80	19	150	75	50
ii)	29.2	Paper sorting and hand printing	300 – 500 - 750	0.60	80	19	150	75	50
iii)	29.3	Type setting, retouching, lithography	750 – 1000 -1500	0.70	80	19	150	75	50
iv)	29.4	Colour inspection in multicoloured printing	1000 -1500 -2000	0.70	90	19	150	75	50
v)	29.5	Steel and copper engraving	1500– 2000- 3000	0.70	80	19	150	75	50

Table 30 Industrial Activities and Crafts – Rolling Mills, Iron and Steel Works

(*Clause* **6.2**)

Sl. No	Ref. no.	Type of task/activity area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	30.1	Production plants without manual operation	30 – 50 – 75	0.40	70	-	-		
ii)	30.2	Production plants with occasional manual operation	100 – 150 -200	0.40	70	28	50		
iii)	30.3	Production plants with continuous manual operation	150 -200- 300	0.60	80	25	50		
iv)	30.4	Slab Store	30 – 50 – 75	0.40	70	-	-		
v)	30.5	Furnaces	150 -200- 300	0.40	70	25	50		
vi)	30.6	Mill train; coiler; shear line	200 – 300 – 500	0.60	70	25	75		
vii)	30.7	Control platforms; control panels	200 – 300 – 500	0.60	80	22	75		
viii)	30.8	Test, measurement and inspection	300 – 500 - 750	0.60	80	22	150		

ix)	30.9	Underfloor man-sized tunnels; belt sections, cellars, etc.	30 – 50 – 75	0.40	70	-			

Table 31 Industrial Activities and Crafts – Textile Manufacture and Processing

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_m$**,wall** l_x	$\bar{E}_m$**,ceiling** l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	31.1	Work stations and zones in baths, bale opening	150 -200- 300	0.60	70	25	50		
ii)	31.2	Carding, washing, ironing, devilling machine work, drawing, combing, sizing, card cutting, pre-spinning, jute and hemp spinning	200 – 300 – 500	0.60	70	22	100		
iii)	31.3	Spinning, plying, reeling, winding	300 – 500 - 750	0.60	70	22	150		
iv)	31.4	Warping, weaving, braiding, knitting	300 – 500 - 750	0.60	70	22	150		

v)	31.5	Sewing, fine knitting, taking up stitches	500 – 750 - 1000	0.70	80	22	150			
vi)	31.6	Manual design, drawing patterns	500 – 750 - 1000	0.70	90	22	150			
vii)	31.7	Finishing, dyeing	300 – 500 - 750	0.60	80	22	150			
viii)	31.8	Drying room	75 – 100 - 150	0.40	60	28	50			
ix)	31.9	Automatic fabric printing	300 – 500 - 750	0.60	90	25	100			
x)	31.10	Burling, picking, trimming	750 – 1000 -1500	0.70	80	19	150	75		50
xi)	31.11	Colour inspection; fabric control	750 – 1000 -1500	0.70	90	19	150	75		50
xii)	31.12	Invisible mending	1250-1500 -2000	0.70	90	19	150	75		50
xiii)	31.13	Hat manufacturing	300 – 500 - 750	0.60	80	22	150			

Table 32 Industrial Activities and Crafts – Vehicle Construction and Repair

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ **lx**	$\bar{E}_m$**,wall lx**	$\bar{E}_m$**,ceiling lx**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	32.1	Press shop - large parts	200 – 300 – 500	0.60	80	25	100		
ii)	32.2	Press shop - visual inspection	300 – 500 - 750	0.60	80	22	150		

iii)	32.3	Body work and assembly - automatic line	200 – 300 – 500	0.60	80	25	100		
iv)	32.4	Body work and assembly - manual welding	300 – 500 - 750	0.60	80	22	150		
v)	32.5	Painting, spraying chamber, polishing chamber	500 – 750 - 1000	0.70	80	22	150		
vi)	32.6	Painting, inspection, touch- up and polishing	750 – 1000 -1500	0.70	90	19	150	75	50
vii)	32.7	Upholstery manufacture (manual)	750 – 1000 -1500	0.70	80	19	150	75	50
viii)	32.8	Detailing:							
		Subparts assembly (doors, dashboard, upholstery)							
		Underchassis assembly	500 – 750 - 1000	0.70	80	22	150		
		Motor and mechanical assembly							
		Final assembly conveyor line							
ix)	32.9	Detailing:- work with electronics	500 – 750 - 1000	0.60	90	22	150		
x)	32.10	Final inspection	750 – 1000 -1500	0.70	90	19	150	75	50

xi)	32.11	General vehicle services, repair and testing	300 – 500 - 750	0.60	80	22	100		

Table 33 Industrial Activities and Crafts – Wood Working and Processing

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ **lx**	$\bar{E}_{m,wall}$ **lx**	$\bar{E}_{m,ceiling}$ **lx**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	33.1	Automatic processing, e.g. drying, plywood manufacturing	30 – 50 – 75	0.40	70	28	-		
ii)	33.2	Steam pits	100 – 150 -200	0,40	70	28	50		
iii)	33.3	Saw frame	200 –300–500	0.60	70	25	100		
iv)	33.4	Work at joiner's bench, gluing, assembly	200–300–500	0.60	80	25	100		
v)	33.5	Polishing, painting, fancy joinery	500–750-1000	0.70	80	22	150		
vi)	33.6	Work on wood working machines, e.g. turning, fluting, dressing, rebating, grooving, cutting, sawing, sinking	300–500-750	0.60	80	19	150	75	50
vii)	33.7	Selection of veneer woods	500–750-1000	0.90	70	22	150		

viii)	33.8	Marquetry, inlay work	500–750-1000	0.90	70	22	150		
ix)	33.9	Quality control, inspection	750–1000-1500	0.90	70	19	150	75	50

Table 34 Offices

(*Clause* **6.2**)

