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DRAFT revised EN 12464-1

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

UDC

Descriptors:

English version

Light and Lighting
Lighting of indoor work places

Lumière et Éclairage
Éclairage des lieux de travail intérieurs

Licht und Beleuchtung
Beleuchtung von Arbeitsstätten in Innenräumen

This draft European Standard is submitted to CEN members for Formal Vote.

It has been drawn up by CEN/TC 169/WG 2.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardisation
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Contents

Foreword

This European Standard has been prepared by Working Group 2 of CEN/TC 169 "Light and Lighting".

This document is currently submitted to the Formal Vote.

This document has to be implemented at national level, either by publication of an identical text or by endorsement, by (**month year)**, and conflicting national standards have to be withdrawn by (**month year)**.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this document: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

To enable people to perform visual tasks efficiently and accurately, adequate and appropriate lighting has to be provided. The illumination may be provided by daylight, artificial lighting or a combination of both.

The degree of visibility and comfort required in a wide range of work places is governed by the type and duration of activity.

This standard specifies requirements for lighting systems for most indoor work places and their associated areas in terms of quantity and quality of illumination. In addition recommendations are given for good lighting practice.

It is important that all clauses of the standard are followed although the specific requirements are tabulated in the schedule of lighting requirements (see clause 5).

1 Scope

This European standard specifies lighting requirements for indoor work places, which meet the needs for visual comfort and performance. All usual visual tasks are considered, including Display Screen Equipment (DSE).

This European standard does not specify lighting requirements with respect to the safety and health of workers at work and has not been prepared in the field of application of Article 137 of the EC treaty, although the lighting requirements, as specified in this standard, usually fulfil safety needs. Lighting requirements with respect to the safety and health of workers at work may be contained in Directives based on Article 137 of the EC treaty, in national legislation of member states implementing these directives or in other national legislation of member states.

This standard neither provides specific solutions, nor restricts the designers freedom from exploring new techniques nor restricts the use of innovative equipment.

This standard is not applicable for the lighting of outdoor work places and underground mining or emergency lighting.

For outdoor work places see EN 12464-2 and for emergency lighting see EN 1838 and EN 13032-3.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 12193	Light and Lighting - Sports lighting
EN 12665	Light and Lighting - Part 1: Basic terms and criteria for specifying lighting requirements
EN 13032-1	Light and Lighting - Measurement and presentation of photometric data of lamps and luminaires - Part 1: Measurement

EN 13032-2 Light and Lighting - Measurement and presentation of photometric data of lamps and luminaires - Part 2: Presentation of data for indoor and outdoor work places

EN 13032-3 Light and Lighting - Measurement and presentation of photometric data of lamps and luminaires - Part 3: Presentation of data for emergency lighting of work places

EN 15193 Energy performance of buildings – neregy requirements for lighting

EN 1838 Lighting applications – Emergency lighting…….. ….

IEC Publication 50 (845) International Electro-technical Vocabulary - Chapter 845 "Lighting"

ISO 3864-1 Safety colours and safety signs

CIE Publication 117/1995 Discomfort glare in interior lighting

Check which standards are mentioned in text

3 Definitions

For the purposes of this Standard the following definitions apply:

NOTE: This clause defines terms and quantities that are in use and important to this standard, and which may not be given in EN 12665 and in IEC 50 (845).

3.1 Visual task: The visual elements of the work being done.

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

3.2 Task area: The area in the work place in which the visual task is carried out.

3.3 Immediate surrounding area: A band with a width of at least 0,5 m surrounding the task area within the field of vision

3.4 Maintained illuminance($\bar{E}_m$): Value below which the average illuminance on the specified surface is not allowed to fall.

NOTE: It is the average illuminance at the time maintenance should be carried out.

3.5 Shielding angle: The 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.

3.6 Display screen equipment (DSE): An alphanumeric or graphic display screen, regardless of the display process employed [90/270/EEC].

3.7 Illuminance uniformity (U_0): Ratio of minimum illuminance to average illuminance on a surface (see also IEC 50 (845) / CIE 17.4: 845-09-58 Uniformity ratio of illuminance).

Check: Uniformity of illuminance (like in 4.3.6)???

3.8 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.

3.9 Work station: combination and spatial arrangement of work equipment, surrounded by the work environment under the conditions imposed by the work tasks

3.10 Cylindrical illuminance: the cylindrical illuminance Ez

Peter Thorns, Convenor WG 1, please fill in proper definition

Note: This can be approximated by the average vertical illuminance measured or calculated from the vertical illuminances E_{vi} in one point for the four orthogonal spatial directions

$E_z = ¼ (E_{v1} + E_{v2} + E_{v3} + E_{v4})$

4 Lighting design criteria

4.1 Luminous environment

For good lighting practice it is essential that in addition to the required illuminance, qualitative and quantitative needs are satisfied.

Lighting requirements are determined by the satisfaction of four basic human needs:

- visual comfort, where the workers have a feeling of well-being; in an indirect way also contributing to a high productivity level,
- visual performance, where the workers are able to perform their visual tasks, even under difficult circumstances and during longer periods,
- safety,
-

Main parameters determining the luminous environment are:

- luminance distribution,
- illuminance,
- glare,
- directionality of light,
- colour rendering and colour appearance of the light,
- flicker,
- daylight
- variability of light (levels and colour of light:

Values for illuminance, discomfort glare and colour rendering are given in clause 5.

Note: In addition to the lighting there are other visual ergonomic parameters which influence operators visual performance, such as:.

a) the intrinsic task properties (size, shape, position , calour and reflectance of detail and background)

b) ophthalmic capacity of the operator (visual acuity, depth perception, colour perception)

c) Lighting design, intentional improved and designed luminance environment, glare-free illumination, good colour rendering, contrast marking and optical and tactual guiding systems may improve visibility and sense of direction and locality. See CIE Guidelines for Accessibility: Visibility and Lighting Guidelines for Older Persons and Persons with Disabilities, Draft 4, 25-06-2007.

Attention to these factors can enhance visual performance without the need for higher illuminance.

4.2 Luminance distribution

The luminance distribution in the field of vision controls the adaptation level of the eyes which affects task visibility.