Sl. No	**Ref. no.**	**Type of task/activity area**	$\bar{E}_m$ **(** L_x**)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_m$**,wall** l_x	$\bar{E}_m$**,ceiling** l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	34.1	Filing, copying, etc.	200 – 300 – 500	0.40	80	19	100	75	50
ii)	34.2	General office Area - Writing, typing, reading, data processing	300 – 500 - 750	0.60	80	19	150	75	50
iii)	34.3	Private Cabins	300 - 500 – 750	0.70	80	19	150	75	50
iv)	34.4	CAD work stations	300 – 500 - 750	0.60	80	19	150	75	50
v)	34.5	Huddle / Breakout Area	200 - 300 - 500	0.60	80	19	150	75	50
vi)	34.6.1	Conference and meeting rooms	300 – 500 - 750	0.60	80	19	150	75	50
vii)	34.6.2	Light On Presenter	150 – 200 – 300		80	19			

viii)	34.7	Reception desk	200 – 300 – 500	0.60	80	22	100	75	50
ix)	34.8	Archiving	150 -200- 300	0.40	80	25	75	-	-
x)	34.9	Canteens and Break out areas	150-200-300	0.60	80	22			
xi)	34.10	Resting rooms	75 - 100-200	0.40	80	22			
xii)	34.11	Rooms for Physical exercise	200-300-500	0.40	80	22			
xiii)	34.12	Cloakroom (area), wash room	150- 200-300	0.40	80	25	100	75	50
xiv)	34.13	Facial Lighting infront of mirrors	200 - 300-500	0.40	80				
xv)	34.14	Sick bay	300 - 500-750	0.60	80	19	100	75	50
xvi)	34.15	Rooms for medical attention	300 - 500-750	0.40	90	19	100	75	50
xvii)	34.16	General cleaning	75 - 100-150	0.40	80				
xviii)	34.17	Corridors and circulation areas	75 -100-150	0.40	70	28			
xix)	34.18	Stairs, escalators,travolators	75 - 100-150	0.40	70	25			
xx)	34.19	Elevators, lifts	75 - 100-150	0.40	70	25			
xxi)	34.20	Area in front of lifts,	150 - 200-300	0.40	70	25		75	50

		elevators and escalators						
xxii)	34.21	Auditorium, training hall,town hall, ampitheare	300 - 500-750	0.60	80	19	75	50

SPECIFIC REQUIREMENT RELATED TO OFFICE APPLICATION

Sl. No.	**Ref. no.**	**Specific Requirement**
(1)	(2)	(3)
i)	34.2	Dimmable lighting systems with daylight sensors and occupancy sensors.
ii)	34.3	Same as Above. Recommended to provide Personal Lighting controls
iii)	34.4	Controllable Light is recommended
iv)	34.5	For Video conferencing Lighting should be controllable with options of scene settings with wall mounted or hand help controllers. Semicylindrical /Vertical Plane Lighting of seats facing the video camera at 1.2 m from floor level >150.
v)	34.6.1	Lighting should be controllable.Specular reflections shall be prevented. Direct lighting on screen when displaying content shall be avoided. Lighting at the back of screen or around should be considered to avoid sharp contrast
vi)	34.12	In each individual toilet if these are fully enclosed.
vii)	34.13	Vertical illuminance, 0.5 m in front of mirror at head height.
viii)	34.15	4 000 K $\leq$ TCP $\leq$ 5 000 K
ix)	34.16	Applicable where regular cleaning is necessary.
x)	34.17	The lighting of exits and entrances shall provide a transition zone to avoid sudden changes in illuminance between inside and outside by day or night. Care should be taken to avoid glare to drivers and pedestrians

xi)	34.18	Illuminance at floor level. Requires enhanced contrast on leading edge of the steps.
xii)	34.19	Illuminance at floor level.- light in front of elevator,
xiii)	34.20	Area up to 1 m in front of lift, elevators and escalators. Illuminance at floor level.
xiv)	34.21	Lighting should be controllable to accomodate various A/V needs,

Table 35 Retail Premises

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	35.1	General sales area	200 - 300 - 500	0.40	80	22	75		
ii)	35.2	Till area	300 - 500 -750	0.60	80	19	100	75	50
iii)	35.3	Wrapper table	300 - 500 - 750	0.60	80	22	100		
iv)	35.4	Storage area	200 - 300 - 500	0.40	80	25	50		
v)	355	Dressing/fitting room	200 - 300 - 500	0.4	90	—	—		

Table 36 Places of Public Assembly General Areas

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	36.1	Entrance halls	75 - 100 - 150	0.40	80	22	50		

ii)	36.2	Cloakrooms	150 - 200 - 300	0.40	80	25	75		
iii)	36.3	Lounges	150 – 200 - 300	0.40	80	22	75		
iv)	36.4	Ticket offices	200 - 300 - 500	0.60	80	22	75		

Table 37 Places of Public Assembly- Restaurants And Hotels

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	$\bar{E}_m$ **(lx)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ **lx**	$\bar{E}_{m,Wall}$ **lx**	$\bar{E}_{m,Ceiling}$ **lx**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	37.1	Reception/cashier desk, porters desk	200 - 300 - 500	0.60	80	22	100		
ii)	37.2	Kitchen	300 - 500 - 750	0.60	80	22	100		
iii)	37.3	Restaurant, dining room, function room	—	—	80	—	—		
iv)	37.4	Self-service restaurant	150 - 200 - 300	0.40	80	22	75		
v)	37.5	Buffet	200 - 300 - 500	0.60	80	22	75		
vi)	37.6	Conference rooms	300 - 500 - 750	0.60	80	19	150	75	50
vii)	37.7	Corridors	75 - 100 - 150	0.40	80	25	50		

Table 38 Places of Public Assembly – Theatres, Concert Halls, Cinemas, Places for Entertainment

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,Wall}$ l_x	$\bar{E}_{m,Ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	38.1	Practice rooms	200 - 300 - 500	0.60	80	22	100		
ii)	38.2	Dressing rooms	200 - 300 - 500	0.60	90	22	100		
iii)	38.3	Seating areas – maintenance, cleaning	150 - 200 - 300	0.40	80	22	50		
iv)	38.4	Stage area rigging	200 - 300 - 500	0.40	80	25	75		

Table 39 Places of Public Assembly – Trade Fairs, Exhibition Halls

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,Wall}$ l_x	$\bar{E}_{m,Ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	39.1	General lighting	200 - 300 - 500	0.40	80	22	50		

Table 40 Places of Public Assembly – Museums

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x	Specific Requirements
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	40.1	Exhibits, insensitive to light	—	—	80	—	—	—	—	Lighting is determined by the display requirements.
ii)	40.2	Exhibits sensitive to light	—	—	80	—	—	—	—	Lighting is determined by the display requirements. Protection against damaging radiation is paramount.

Table 41 Places of Public Assembly – Libraries

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	41.1	Bookshelves**	150 -200 - 300	0.40	80	19	—	—	—
ii)	41.2	Reading area	300 - 500 - 750	0.60	80	19	100	75	50
iii)	41.3	Counters	300 - 500 - 750	0.60	80	19	150	75	50
iv)	41.4	General lighting	200 - 300 - 500	0.40	80	22	75		

** Illuminace level mentioned here is vertical at bookshelves

Table 42 Places of Public Assembly – Car Parks (Indoor)

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	42.1	Entry/exit ramps (during daylight hours)	200 - 300 - 500	0.40	70	25	75		
ii)	42.2	Entry/exit ramps (at night)	50 - 75 - 100	0.40	70	25	50		
iii)	42.3	Traffic lanes, internal ramps and pedestrian paths	50 - 75 - 100	0.40	70	25	50		
iv)	42.4	Parking areas – not open to public	50 - 75 - 100	0.25	70	—	50		
v)	42.5	Parking areas – open to public with a large number of users e.g shopping centers, arenas.	100 - 150 - 200	0.40	70	—	50		
vi)	42.6	Ticket office	200 - 300 - 500	0.60	80	19	75	75	50

Table 43 Educational Premises – Nursery School, Play School

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	43.1	Play room	200 - 300 - 500	0.40	80	22	100	75	50
ii)	43.2	Nursery	200 - 300 - 500	0.40	80	22	100	75	50
iii)	43.3	Handicraft room	200 - 300 - 500	0.60	80	19	100	75	50

Table 44 Educational Premises – Educational Buildings

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	44.1	Classroom - General activities	300 - 500 - 750	0.60	80	19	150	75	50
ii)	44.2	Auditorium, lecture halls	300 - 500 - 750	0.60	80	19	150	75	50

iii)	44.3	Attending lecture in seating areas in auditoriums and lecture halls	150 - 200 - 300	0.60	80	19	75	75	50
iv)	44.4	Black, green and white boards**	300 - 500 - 750	0.70	80	19	—		
v)	44.5	Black, green and white boards in auditorium and lecture halls	300 - 500 - 750	0.60	80	19	—		
vi)	44.6	Projector and smartboard presentation	—	—	—	—	—		
vii)	44.7	Display board**	150 - 200 - 300	0.60	80	19	—		
viii)	44.8	Demonstration table in auditoriums and lecture halls	500 - 750 - 1000	0.70	80	19	—		
ix)	44.9	Light on teacher / presenter	—	—	80	—	150		
x)	44.10	Light on podium area	200 - 300 - 500	0.70	80	—	—		
xi)	44.11	Computer work only	200 - 300 - 500	0.60	80	19	100	75	50
xii)	44.12	Art rooms in art schools	500 - 750 - 1000	0.70	90	19	150	75	50

xiii)	44.13	Technical drawing rooms	500 - 750 - 1000	0.60	80	19	150	75	50
xiv)	44.14	Practical rooms and laboratories	300 - 500 - 750	0.60	80	19	150	75	50
xv)	44.15	Handcraft rooms	300 – 500 – 750	0.60	80	19	150	75	50
xvi)	44.16	Teaching workshop	300 – 500 – 750	0.60	80	19	150	75	50
xvii)	44.17	Preparation rooms and workshops	300 - 500 - 750	0.60	80	22	150		
xviii)	44.18	Entrance halls	150 - 200 - 300	0.40	80	22	75		
xix)	44.19	Circulation areas, corridors	75 - 100 - 150	0.40	80	25	50		
xx)	44.20	Stairs	100 - 150 - 200	0.40	80	25	50		
xxi)	44.21	Student common rooms and assembly halls	150 - 200 - 300	0.40	80	22	75		
xxii)	44.22	Teachers rooms	200 – 300 – 500	0.60	80	19	100	75	50
xxiii)	44.23	Library: bookshelves**	150 -200- 300	0.60	80	19	75	75	50
xxiv)	44.24	Library: reading areas	300 – 500 - 750	0.60	80	19	100	75	50

xxv)	44.25	Stock rooms for teaching materials	75 – 100 - 150	0.40	80	25	50	
xxvi)	44.26	Sports halls, gymnasiums, swimming pools	200 – 300 – 500	0.60	80	22	100	
xxvii)	44.27	School canteens	150 -200- 300	0.40	80	22	75	
xxviii)	44.28	Kitchen	300 – 500 - 750	0.60	80	22	100	

** Vertical Illuminance

Table 45 Health Care Premises – Rooms for General Use

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	$\bar{E}_m$ **(L_x)**	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	45.1	Waiting rooms	150 -200- 300	0.40	80	22	75	75	30
ii)	45.2	Corridors: during the day	75 – 100 - 150	0.40	80	22	50	50	30
iii)	45.3	Corridors: cleaning	75 – 100 - 150	0.40	80	22	50	50	30
iv)	45.4	Corridors: during the night	30 – 50 - 75	0.40	80	22	—	—	—
v)	45.5	Corridors with multi- purpose use (e.g. preexaminatio n of patients)	150 -200- 300	0.60	80	22	75	75	50
vi)	45.6	Day rooms	200 – 300 – 500	0.60	80	22	75	75	50

vii)	45.7	Elevators, lifts for persons and visitors	75– 100 - 150	0.60	80	22	50	50	30
viii)	45.8	Service lifts	150 -200- 300	0.60	80	22	75	75	50