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 field of vision also affects visual comfort. The following should be avoided for the reasons given:

- too high luminances which may give rise to glare,

- too high luminance contrasts which will cause fatigue because of constant re-adaptation of the eyes,
- too low luminances and too low luminance contrasts which result in a dull and non-stimulating working environment.

The luminances of all surfaces are important to create a well balanced luminance distribution and will be determined by the reflectance and the illuminance ~~of~~ on the surfaces.

Recommended reflectances for the major interior surfaces are:

- ceiling: 0,7 to 0,9
- walls: 0,5 to 0,8
- 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.

These recommended reflectances should be used together with the illuminances on the room surfaces.

Maintained illuminances of the major surfaces shall have the following values:

- effective wall: 50 lx with $U_0 \geq 0.1$ and
- ceiling: 30 lx with $U_0 . \geq 0.1$.

The height of the effective wall is the mounting height.

Exeptions: for high bay lighting the maintained illuminance on the ceiling may have lower values.

Note: Some applications or activity areas such as offices, teaching areas and hospitals need brighter surfaces. Recommended maintained illuminances for walls: 100 lx and for ceilings: 50 lx.

4.3 Illuminance

The illuminance and its distribution on the task area and the surrounding area have a great impact on how quickly, safely and comfortably a person perceives and carries out the visual task.

All values of illuminances specified in this standard are maintained illuminances and will provide for visual comfort and performance needs.

4.3.1 Scale of illuminance

A factor of approximately 1,5 represents the smallest significant difference in subjective effect of illuminance. In normal lighting conditions approximately 20 lx is required to just discern features of the human face and is the lowest value taken for the scale of illuminances. The recommended scale of illuminance (in lx) is:

20 - 30 - 50 - 75 - 100 - 150 - 200 - 300 - 500 - 750 - 1000 - 1500 - 2000 - 3000 - 5000

4.3.2 Illuminances on the task area (check whole document)

The values given in clause 5 are maintained illuminances over the task area on the reference surface which may be horizontal, vertical or inclined. The average illuminance for each task shall not fall below the value given in clause 5, regardless of the age and condition of the installation. The values are valid for normal visual conditions and take into account the following factors:

- psycho-physiological aspects such as visual comfort and well-being,
- requirements for visual tasks,
- visual ergonomics,
- practical experience,
- safety,
- economy.

The value of illuminance may be adjusted by at least one step in the scale of illuminances (see below), if the visual conditions differ from the normal assumptions.

The required maintained illuminance should be increased, when:

- visual work is critical,
- errors are costly to rectify,
- accuracy, higher productivity or increased concentration is of great importance,
- task details are of unusually small size or low contrast,
- the task is undertaken for an unusually long time.
- the visual capacity of the worker is below normal (elderly and/or visually impaired people),

The required maintained illuminance may be decreased when:

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

The size and position of the task area should be stated and documented.

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

a) the whole area is treated as the task area or
b) the whole area is uniformly ($U_0 \geq 0,4$) lit to a illuminance level specified by the designer. If the task area becomes known, the illuminances are increased to the relevant values

If the type of the task is not known the designer has to make an assumption about and state task requirements

4.3.3 Illuminance on the immediate surrounding area

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

Large spatial variations in illuminances around the task area may lead to visual stress and discomfort.

The illuminance of the immediate surrounding areas may be lower than the illuminance on the task area but shall be not less than the values given in table 1.

In addition to the illuminance on the task the lighting shall provide adequate adaptation luminance in accordance with clause 4.2.

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

4.3.4 Illuminance on the background area

In work places, the areas beyond the immediate surrounding area of all active work stations shall be illuminated with a maintained illuminance horizontal on floor level as indicated in table 1 .

Table 1: Relationship of illuminances of immediate surrounding and background areas to task are

Illuminance on the task area (lx)	Illuminance on immediate surrounding areas (lx)	Illuminance on background area (lx)
≥ 750	500	100
500	300	100
300	200	100
200	E_{task}	100
150	E_{task}	100
≤ 100	E_{task}	E_{task}

4.3.5 Illuminance uniformity (U_o)

The illuminance uniformity in the task area shall be not less than the minimum uniformity values provided in the tables of clause 5.3.

The illuminance uniformity in the immediate surrounding and in the background area shall not be less than 0.4.

4.4 Illuminance grid

For the task area(s) a grid system shall be created to indicate the points at which the illuminance values are calculated and verified.

Grids approximating 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). The maximum grid size shall be:

$$p = 0{,}2 \times 5^{\log d} \qquad (1)$$

where:

$p \leq 10$

d is the longer dimension of the area (m) if the ratio of the longer to the shorter side is less than 2 otherwise “d” is the shorter dimension of the area, and

p is the maximum grid cell size (m).

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

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

Note: The formula (coming from CIE Report X005) has been derived under the assumption log p 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

A border of 0,5 m from the walls is excluded from the calculation area except for task areas which are defined and near the wall.

Note: The table below gives typical examples of grid point spacings relative to the length of the task area.

Length of the area in meters	Maximum distance between grid points in meters	Minimum odd number of grid points
0,40	0,15	3
0,60	0,20	3
1.00	0,20	5
2.00	0,30	7
5.00	0,60	9
10.00	1.00	11
25.00	2.00	13
50.00	3.00	17
100.00	5.00	21

For the immediate surround area the same grid spacing as for the task area should be applied.

For the background the whole room with a border of 0,5 m from the walls the grid spacing should be in accordance to the room size.

4.5 Glare

Glare is the sensation produced by bright areas within the field of vision and may be experienced either as discomfort glare or disability glare. Glare caused by reflections in specular surfaces is usually known as veiling reflections or reflected glare.

It is important to limit the glare to avoid errors, fatigue and accidents.

In interior work places, discomfort glare may arise directly from bright luminaires or windows. If discomfort glare limits are met, disability glare is not usually a major problem.

NOTE: Special care is needed to avoid glare when the direction of view is above horizontal.

4.5.1 Discomfort glare

The rating of discomfort glare directly from the luminaires of an indoor lighting installation shall be determined using the CIE Unified Glare Rating (UGR-) tabular method, based on the formula:

$$UGR = 8\log_{10}\left(\frac{0{,}25}{L_b}\sum\frac{L^2\omega}{p^2}\right)$$

where:

- L_b is the background luminance in cd × m^{-2}, calculated as $E_{ind} \times \pi^{-1}$, in which E_{ind} is the vertical indirect illuminance at the observer's eye,
- L is the luminance of the luminous parts of each luminaire in the direction of the observer's eye in cd × m^{-2},
- ω is the solid angle (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.

All assumptions made in the determination of UGR shall be stated in the scheme documentation. The UGR value of the lighting installation shall not exceed the value given in clause 5.

NOTE 1: The variations of UGR within the room may be determined using the formula (or the comprehensive table) for different observer positions. Limits for this condition are under consideration.

NOTE 2: If the maximum UGR value in the room is higher than the UGR limit given in clause 5, information on appropriate positions for work stations within the room may be needed.

NOTE 3: Discomfort glare from windows is still a topic of research. There is currently no suitable glare rating method available.

4.5.2 Shielding against glare

Bright light sources can cause glare and can impair the vision of objects. It shall be avoided for example by suitable shielding of lamps or shading of windows by blinds.

The minimum shielding angles in the field of vision given in table 2 shall be applied for the specified lamp luminances.

NOTE: The values given in table 2 do not apply to uplighters or to luminaires mounted below normal eye level.

Table 2: Minimum shielding angles at specified lamp luminances

Lamp luminance kcd × m^{-2}	**Minimum shielding angle α**
20 to < 50	15°
50 to < 500	20°
≥ 500	30°

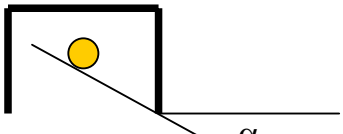

Figure 1: Shielding angle α

4.5.3 Veiling reflections and reflected glare

High brightness reflections in the visual task may alter task visibility, usually detrimentally. Veiling reflections and reflected glare may be prevented or reduced by the following measures:

- arrangement of luminaires and work places,
- surface finish (matt surfaces),
- luminance restriction of luminaires,
- increased luminous area of the luminaire,
- bright ceiling and bright walls.

4.6 Lighting in the interior space

In addition to task lighting it is important to light the volume of space occupied by people. This light is required to highlight objects, reveal texture and improve the appearance of people within the space. The terms “mean cylindrical illuminance”, "modelling index" and “directional lighting” describe the lighting conditions.

4.6.1 Mean cylindrical illuminance requirement in the activity space

Good visual communication and recognition requires sufficient brightness of all solid objects and specially people´s faces. Therefore the volume of space in which people move or work shall be illuminated. This is satisfied by providing adequate mean cylindrical illuminance in the space.

The maintained mean cylindrical illuminance (average vertical plane illuminance) in the activity and interior areas shall be not less than 50 lx on a horizontal plane 1.2 m above the floor.

Note 1: In all areas, where good visual communication is important, especially in offices, meeting and teaching areas, the maintained cylindrical illuminance E_z at 1.2 m above floor level should be not less than 150 lx.

4.6.2. Modelling index

Modelling is the balance between diffuse and directed light. It is a valid criterion of lighting quality in virtually all types of interiors. 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. This occurs when the light comes predominantly from one direction; the shadows so essential to good modelling are then formed without confusion.

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.

Note 1: The ratio between cylindrical and horizontal illuminance at a point is called modelling index. A modelling index of at least 0,3 is an indicator of good modelling.

4.6.3 Directional lighting of visual tasks

Lighting from a specific direction may reveal details within a visual task, increasing their visibility and making the task easier to perform. Veiling reflections and reflected glare should be avoided, see 4.4.3.

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

4.7 Colour aspects

The colour qualities of a near-white lamp are characterised by two attributes:

- the colour appearance of the lamp itself,
- its colour rendering capabilities, which affect the colour appearance of objects and persons illuminated by the lamp.

These two attributes shall be considered separately.

4.7.1 Colour appearance

The "colour appearance" of a lamp refers to the apparent colour (chromaticity) of the light emitted. It is quantified by its correlated colour temperature (T_{CP}).

Colour appearance may also be described as in Table 3.

Table 3: Lamp colour appearance groups

Colour appearance	Correlated colour temperature T_{CP}
Warm	below 3300 K
Intermediate	3300 to 5300 K
Cool	above 5300 K

The choice of colour appearance is a matter of psychology, aesthetics and of what is considered to be natural. The choice will depend on illuminance level, colours of the room and furniture, surrounding climate and the application. In warm climates generally a cooler light colour appearance is preferred, whereas in cold climates a warmer light colour appearance is preferred.

4.7.2 Colour rendering

It is important for visual performance and the feeling of comfort and well being, that colours in the environment, of objects and of human skin are rendered naturally, correctly and in a way that makes people look attractive and healthy.

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

To provide an objective indication of the colour rendering properties of a light source the general colour rendering index R_a has been introduced. The maximum value of R_a is 100. This figure decreases with decreasing colour rendering quality.

Lamps with a colour rendering index lower than 80 should not be used in interiors where people work or stay for longer periods. Exceptions may apply for some places and/or activities (e.g. high-bay lighting), but suitable measures shall be taken to ensure lighting with higher colour rendering at fixed continually occupied work places and where safety colours have to be recognised. Higher colour rendering indexes are used when critical colour rendition is required.

The minimum value of colour rendering index for distinct types of interiors (areas), tasks or activities are given in clause 5.

4.8 Flicker and stroboscopic effects

Flicker causes distraction and may give rise to physiological effects such as headaches.

Stroboscopic effects can lead to dangerous situations by changing the perceived motion of rotating or reciprocating machinery.

Lighting systems should be designed to avoid flicker and stroboscopic effects.

NOTE: This can usually be achieved for example by use of DC electrical supply for incandescent lamps, or by operating incandescent or discharge lamps at high frequencies (around 30 kHz).

4.9 Maintenance factor

The lighting scheme should be designed with an overall maintenance factor calculated for the selected lighting equipment, space environment and specified maintenance schedule.

The recommended illuminance for each task is given as maintained illuminance. The maintenance factor depends on the maintenance characteristics of the lamp and control gear, the luminaire, the environment and the maintenance programme.