Table 46 Health Care Premises – Staff Rooms

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$** l_x	**$\bar{E}_{m,wall}$** l_x	**$\bar{E}_{m,ceiling}$** l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	46.1	Staff office	300 – 500 - 750	0.60	80	19	150	75	50
ii)	46.2	Staff rooms	200 – 300 – 500	0.60	80	19	100	75	50

Table 47 Health Care Premises – Wards, Maternity Wards

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$** l_x	**$\bar{E}_{m,wall}$** l_x	**$\bar{E}_{m,ceiling}$** l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	47.1	General lighting	75 – 100 - 150	0.70	80	19	50	50	30
ii)	47.2	Reading lighting	200 – 300 – 500	0.70	80	19	100	75	50
iii)	47.3	Wards - Simple examinations	200 – 300 – 500	0.70	80	19	100	75	50

iv)	47.4	Examination and treatment	750 – 1000 -1500	0.70	90	19	150	75	50
v)	47.5	Night lighting, observation lighting	5	—	80	—	—	—	—
vi)	47.6	Bathrooms and toilets for patients	150 -200- 300	0.70	90	22	75	75	50

Table 48 Health Care Premises – Examination Rooms (General)

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$ l_x**	**$\bar{E}_{m,wall}$ l_x**	**$\bar{E}_{m,ceiling}$ l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	48.1	General lighting	300 – 500 - 750	0.60	90	19	150	75	50
ii)	48.2	Examination and treatment	750 - 1000 - 1500	0.70	90	19	150	75	50

Note— preferred Color temperature should be 4000K to 5000K

Table 49 Health Care Premises – Eye Examination Rooms

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$ l_x**	**$\bar{E}_{m,wall}$ l_x**	**$\bar{E}_{m,ceiling}$ l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	49.1	General lighting*	300 – 500 - 750	0.60	90	19	150	75	50

ii)	49.2	Examination of the outer eye**	750 - 1000 - 1500	—	90	—	150	75	50
iii)	49.3	Reading and colour vision tests with vision charts**	300 – 500 - 750	0.70	90	19	150	75	50

preferred Color temperature should be 4000K to 5000K
** Note : preferred Color temperature should be 4000K to 6500K

Table 50 Health Care Premises – Ear Examination Rooms

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$ l_x**	**$\bar{E}_{m,wall}$ l_x**	**$\bar{E}_{m,ceiling}$ l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	50.1	General lighting	300 – 500 - 750	0.60	90	19	150	75	50
ii)	50.2	Ear examination	750 - 1000 - 1500	—	90	—	150	75	50

Table 51 Health Care Premises – Scanner Rooms

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$ l_x**	**$\bar{E}_{m,wall}$ l_x**	**$\bar{E}_{m,ceiling}$ l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	51.1	General lighting	200 – 300 – 500	0.60	80	19	100	75	50

ii)	51.2	Scanners with image enhancers and television systems	30 – 50 - 75	—	80	19	—	—	—

Table 52 Health Care Premises – Delivery Rooms

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$ l_x**	**$\bar{E}_{m,wall}$ l_x**	**$\bar{E}_{m,ceiling}$ l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	52.1	General lighting	200 – 300 – 500	0.60	90	19	100	75	50
ii)	52.2	Examination and treatment	750 - 1000 – 1500	0.70	90	19	150	75	50

Table 53 Health Care Premises – Treatment Rooms (General)

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$ l_x**	**$\bar{E}_{m,wall}$ l_x**	**$\bar{E}_{m,ceiling}$ l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	53.1	Dialysis	300 – 500 - 750	0.60	80	19	150	75	50
ii)	53.2	Dermatology	300 – 500 - 750	0.60	90	19	150	75	50
iii)	53.3	Endoscopy	200 – 300 – 500	0.60	80	19	100	75	50
iv)	53.4	Plastering	300 – 500 - 750	0.60	80	19	150	75	50
v)	53.5	Medical baths	200 – 300 – 500	0.60	80	19	100	75	50
vi)	53.6	Massage and radiotherapy	200 – 300 – 500	0.60	80	19	100	75	50

Table 54 Health Care Premises – Operating Areas

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	54.1	Pre-op and recovery rooms	500 – 750 - 1000	0.60	90	19	150	75	50
ii)	54.2	Operating cavity surround	750– 1000-1500	0.60	90	19	150	75	50
iii)	54.3	Operating theatre	750-100 –1500	0.60	90	19	—	—	—
iv)	54.4	Operating cavity	—	—	90	—	—	—	—

Note— Additional local lighting to be provided to achieve 10,000Lux to 50,000Lux

Table 55 Health Care Premises – Intensive Care Unit

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	55.1	General lighting	200 – 300 – 500	0.60	90	19	50	50	30
ii)	55.2	Simple examinations	300 – 500 - 750	0.60	90	19	100	75	50

iii)	55.3	Examination and treatment	1000 – 1250 - 1500	0.70	90	19	150	75	50
iv)	55.4	Night watch	20	—	90	19	—	—	—

Table 56 Health Care Premises – Dentists

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$** l_x	**$\bar{E}_{m,wall}$** l_x	**$\bar{E}_{m,ceiling}$** l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	56.1	General lighting	300 – 500 - 750	0.60	90	19	150	75	50
ii)	56.2	At the patient	750 - 1000 – - 1500	0.70	90	—	150	75	50
iii)	56.3	Operating cavity	—	—	—	—	—	—	—
iv)	56.4	White teeth matching	—	—	—	—	—	—	—

Table 57 Health Care Premises – Laboratories and Pharmacies

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$** l_x	**$\bar{E}_{m,wall}$** l_x	**$\bar{E}_{m,ceiling}$** l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	57.1	General lighting	300 – 500 - 750	0.60	80	19	150	75	50
ii)	57.2	Colour inspection	750 - 1000- 1500	0.70	90	19	150	75	50