The lighting scheme should be designed with the overall maintenance factor MF for the selected lamp(s), luminaire(s), surfaces reflectance, environment and specified maintenance schedule with the equation:

MF = LLMF x LSF x LMF x RSMF

Where MF is the overall Maintenance Factor
LLMF is the Lamp Lumen Maintenance Factor
LMF is the Luminaire Maintenance Factor
LSF is the Lamp Survival Factor
RSMF is the Room Surfaces Maintenance Factor

The designer shall:

- state the maintenance factor and list all assumptions made in the derivation of the value,
- specify lighting equipment suitable for the application environment,
- prepare a comprehensive maintenance schedule to include frequency of lamp replacement, luminaire and room cleaning intervals and cleaning method.

The Maintenace Factor has a great impact on the energy efficiency consideration. The assumptions made in the derivation of the MF shall be optimized in a way that leads to a high value.
Remark: Check result of EuP IM for Tertiary Lighting.

4.10 Energy Efficiency Requirements

A lighting installation should meet the lighting requirements of a particular space in an energy efficient manner.

An estimation of the energy requirements of a lighting installation needs to be made according to EN 15193 ‘Energy performance of buildings - Energy requirements for lighting’. It gives a methodology for a numeric indicator of energy performance of buildings. This indicator can be used for single rooms on a comparative basis only, as the benchmark values given in the EN 15193 are drawn up for a complete building.
It is important not to compromise the visual aspects of a lighting installation simply to reduce energy consumption. Light levels as set in this EN 12464-1 are minimum average illuminance values, and need to be obtained. Therefore, to achieve the required energy performance, the consideration of appropriate lighting systems, equipment, controls and the use of available daylight is essential.

4.11 Daylight

Daylight may provide all or part of the lighting for visual tasks. It varies in level and spectral composition with time and therefore provides variability within an interior. Daylight may create a specific modelling and luminance distribution due to its nearly horizontal flow of light from side windows.

Windows may provide visual contact with the outside world, which is preferred by most people.

In interiors with side windows the available daylight decreases rapidly with the distance from the window. Supplementary lighting is needed to ensure the required illuminance at the work place and to balance the luminance distribution within

the room. Automatic or manual switching and/or dimming may be used to ensure appropriate integration between electric lighting and daylight.

To reduce glare from windows, screening should be provided where appropriate.

The impact of daylight under energy efficiency considerations can be calculated according to EN 15193. See also item 4.10.

4.12 Lighting of workstations with Display Screen Equipment (DSE)

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

For these areas the lighting criteria and system shall be chosen in accordance with activity area, task type and type of interior from the schedule in clause 5; some countries have additional requirements.

The DSE and, in some circumstances, the keyboard may suffer from reflections causing disability and discomfort glare. It is therefore necessary to select, locate and arrange the luminaires to avoid high brightness reflections.

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

4.12.1 Luminaire luminance limits with downward flux

Lighting can lower the contrast of the presentation on DSE by

a) veiling reflection caused by the illuminance on the displays´s surface
b) luminances from luminaires and bright surfaces reflected in the display

Based on the intended context of use ISO 9241-307 gives requirements for the visual qualities of displays concerning unwanted reflections

This paragraph describes luminance limits for luminaires which may be reflected in DSE for normal viewing directions.

Table 4 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 places where display screens, which are vertical or inclined up to 15° tilt angle, are used.

Table 4: Average luminance limits of luminaires, which can be reflected in flat screens

Screen high state luminance	High ≥ 200 cd/m²	Medium < 200 cd/m²	
Case A	≤ 3000 cd × m^{-2}	≤ 1500 cd × m^{-2}	
Case B	≤ 1500 cd × m^{-2}	≤ 1000 cd × m^{-2}	

Note: For the old type CRT screens luminaire luminance limits are 200 cd/m² for negative and 500 cd/m² for positive polarity

Display usage:

Case A: positive polarity and normal requirements concerning colour and details of the shown information (like used in office, education etc)

Case B: negative polarity and/or higher requirements concerning color and details of the shown information (like used for CAD color inspection, etc)

Some tasks or activities require different lighting treatment (e.g. lower luminance limits, special shading, individual dimming etc.)
Do we need to say what some tasks are?

In areas of industrial activities and crafts displays are sometimes protected by additional front glasses. The unwanted reflections on these protection glasses have to be reduced by suitable methods (like anti reflex treatment, declined position of the protection glass or by shutters)

4.13 Variablity of light

Light is important to people's health and wellbeing. 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. Up to date research indicates that these phenomena, in addition to the lighting design criteria defined in EN 12464-1, can be provided by the so-called "non-image forming" illuminances and colour appearance of light. Varying lighting conditions in time by higher illuminance, luminance distribution and wider range of colour temperature than specified in this standard with daylight and/or dedicated electric lighting solutions can stimulate people and enhance their wellbeing. The recommended band of variations is under consideration.

5 Schedule of lighting requirements

The lighting requirements for various rooms and activities are given in the tables of 5.3.

5.1 Composition of the tables

Column 1 lists the **reference number** for each interior (area), task or activity.

Column 2 lists those **interior areas, task areas or activity areas**, for which specific requirements are given. If the particular interior area, task area or activity area is not listed, the values given for a similar, comparable situation should be adopted.

Column 3 gives the **maintained illuminance $\bar{E}_m$** on the reference surface (see 4.3) for the interior (area), task or activity given in column 2.

Note: The maintained illuminance in same circumstances may need to be increased (see clause 4.3.2)

NOTE: Lighting control may be required to achieve adequate flexibility for the variety of tasks performed.

Where **UGR limits (Unified Glare Rating limit, UGR_l)** are applicable to the situation listed in column 2, they are listed in **column 4** (see 4.4).

Column 5 gives the minimum **colour rendering indices (R_a)** (see 4.6.2) for the situation listed in column 2.

In **column 6, specific requirements and notes** are given for exceptions and special applications for the situations listed in column 2.

5.2 The schedule of interiors (areas), tasks and activities

Add/adjust: 1.5.2 Gangways, manned

Some remark should be added about vertical illumination if labels have to be read.

Table 5.1 Traffic zones and general areas inside buildings

1.1 Traffic zones
1.2 Rest, sanitation and first aid rooms
1.3 Control rooms
1.4 Store rooms/cold stores
1.5 Storage rack areas
1.5?? Gangways, manned

Table 5.2 Industrial activities and crafts

2.1 Agriculture
2.2 Bakeries
2.3 Cement, cement goods, concrete, bricks
2.4 Ceramics, tiles, glass, glassware
2.5 Chemical, plastics and rubber industry
2.6 Electrical industry
2.7 Food stuffs and luxury food industry
2.8 Foundries and metal casting
2.9 Hairdressers
2.10 Jewellery manufacturing
2.11 Laundries and dry cleaning
2.12 Leather and leather goods
2.13 Metal working and processing
2.14 Paper and paper goods
2.15 Power stations
2.16 Printers
2.17 Rolling mills, iron and steel works
2.18 Textile manufacture and processing
2.19 Vehicle construction
2.20 Wood working and processing

Table 5.3 Offices

Table 5.4 Retail premises

Table 5.5 Places of public assembly

5.1 General areas
5.2 Restaurants and hotels
5.3 Theatres, concert halls, cinemas
5.4 Trade fairs, exhibition halls
5.5 Museums
5.6 Libraries
5.7 Public car parks (indoor)

Table 5.6 Educational premises

6.1 Nursery school, play school
6.2 Educational buildings

5.6.1 / 6.2.21 Libraries, bookshelves Add note Illumination should be vertical along bookshelf.

Table 5.7 Health care premises

7.1 Rooms for general use
7.2 Staff rooms
7.3 Wards, maternity wards
7.4 Examination rooms (general)
7.5 Eye examination rooms
7.6 Ear examination rooms
7.7 Scanner rooms
7.8 Delivery rooms
7.9 Treatment rooms (general)
7.10 Operating areas
7.11 Intensive care units
7.12 Dentists
7.13 Laboratories and pharmacies
7.14 Decontamination rooms
7.15 Autopsy rooms and mortuaries

Table 5.8 Transportational areas

8.1 Airports
8.2 Railway installations

5.3 Lighting requirements for interior areas, task areas and activity areas

New numbering proposals requested for coming meeting

Table 5.1: Traffic zones and general areas inside buildings

1.1	Traffic zones					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Specific requirements (to be replaced for all tables)**
1.1.1	Circulation areas and corridors	100	28	0.4	40	1. Illuminance at floor level. 2. R_a and UGR similar to adjacent areas. 3. 150 lx if there are vehicles on the route. 4. 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. 5. Care should be taken to avoid glare to drivers and pedestrians.
1.1.2	Stairs, escalators, travolators	150	25	0.4	40	Note: Lichtrichtung???
1.1.3	Elevators, lifts	100?				Lifts in hospitals: 200 Lx? during daylight and 50 Lx? During night time.
1.1.3	Loading ramps/bays	150	25	0.4	40	
1.2	**Rest, sanitation and first aid rooms**					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
1.2.1	Canteens, pantries	200	22	0.4	80	
1.2.2	Rest rooms	100	22	0.4	80	
1.2.3	Rooms for physical exercise	300	22	0.4	80	
1.2.4	Cloakrooms, washrooms, bathrooms, toilets	200	25	0.4	80	
1.2.5	Sick bay	500	19	0.6	80	
1.2.6	Rooms for medical attention	500	16	0.6	90	$T_{CP} \geq 4000$ K
1.3	**Control rooms**					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
1.3.1	Plant rooms, switch gear rooms	200	25	0.4	60	
1.3.2	Telex, post room, switchboard	500	19	0.6	80	
1.4	**Store rooms, cold stores**					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
1.4.1	Store and stockrooms	100	25	0.4	60	200 lx if continuously occupied.
1.4.2	Dispatch packing handling areas	300	25	0.6	60	
1.5	**Storage rack areas**					

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
1.5.1	Gangways: unmanned	20	-	0.4	40	Illuminance at floor level.
1.5.2	Gangways: manned	150	22	0.4	60	Illuminance at floor level.
1.5.3	Control stations	150	22	0.6	60	(besser Ra 80 ?)

Table 5.2: Industrial activities and crafts

2.1	Agriculture					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.1.1	Loading and operating of goods, handling equipment and machinery	200	25	0.4	80	
2.1.2	Buildings for livestock	50	-	0.4	40	
2.1.3	Sick animal pens; calving stalls	200	25	0.6	80	
2.1.4	Feed preparation; dairy; utensil washing	200	25	0.6	80	

2.2	Bakeries					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.2.1	Preparation and baking	300	22	0.6	80	
2.2.2	Finishing, glazing, decorating	500	22	0.7	80	

2.3	Cement, cement goods, concrete, bricks					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.3.1	Drying	50	28	0.4	20	Safety colours shall be recognisable.
2.3.2	Preparation of materials; work on kilns and mixers	200	28	0.4	40	
2.3.3	General machine work	300	25	0.6	80	For high-bay: see clause 4.6.2.
2.3.4	Rough forms	300	25	0.6	80	For high-bay: see clause 4.6.2.

2.4	Ceramics, tiles, glass, glassware					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.4.1	Drying	50	28	0.4	20	Safety colours shall be recognisable.
2.4.2	Preparation, general machine work	300	25	0.6	80	For high-bay: see clause 4.6.2.
2.4.3	Enamelling, rolling, pressing, shaping simple parts, glazing, glass blowing	300	25	0.6	80	For high-bay: see clause 4.6.2.
2.4.4	Grinding, engraving, glass polishing, shaping precision parts, manufacture of glass instruments	750	19	0.7	80	For high-bay: see clause 4.6.2.
2.4.5	Grinding of optical glass, crystal, hand grinding and engraving	750	16	0.7	80	
2.4.6	Precision work e.g. decorative grinding, hand painting	1000	16	0.7	90	$T_{CP} \geq 4000$ K.
2.4.7	Manufacture of synthetic precious stones	1500	16	0.7	90	$T_{CP} \geq 4000$ K.