Table 58 Health Care Premises – Decontamination Rooms

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	58.1	Sterilization	300 – 500 - 750	0.60	80	22	100	75	50
ii)	58.2	Disinfection	300 – 500 - 750	0.60	80	22	100	75	50

Table 59 Health Care Premises – Autopsy Rooms and Mortuaries

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	59.1	General lighting	300 – 500 - 750	0.60	90	19	150	75	50
ii)	59.2	Autopsy table and dissecting table	5000 –7500	0.70	90	—	150	75	50

Table 60 Transportation Areas – Airports

(*Clause* **6.2**)

Sl. No.	Ref. No.	Type of Task/Activity Area	$\bar{E}_m$ (L_x)	U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ l_x	$\bar{E}_{m,wall}$ l_x	$\bar{E}_{m,ceiling}$ l_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	60.1	Arrival and departure halls, baggage claim areas	150 -200- 300	0.40	80	22	75		
ii)	60.2	Connecting areas	100 – 150 - 200	0.40	80	22	50		
iii)	60.3	Information desks, check-in desks	300 – 500 - 750	0.70	80	19	150		

iv)	60.4	Customs and passport control desks	300 – 500 - 750	0.70	80	19	150		
v)	60.5	Waiting areas	150 -200- 300	0.40	80	22	50		
vi)	60.6	Luggage storage rooms	150 -200- 300	0.40	80	25	50		
vii)	60.7	Security check areas	200 – 300 – 500	0.60	80	19	100		
viii)	60.8	Air traffic control tower	300 – 500 - 750	0.60	80	19	50	75	50
ix)	60.9	Tasks in hangars: Testing and repair areas Engine test areas Measuring areas	300 – 500 - 750	0.60	80	22	50		

Table 61 Transportation Areas – Railway Installations

(*Clause* **6.2**)

Sl. No.	**Ref. No.**	**Type of Task/Activity Area**	**$\bar{E}_m$ (L_x)**	**U_o**	**R_a**	**R_{UGL}**	**$\bar{E}_{m,z}$** **l_x**	**$\bar{E}_{m,wall}$** **l_x**	**$\bar{E}_{m,ceiling}$** **l_x**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	61.1.1	Fully enclosed platforms, small number of passengers	30 – 50 - 75	0.30	80	—	—	—	—
ii)	61.1.2	Fully enclosed platforms, medium number of passengers	75 – 100 - 150	0.40	80	—	—	—	—
iii)	61.1.3	Fully enclosed platforms, large	150 -200- 300	0.50	80	—	—	—	—

		number of passengers							
iv)	61.2.1	Fully enclosed passenger subways (underpasses), small number of passengers	30 – 50 - 75	0.30	80	—	—	—	—
v)	61.2.2	Fully enclosed passenger subways (underpasses), medium number of passengers	75 – 100 - 150	0.40	80	—	—	—	—
vi)	61.2.3	Fully enclosed passenger subways (underpasses), large number of passengers	150 -200- 300	0.50	80	—	—	—	—
vii)	61.3.1	Stairs, ecalators, small number of passengers	30 – 50 - 75	0.30	80	—	—	—	—
viii)	61.3.2	Stairs, ecalators, medium number of passengers	75 – 100 - 150	0.40	80	—	—	—	—
ix)	61.3.3	Stairs, ecalators, large number of passengers	150 -200- 300	0.50	80	—	—	—	—
x)	61.4	Ticket hall and concourse	150 -200- 300	0.50	80	28	75		
xi)	61.5	Ticket counters and luggage offices	200 – 300 – 500	0.50	80	19	100	75	50
xii)	61.6	Waiting rooms	150 -200- 300	0.40	80	22	75		
xiii)	61.7	Entrance halls, station halls	150 -200- 300	0.40	80	—	75		
xiv)	61.8	Switch and plant rooms	150 -200- 300	0.50	80	28	50		

xv)	61.8.1	Railway control centre (area of dispatcher)	150 -200- 300	0.50	80	19	—	__	__
xvi)	61.9	Access tunnels	30 – 50 - 75	0.40	20	—	—	__	__
xvii)	61.10.1	Assembly work in maintenance sheds - rough	150 -200- 300	0.40	80	—	—	__	__
xviii)	61.10.2	Assembly work in maintenance sheds - medium	200 – 300 – 500	0.50	80	—	—	__	__
xix)	61.10.3	Assembly work in maintenance sheds - fine	300 – 500 -750	0.60	80	—	—	__	__
xx)	61.10.4	Assembly work in maintenance sheds - precision	500 – 750 - 1000	0.70	80	—	—	__	__
xxi)	61.10.5	Circulation areas for maintenance halls for railway vehicles (without additional vehicular traffic)	75 – 100 - 150	0.25	80	—	—	__	__
xxii)	61.10.6	Circulation areas for maintenance halls for railway vehicles (with additional vehicular traffic)	100 – 150 – 200	0.40	80	—	—	__	__

7 VERIFICATION PROCEDURES

7.1 General

Specified design criteria which are listed in this document shall be verified by the following procedures. In lighting design, calculations and measurements, certain assumptions including degree of accuracy have been made. These shall be declared. The installation and the environment shall be checked against the design assumptions.

7.2 Illuminances

When verifying conformity to the illuminance requirements the measurement points shall coincide with any design points or grids used. Verification shall be made to the criteria of the relevant surfaces.
For subsequent measurements, the same measurement points shall be used.

Verification of illuminances that relate to specific tasks shall be measured perpendicular to the plane of the task.

When verifying illuminances, account should be taken of the calibration of the light meters used, the conformity of the light source and luminaires to the published photometric data, and of the design assumptions made about surface reflectance, etc., compared with the real values.

The average illuminance and uniformity shall be calculated from the measured values and taking into account the maintenance factor shall be not less than the values specified.

7.3 Unified Glare Rating

Authenticated UGR data produced by the tabular method shall be provided for the luminaire scheme by the manufacturer of the luminaire. The spacing shall be declared for the UGR-tables provided.

7.4 Colour Rendering and Colour Appearance

Authenticated colour rendering index R_a and correlated colour temperatures CCT data shall be provided for the light source in the scheme by the manufacturer of the light source. The light sources shall be checked against the design specifications.

7.5 Luminaire Luminance

The average luminance of the luminous parts of the luminaire shall be measured and/or calculated in the C-plane (azimuth) at intervals of 15° starting at 0° and the γ-plane (elevation) for angles of 65°, 70°, 75°, 80° and 85°. Usually the manufacturer of the luminaire shall provide these data based on maximum (light source/luminaire) output (*see* also EN 13032-1, EN 13032-2 and EN 13032-4).

7.6 Maintenance Schedule

The maintenance schedule shall be provided according to **6.3**.

ANNEX A

(Informative)

Recommended Practice Regarding Implementation of UGR Tabular Method for 'Non-Standard' Situations

A.1 GENERAL

The boundary conditions for the determination of the UGR value include having a rectangular space, a regular luminaire grid and only one type of luminaire. The UGR methodology does not apply to totally indirect luminaires. The UGR tabular method is only applicable for luminaires with at least 2-axis symmetrical light distribution in horizontal position of the light emission surface. This limits the application of the methodology to some extent, but does not exclude its use. However, as the limiting values (in the tables in **7.3**) have been determined based on the UGR tabular method, the limiting values cannot be applied to other uses of the UGR formula (such as individual point calculations) without further scientific validation. To maximize the applicability of the tabular method, **A.2** covers recommended practices when specific boundary conditions are not met.

NOTES—

1. The UGR methodology is intended to support the selection of luminaires which are appropriate for the given application. It is not intended as an exact prediction of glare in the given space.
2. The highest UGR value will generally occur in the largest room with the lowest reflectances. When using the recommended practices below it is advisable to keep this in mind when determining the worst-case scenarios.

A.2 RECOMMENDED PRACTICES

A.2.1 Deviating Luminaire Sizes

The UGR methodology can be applied to luminaires visible in boundaries 0.000 3 sr to 0.1 sr as given in CIE 117 (for usual room heights (except high halls) this corresponds to luminaires from 0.005 m^2 to 1.5 m^2). For luminaires outside this range some advice is given in CIE 147.

A.2.2 Irregular Area Shapes

The UGR methodology is based upon rectangular rooms. For a non-rectangular room, the room dimensions can be approximated by fitting it with a rectangle. The used dimensions of the approximated rectangle should be documented in the lighting design.

A.2.3 Irregular Luminaire Placement Patterns

As the UGR-tabular method uses a 'virtual' luminaire placement to determine the UGR value, the exact luminaire placement pattern can be disregarded. However, in extreme cases such as clusters of luminaires tightly grouped together, the UGR-tabular method should not be used.

A.2.4 Deviating Room Reflectances

If the exact reflectances are not given in the standard UGR table, the set of reflectances closest to these reflectances should be used as a best approximation. Keep in mind that the lower the reflectances, the higher the UGR value. As such, for the worst-case scenario it is preferable to select a set of values lower than the requested values. Alternatively, a set of transfer values can be calculated allowing the calculation of standard UGR values for the required reflectances.

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A.2.5 Multiple Luminaire Types

When multiple luminaire types are used, the UGR should be determined for each individual luminaire type. For the worst-case scenario, the luminaire type with the highest UGR value should be referenced against the set limiting value.

A.2.6 Luminaires with (Only) Up-Lighting or Luminous Ceilings

The UGR methodology does not apply to up-lighters (i.e. luminaires with only up-light or luminaires in which the downward component only has an aesthetic function and does not contribute to achieving the lighting requirements specified within this document). Additionally, the UGR methodology does not apply to luminous ceilings (*see* size limits in **A.2.1**).

A.2.7 Room Dimensions Smaller or Larger Than the Tabular Values

Assuming ‘H’ as the distance between the observer and luminaire plane, for room dimensions larger than 12H (the maximum dimension ratio in the tabular method), 12H can be taken as a representative value. In this case, the used dimension should be reported. For room dimensions smaller than 2H, discomfort glare is unlikely to occur.

For room dimensions > 12H or in production facilities with large height differences between the height of the user's eye and the mounting height (e.g. > 7 m), it should be checked whether the UGR method should be used or whether in these cases disability glare could be more important than discomfort glare.

ANNEX B

(Informative)

Additional Information On Visual and Non-Visual (Non-Image Forming) Effects of Light

B.1 GENERAL

There is strong scientific evidence that light is not only essential for vision but also elicits important biological, non-image-forming effects, and emotional effects that are highly relevant for human performance, well-being and health. Current lighting practice and the demand for energy saving tends to reduce indoor illumination levels. This can create lighting conditions that are not supportive for human well-being and visual performance.

The emotional and non-visual (non-image forming) effects of light have a direct impact on people's performance and well-being in their social and work life. This has implications for architecture, interior design, and lighting. The consideration of these effects in lighting designs and applications requires additional design practices and methods to those currently in use. This document suggests using the recommended value (*see* Clauses **5** and **6**) as a first step in this direction.

B.2 PERCEIVED ROOM BRIGHTNESS

The perceived brightness of a space is important for the occupant's well-being and alertness. In the visual field, the perceived brightness (luminance pattern) is a result of the interaction between illumination and the reflectance properties of objects and room surfaces. However, illuminances are more practical to evaluate than luminance, since often no detailed information is available on interior decor or occupant seating and primary viewing directions in the design practice. By using the values for $\bar{E}_{m,wall}$ and $\bar{E}_{m,ceiling}$ as well as $\bar{E}_z$ as specified in the tables in **7.3** proper perceived room brightness and illumination of people and objects can be ensured. The values are application specific and as such need to be adapted to the activity and/or task characteristics. These include visual communication (e.g. in classrooms, meeting rooms and offices) and visual comfort for areas where the specified task or activity is performed for extended periods of time.