2.5	Chemical, plastics and rubber industry					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.5.1	Remote-operated processing installations	50	-	0.4	20	Safety colours shall be recognisable

Table 5.2: Industrial activities and crafts (continued)

2.5 Chemical, plastics and rubber industry (continued)

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
2.5.2	Processing installations with limited manual intervention	150	28	0.4	40	
2.5.3	Constantly manned work places in processing installations	300	25	0.6	80	
2.5.4	Precision measuring rooms, laboratories	500	19	0.6	80	
2.5.5	Pharmaceutical production	500	22	0.6	80	
2.5.6	Tyre production	500	22	0.6	80	
2.5.7	Colour inspection	1000	16	0.7	90	$T_{CP} \geq 4000$ K.
2.5.8	Cutting, finishing, inspection	750	19	0.7	80	

2.6 Electrical industry

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
2.6.1	Cable and wire manufacture	300	25	0.6	80	For high-bay: see clause 4.6.2.
2.6.2	Winding:					
	- large coils	300	25	0.6	80	For high-bay: see clause 4.6.2.
	- medium-sized coils	500	22	0.6	80	For high-bay: see clause 4.6.2.
	- small coils	750	19	0.7	80	For high-bay: see clause 4.6.2.
2.6.3	Coil impregnating	300	25	0.6	80	For high-bay: see clause 4.6.2.
2.6.4	Galvanising	300	25	0.6	80	For high-bay: see clause 4.6.2.
2.6.5	Assembly work:					
	- rough e.g. large transformers	300	25	0.6	80	For high-bay: see clause 4.6.2.
	- medium e.g. switchboards	500	22	0.6	80	For high-bay: see clause 4.6.2.
	- fine e.g. telephones	750	19	0.7	80	
	- precision e.g. measuring equipment	1000	16	0.7	80	
2.6.6	Electronic workshops, testing, adjusting	1500	16	0.7	80	

2.7 Food stuffs and luxury food industry

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
2.7.1	Work places and zones in - breweries, malting floor, - for washing, barrel filling, cleaning, sieving, peeling, - cooking in preserve and chocolate factories, - work places and zones in sugar factories, - for drying and fermenting raw tobacco, fermentation cellar	200	25	0.4	80	
2.7.2	Sorting and washing of products, milling, mixing, packing	300	25	0.6	80	
2.7.3	Work places and critical zones in slaughter houses, butchers, dairies mills, on filtering floor in sugar refineries	500	25	0.6	80	
2.7.4	Cutting and sorting of fruit and vegetables	300	25	0.6	80	

Table 5.2: Industrial activities and crafts (continued)

2.7	Food stuffs and luxury food industry (continued)					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.7.5	Manufacture of delicatessen foods, kitchen work, manufacture of cigars and cigarettes	500	22	0.6	80	
2.7.6	Inspection of glasses and bottles, product control, trimming, sorting, decoration	500	22	0.6	80	
2.7.7	Laboratories	500	19	0.6	80	
2.7.8	Colour inspection	1000	16	0.7	90	$T_{CP} \geq 4000$ K.

2.8	Foundries and metal casting					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.8.1	Man-size underfloor tunnels, cellars etc.	50	-	0.4	20	Safety colours shall be recognisable.
2.8.2	Platforms	100	25	0.4	40	
2.8.3	Sand preparation	200	25	0.4	80 60?	For high-bay: see clause 4.6.2.
2.8.4	Dressing room	200	25	0.4	80 60?	For high-bay: see clause 4.6.2.
2.8.5	Work places at cupola and mixer	200	25	0.4	80 60?	For high-bay: see clause 4.6.2.
2.8.6	Casting bay	200	25	0.4	80 60?	For high-bay: see clause 4.6.2.
2.8.7	Shake out areas	200	25	0.4	80 60?	For high-bay: see clause 4.6.2.
2.8.8	Machine moulding	200	25	0.4	80 60?	For high-bay: see clause 4.6.2.
2.8.9	Hand and core moulding	300	25	0.6	80	For high-bay: see clause 4.6.2.
2.8.10	Die casting	300	25	0.6	80	For high-bay: see clause 4.6.2.
2.8.11	Model building	500	22	0.6	80	For high-bay: see clause 4.6.2.

Ra 80 ? oder Ra 60? Siehe auch Tabelle 2.13

2.9	Hairdressers					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.9.1	Hairdressing	500	19	0.6	90	

2.10	Jewellery manufacturing					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.10.1	Working with precious stones	1500	16	0.7	90	$T_{CP} \geq 4000$ K.
2.10.2	Manufacture of jewellery	1000	16	0.7	90	
2.10.3	Watch making (manual)	1500	16	0.7	80	
2.10.4	Watch making (automatic)	500	19	0.6	80	

2.11 Laundries and dry cleaning

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
2.11.1	Goods in, marking and sorting	300	25	0.6	80	
2.11.2	Washing and dry cleaning	300	25	0.6	80	

Table 5.2: Industrial activities and crafts (continued)

2.11	Laundries and dry cleaning (continued)					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.11.3	Ironing, pressing	300	25	0.6	80	
2.11.4	Inspection and repairs	750	19	0.7	80	

2.12	Leather and leather goods					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.12.1	Work on vats, barrels, pits	200	25	0.4	40	
2.12.2	Fleshing, skiving, rubbing, tumbling of skins	300	25	0.4	80	
2.12.3	Saddlery work, shoe manufacture: stitching, sewing, polishing, shaping, cutting, punching	500	22	0.6	80	
2.12.4	Sorting	500	22	0.6	90	$T_{CP} \geq 4000$ K.
2.12.5	Leather dyeing (machine)	500	22	0.6	80	
2.12.6	Quality control	1000	19	0.7	80	
2.12.7	Colour inspection	1000	16	0.7	90	$T_{CP} \geq 4000$ K.
2.12.8	Shoe making	500	22	0.6	80	
2.12.9	Glove making	500	22	0.6	80	

2.13	Metal working and processing					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.13.1	Open die forging	200	25	0.6	60	
2.13.2	Drop forging	300	25	0.6	60	
2.13.3	Welding	300	25	0.6	60	
2.13.4	Rough and average machining: tolerances ≥ 0,1 mm	300	22	0.6	60	
2.13.5	Precision machining; grinding: tolerances < 0,1 mm	500	19	0.7	60	
2.13.6	Scribing; inspection	750	19	0.7	60	
2.13.7	Wire and pipe drawing shops; cold forming	300	25	0.6	60	
2.13.8	Plate machining: thickness ≥ 5 mm	200	25	0.6	60	
2.13.9	Sheet metalwork: thickness < 5 mm	300	22	0.6	60	
2.13.10	Tool making; cutting equipment manufacture	750	19	0.7	60	
2.13.11	Assembly:					
	- rough	200	25	0.6	80	For high-bay: see clause 4.6.2.
	- medium	300	25	0.6	80	For high-bay: see clause 4.6.2.
	- fine	500	22	0.6	80	For high-bay: see clause 4.6.2.
	- precision	750	19	0.7	80	For high-bay: see clause 4.6.2.
2.13.12	Galvanising	300	25	0.6	80	For high-bay: see clause 4.6.2.
2.13.13	Surface preparation and painting	750	25	0.7	80	
2.13.14	Tool, template and jig making, precision mechanics, micro-mechanics	1000	19	0.7	80	

Table 5.2: Industrial activities and crafts (continued)

2.14 Paper and paper goods

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
2.14.1	Edge runners, pulp mills	200	25	0.4	80	For high-bay: see clause 4.6.2.
2.14.2	Paper manufacture and processing, paper and corrugating machines, cardboard manufacture	300	25	0.6	80	For high-bay: see clause 4.6.2.
2.14.3	Standard bookbinding work, e.g. folding, sorting, gluing, cutting, embossing, sewing	500	22	0.6	80	

2.15 Power stations

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
2.15.1	Fuel supply plant	50	-	0.4	20	Safety colours shall be recognisable.
2.15.2	Boiler house	100	28	0.4	40	
2.15.3	Machine halls	200	25	0.4	80	For high-bay: see clause 4.6.2.
2.15.4	Side rooms, e.g. pump rooms, condenser rooms etc.; switchboards (inside buildings)	200	25	0.4	60	
2.15.5	Control rooms	500	16	0.7	80	1. Control panels are often vertical. 2. Dimming may be required. 3. For DSE-work see clause 4.11.
2.15.6	Outdoor switch gear	20	-	0.4	20	Safety colours shall be recognisable.

2.16 Printers

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
2.16.1	Cutting, gilding, embossing, block engraving, work on stones and platens, printing machines, matrix making	500	19	0.6	80	
2.16.2	Paper sorting and hand printing	500	19	0.6	80	
2.16.3	Type setting, retouching, lithography	1000	19	0.7	80	
2.16.4	Colour inspection in multicoloured printing	1500	16	0.7	90	$T_{CP} \geq 5000$ K.
2.16.5	Steel and copper engraving	2000	16	0.7	80	For directionality see clause 4.5.2.

2.17	Rolling mills, iron and steel works					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.17.1	Production plants without manual operation	50	-	0.4	20	Safety colours shall be recognisable.
2.17.2	Production plants with occasional manual operation	150	28	0.4	40	
2.17.3	Production plants with continuous manual operation	200	25	0.6	80	For high-bay: see clause 4.6.2.
2.17.4	Slab Store	50	-	0.4	20	Safety colours shall be recognisable.
2.17.5	Furnaces	200	25	0.4	20	Safety colours shall be recognisable.
2.17.6	Mill train; coiler; shear line	300	25	0.6	40	
2.17.7	Control platforms; control panels	300	22	0.6	80	
2.17.8	Test, measurement and inspection	500	22	0.6	80	
2.17.9	Underfloor man-sized tunnels; belt sections; cellars etc.	50	-	0.4	20	Safety colours shall be recognisable.

Table 5.2: Industrial activities and crafts (continued)

2.18	Textile manufacture and processing					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.18.1	Work places and zones in baths, bale opening	200	25	0.6	60	
2.18.2	Carding, washing, ironing, devilling machine work, drawing, combing, sizing, card cutting, pre-spinning, jute and hemp spinning	300	22	0.6	80	
2.18.3	Spinning, plying, reeling, winding	500	22	0.6	80	Prevent stroboscopic effects.
2.18.4	Warping, weaving, braiding, knitting	500	22	0.6	80	Prevent stroboscopic effects.
2.18.5	Sewing, fine knitting, taking up stitches	750	22	0.7	80	
2.18.6	Manual design, drawing patterns	750	22	0.7	90	$T_{CP} \geq 4000$ K.
2.18.7	Finishing, dyeing	500	22	0.6	80	
2.18.8	Drying room	100	28	0.4	60	
2.18.9	Automatic fabric printing	500	25	0.6	80	
2.18.10	Burling, picking, trimming	1000	19	0.7	80	
2.18.11	Colour inspection; fabric control	1000	16	0.7	90	$T_{CP} \geq 4000$ K.
2.18.12	Invisible mending	1500	19	0.7	90	$T_{CP} \geq 4000$ K.
2.18.13	Hat manufacturing	500	22	0.6	80	

2.19	Vehicle construction and repair					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.19.1	Body work and assembly	500	22	0.6	80	
2.19.2	Painting, spraying chamber, polishing chamber	750	22	0.7	80	
2.19.3	Painting: touch-up, inspection	1000	19	0.7	90	$T_{CP} \geq 4000$ K.
2.19.4	Upholstery manufacture (manned)	1000	19	0.7	80	
2.19.5	Final inspection	1000	19	0.7	80	

2.20	Wood working and processing					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.20.1	Automatic processing e.g. drying, plywood manufacturing	50	28	0.4	40	

Table 5.2: Industrial activities and crafts (continued)

2.20	Wood working and processing (continued)					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
2.20.2	Steam pits	150	28	0.4	40	
2.20.3	Saw frame	300	25	0.6	60	Prevent stroboscopic effects.
2.20.4	Work at joiner's bench, gluing, assembly	300	25	0.6	80	
2.20.5	Polishing, painting, fancy joinery	750	22	0.7	80	
2.20.6	Work on wood working machines e.g. turning, fluting, dressing, rebating, grooving, cutting, sawing, sinking	500	19	0.6	80	Prevent stroboscopic effects.
2.20.7	Selection of veneer woods	750	22	0.7	90	$T_{CP} \geq 4000$ K.
2.20.8	Marquetry, inlay work	750	22	0.7	90	$T_{CP} \geq 4000$ K.
2.20.9	Quality control, inspection	1000	19	0.7	90	$T_{CP} \geq 4000$ K.