B.3 ALTERNATIVE PARAMETERS

B.3.1 General

As stated in **B.2**, the wall, ceiling and cylindrical illuminances are employed by this document as indicators of room brightness and the recognition of objects and people. Due to their practical and intuitive nature, alternative methods have been proposed and three of these are briefly described below.

B.3.2 Mean Ambient Illuminance, $\bar{E}_{amb}$

This method calculates an approximation of the apparent brightness within a space by evaluating the total amount of light reaching the walls and ceiling of the space. The average illuminances on these surfaces are calculated and these values are then averaged to calculate the mean ambient illuminance for the room.

$\bar{E}amb = (\bar{E}v\ wall1 + \bar{E}v\ wall2 + \bar{E}v\ wall3 + \bar{E}v\ wall4 + \bar{E}ceiling) / 5$ (**B.1**)

For work spaces where ambient light is considered (for example offices, class rooms, hospital wards), the mean ambient illuminance is recommended to be within a band of 200 lx < $\bar{E}amb$ < 500 lx and the ratio between the mean ambient illuminance and the maintained illuminance on the task area or activity area, $\bar{E}amb / \bar{E}m$, should not be lower than 1:2 (i.e. ≥ 50 %).

Formula (**B.1**) is applicable for mid and large size rooms. For small rooms (such as cellular offices) the wall illuminance within the normal visual field can be used as the value for $\bar{E}amb$.

B.3.3 Mean Room Surface Luminous Exitance, Mrs (Cuttle)[2]

This approach considers that the visual appearance of a space is based upon the brightness of the room surfaces. That is the luminous flux leaving a surface as opposed to the luminous flux falling onto the surface. It proposes the use of mean room surface luminous exitance, which serves as a measure of average illuminance for all points within the space due to reflected light from the room surfaces, (direct light from either luminaires or windows is excluded) and is expressed in lm m-2. It is calculated as the first reflected flux (Φ fr, abbreviation FRF) for the room divided by the absorption-weighted room area

Aα. The luminous flux Φ fr is the sum of the direct flux reflected from each surface in the room.
fr
*M*rs
Aα
Φ
= fr s(d) *s*
s
$\Phi = \Sigma\Phi \cdot \rho\ s\ (1\ s)$
s
$A\alpha = \Sigma A \cdot - \rho$
where
s(d) Φ is the direct flux onto surface *s*, *ρ*s is the reflectance of surface *s* and *A*s is the area of surface *s*.
*M*rs values may be used to specify perceived adequacy of illumination (PAI) for specific applications in lighting standards, or by lighting designers to specify perceived brightness of illumination (PBI) on a scale of very dim to very bright.

Tentative values of mean room surface luminous exitance give 10 lm m^{-2} as the lowest level for reasonable colour discrimination, 30 lm m^{-2} as having a dim appearance, 100 lm m^{-2} as the lowest level for an acceptably bright appearance, 300 lm m^{-2} for a bright appearance and 1000 lm m^{-2} for a distinctly bright appearance.

B.3.4 Visual Lightness and Interest - 40 Degree Band Luminance

This considers that the key factors in the perception of a space are the two subjective parameters of 'visual lightness' and 'visual interest' related to the brightness of a horizontal band, 40° high and

centred at normal eye height. In relatively small rooms this 40° band relates closely to the area of the walls, but in larger rooms it includes the ceiling and the floor.

On the basis of the results of experiments it was proposed that for a commercial interior (e.g. salesrooms, restaurants) to have a measure of visual lightness the average luminance of the horizontal 40° band should not be less than 30 cd m^{-2}. For a possible maximum value, it was noted that beyond 100 cd m-2 there was little change in subjective assessment.

Regarding visual interest, it was suggested that the ratio of maximum to minimum luminance within the 40° band should be between 10 % and 50 % which can be achieved either by a variation in illuminance or reflectance or both. These values are only relevant for commercial interior spaces, not for work spaces.

B.4 Adaptation Luminance Within the Normal Visual Field

The adaptation luminance describes the luminance to which the eye is adapted. The viewing direction and spatial luminance distribution have an impact on adaptation luminance within the visual field.

Within the visual field space dimensions and the position of the observer determine which parts of the space are the dominant aspects, e.g. walls, ceilings, furniture and partition walls.

Which main surfaces determine the adaptation luminance to which extent, is highly dependent on the space dimensions. In smaller spaces, the walls will be major determining factor, whereas in larger spaces the ceiling, floor and furniture will start to play a more prominent role.

B.5 The Influence of Spectral Power Distribution on Non-Image Forming Effects

The spectral power distribution of a light source plays a large role in the stimulation of the different receptors in the eye. The receptors for vision, the rods and cones, are relatively well understood and
their spectral sensitivities characterized by documents such as CIE S 026 and CEN/TR 16791. Although scientific evidence shows that melanopsin containing retinal ganglion cells (intrinsically photosensitive Retinal Ganglion Cells, ipRGCs,), which are most sensitive to short wavelength parts of the spectral power distribution (between 460 nm and 500 nm), play an important role in the non-image-forming effects of light, this evidence was not yet included in existing lighting standards and recommendations.

Therefore, a description of optical radiation solely according to the photopic spectral luminous efficiency $V(\lambda)$ is not sufficient. The actual biological effect of ocular exposure to light will depend on the relative response of all photoreceptors and there is good evidence for synergistic responses between the receptors. For a deeper understanding of how a stimulation of the photoreceptors leads to a desirable or undesirable biological effect, light must be characterized in a way to quantify the input to each of the five known photoreceptors. CIE S 026 and CEN/TR 16791, have defined a method to characterize illuminants according to their potential in eliciting biological stimulation and sensation.

It is also important to recognize the importance of darkness, and the daily pattern of light and dark, particularly around and during periods of sleep. Additionally, certain changes to the balance of the spectrum of light at different times of day can be helpful in stabilizing circadian rhythms, but further practice-oriented evidence is needed to support this as a general principle. Analysing the involvement of different photoreceptors would be crucial to understand how such outcomes can have an impact on human well-being.

For improvement of health and well-being in office spaces it is recommended to provide a maintained average Melanopic Equivalent Daylight (D65) illuminance (MEDI) of at least 250lux as measured on the vertical plane facing forward at surfaces 1.2 m [4 ft] above finished floor. Tunable lighting system is recommended for offices where personalized lighting is required.

NOTES—

1. The spectral power distribution has an impact on human circadian rhythm. This impact can be described approximately by means of the Correlated Colour Temperature (*CCT*) or, more accurately, by means of evaluation of the spectral power distribution of the light source.
2. The perception of light colour in a space is related to the illuminance of the electrical lighting system, the colour of the décor of the room, and the amount of daylight penetration. High *CCT* is more likely to have impact on non-image forming effects.
3. The variability of the light colour over the day is one factor that can also influence the circadian rhythm. Individual preferences arising from, e.g. gender and culture can be considered.

B.6 Varying Lighting Conditions

Varying lighting conditions in time by changing illuminances, different luminance distributions and wider range of colour temperature with daylight and/or electric lighting solutions can enhance people's well-being. Variation in illuminance can also make a space appear less monotonous. However, the perceived difference between bright and dark zones should be moderate to fit the adaptation luminance of the eye.

The acceptance of lighting systems can be increased by the possibility of personal influence on light settings, e.g. with the use of adjustable task lighting (direction of light, illuminance and possibly colour temperature).

Electric light can be used to support space functions. Pre-programmed light scenarios can improve occupants' well-being through variation and personal interaction, while enabling energy savings, *see* also **6.6**.

B.7 Daylight Provision

Daylight is the essential illumination source for human well-being. Daylighting is dynamic and it varies in magnitude, direction and spectral distribution with time and season. It provides variable modelling and luminance patterns, which is perceived as being beneficial for people in indoor environments.

Daylight needs to be assessed in terms of daylight quantity and distribution, exposure to sunlight and protection from glare. Daylight openings should also be assessed in terms of view out.

EN 17037 specifies an evaluation method for daylight provision in a space to ensure sufficient levels of daylight throughout the year. To demonstrate compliance with EN 17037, it is necessary to show that a target illuminance level is achieved across 50 % of a reference plane for at least half of the yearly daylight hours. In addition, for spaces with vertical or inclined daylight openings, a minimum target illuminance level is also to be achieved across 95 % of the reference plane. The standard proposes two methods to assess daylight provision in the interior:

a) Method 1: A calculation method based on daylight factor and yearly daylight availability of diffuse skylight;
b) Method 2: A calculation method based on the direct prediction of illuminance levels using hourly climate data of diffuse skylight and direct sunlight. Recommended values of illuminance level and daylight factor are provided for all capital cities of CEN national members. Relevant differences between EN 17037 and EN 12464-1 are:
   illuminance levels stated in EN 17037 are not identical to the values of the maintained illuminance levels referred to in this document;
c) the reference plane described in EN 17037 is different from the reference area referred to in this document;
d) specification of calculation grids.

The interplay between daylight and electric lighting is of utmost importance. Possibilities to adjust the electric lighting to the daylight conditions over time can be used. The available daylight decreases rapidly with the distance from vertical or inclined openings and this introduces strong illuminance gradients, especially close to openings. It is recommended to ensure uniformity levels on the task or activity area and immediate surrounding similar to those in **5.3.6**.

Increasing ambient illuminance and task area illuminance provided by electric lighting with an appropriate spectral power distribution can partly reduce negative impacts of insufficient levels of daylight.

ANNEX C

NORMATIVE REFERENCES

Indian Standard / Other Standard	*Title*
90/270/EEC	Minimum safety and health requirements for work with display screen equipment
89/654/EE	Concerning the minimum safety and health requirements for the workplace
CIE 227:2017	Lighting for older people and people with visual impairment in buildings
CIE x005-1992	Proceedings of the CIE Seminar '92 on computer programs for light and lighting
EN 17037: 2018	Daylight in buildings
CIE 117-1995	Discomfort glare in interior lighting
CIE 190-2010	Calculation and presentation of unified glare rating tables for indoor lighting lumimnaires
CIE 232:2019	Discomfort caused by glare from luminaires with a non-uniform source luminance
CIE TN 006:2016	Visual aspects of time-modulated lighting systems – definitions and measurement models
IEC TR 61547-1:2020	Equipment for general lighting purposes - emc immunity requirements - part 1: objective light flickermeter and voltage fluctuation immunity test method
IEC TR 63158:2018	Equipment for general lighting purposes - objective test method for stroboscopic effects of lighting equipment
EN ISO 9241- 307: 2008	Ergonomics of human- system interaction part 37: analysis and compliance test methods for electronic visual displays
ISO / CIE TS 22012 :2019	Light and lighting – maintenance factor determination – way of working
CIE 97: 2005	Guide on the maintenance of indoor electric lighting systems, 2nd ed.

EN 17037 : 2018	Day lighting in building
CIE S 026/E:2018	System for Metrology of Optical Radiation for ipRGC-Influenced Responses to Light.
CEN/TR 16791:2017	Quantifying irradiance foe eye- mediated non- image-forming effects of light in humans
EN 13032-1 :2004 + A1:2012	Light and lighting – Measurement and presentation of photometric data f lamps and luminaires – Part 1: Measurement and file format
EN 13032-2 :2017	Light and lighting – Measurement and presentation of photometric data f lamps and luminaires – Part 1: Measurement and file format – Part 2: Presentation of data for indoor and outdoor work places
EN 13032-4 :2015+ A1 : 2019	Light and lighting – Measurement and presentation of photometric data f lamps and luminaires – Part 1: Measurement and file format – Part 4: LED lamps, modules and luminaires
NEN-EN 12464-1:2021	Light and lighting - Lighting of work places - Part 1: Indoor work places
CEN/TR 16791:2017	Quantifying irradiance for eye-mediated non-image-forming effects of light in humans