Table 5.3: Offices

3	Offices					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
3.1	Filing, copying, circulation areas etc.	300	19	0,4	80	
3.2	Writing, typing, reading, data processing	500	19	0,6	80	DSE-work: see clause 4.11. General: Illuminances on the wall should be 0.5 of the task area illuminance (or give a min. value)
3.3	Technical drawing	750	16	0,7	80	
3.4	CAD work stations	500	19	0,6	80	DSE-work: see clause 4.11.
3.5	Conference and meeting rooms	500	19	0,6	80	Lighting should be controllable.
3.6	Reception desk	300	22	0,6	80	
3.7	Archives	200	25	0,4	80	

Table 5.4: Retail premises

4	Retail premises					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
4.1	Sales area	300	22	0,4	80	Both illuminance and UGR requirements are determined by the type of shop.
4.2	Till area	500	19	0,6	80	
4.3	Wrapper table	500	19	0,6	80	

Table 5.5: Places of public assembly

5.1	General areas					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
5.1.1	Entrance halls	100	22	0,4	80	UGR only if applicable.
5.1.2	Cloakrooms	200	25	0,4	80	
5.1.3	Lounges	200	22	0,4	80	
5.1.4	Ticket offices	300	22	0,6	80	

Table 5.5: Places of public assembly (continued)

5.2	Restaurants and hotels					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
5.2.1	Reception/cashier desk, porters desk	300	22	0,6	80	
5.2.2	Kitchen	500	22	0,6	80	There should be a transition zone between kitchen and restaurant.
5.2.3	Restaurant, dining room, function room	-	-	-	80	The lighting should be designed to create the appropriate atmosphere.
5.2.4	Self-service restaurant	200	22	0,4	80	
5.2.5	Buffet	300	22	0,6	80	
5.2.6	Conference rooms	500	19	0,6	80	Lighting should be controllable.
5.2.7	Corridors	100	25	0,4	80	During night-time lower levels are acceptable.

5.3	Theatres, concert halls, cinemas					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
5.3.1	Practice rooms, dressing rooms	300	22	0.6	80	Lighting of mirrors for make-up shall be glare-free.
5.3.2	Further proposals from Erlend!					
5.3.3						

5.3	Theatres, concert halls, cinemas, etc or: Performance premises: Theatres, concert halls, cinemas, etc					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
5.3.1	Practice rooms	300	22	0.6	80	
5.3.2	Dressing rooms	300	22	0.6	**90**	Lighting **at** mirrors for make-up shall be “glare-free.” Disability glare should be avoided at mirrors for make-up.
5.3.3	Seating areas – before and after performance	200	22	0.5	80	
5.3.4	Seating areas – during performance	0 – 50	n/a - 19	n/a 0.5	n/a 80	Illuminance vary according to type of performance; movie 0 lux to dinner show 50 lux
5.3.5	Seating areas – during conference or meetings					See 6.2.3 Auditorium, lecture hall
5.3.6	Seating areas – maintenance, cleaning	200	22	0.5	80	Illuminance at floor level
5.3.7	Circulation areas within theatres/auditorium; stairs, ramps and exit/entry areas – before and after performance	100	25	0.4	80	Illuminance at floor level
5.3.8	Circulation areas within theatres/auditorium; stairs, ramps and exit/entry areas – during performance	0 – 50	n/a - 19	n/a 0.5	n/a 80	1. Illuminance vary according to type of performance; movie 0 lux to dinner show 50 lux 2. If 0 lux illuminance required, steps, level changes and obstacles must still be visible
5.3.9	Circulation areas within					See 6.2.16, 6.2.17, 6.2.18

	theatres/auditorium; stairs, ramps and exit/entry areas – during conference or meetings					
5.3.10	Stage area					Additional performance lighting may be required, i.e lighting for and of speaker, Performance lighting, ramp light, spot light etc. is not included in this standard
5.3.11	Stage area - rigging	300	25	0.4	80	Illuminance at floor level
	For other areas se table 6.2 Educational building					

5.4 Trade fairs, exhibition halls

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
5.4.1	General lighting	300	22	0.4	80	

5.5 Museums

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
5.5.1	Exhibits, insensitive to light					Lighting is determined by the display requirements.
5.5.2	Light sensitive exhibits					1. Lighting is determined by the display requirements. 2. Protection against damaging radiation is paramount.

5.6 Libraries

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	U_o	R_a	Remarks
5.6.1	Bookshelves	200	19	0,4	80	
5.6.2	Reading area	500	19	0,6	80	
5.6.3	Counters	500	19	0,6	80	

5.7	Public car parks (indoor)					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
5.7.1	In/out ramps (during the day)	300	25	0.4	20	1. Illuminances at floor level. 2. Safety colours shall be recognisable.

5.7	Public car parks (indoor)					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
5.7.2	In/out ramps (at night)	75	25	0,4	20	1. Illuminances at floor level. 2. Safety colours shall be recognisable.
5.7.3	Traffic lanes	75	25	0,4	20	1. Illuminances at floor level. 2. Safety colours shall be recognisable.
5.7.4	Parking areas	75	-	0,4	20	1. Illuminances at floor level. 2. Safety colours shall be recognisable. 3. A high vertical illuminance increases recognition of peoples faces and therefore the feeling of safety.
5.7.5	Ticket office	300	19	0,6	80	1. Avoid reflections in the windows. 2. Prevent glare from outside.

Table 5.6: Educational premises

6.1	Nursery school, play school					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
6.1.1	Play room	300	19	0,4	80	
6.1.2	Nursery	300	19	0,4	80	
6.1.3	Handicraft room	300	19	0,6	80	

6.1	Educational buildings					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
6.2.1	Classrooms, tutorial rooms	300	19	0,6	80	Lighting should be controllable. General: Illuminances on the wall should be 0.5 of the task area illuminance (or give a min. value)
6.2.2	Classroom for evening classes and	500	19	0,6	80	Lighting should be controllable.

	adults education					General: Illuminances on the wall should be 0.5 of the task area illuminance (or give a min. value)
6.2.3	Auditorium, lecture halls	500	19	0,6	80	Lighting should be controllable to accommodate various A/V needs
6.2.4.	Black, green and white boards	500	19	0,7	80	Prevent specular reflections. Presenter/teacher shall be illuminated with suitable vertical illuminance
6.2.5	Demonstration table	500	19	0,7	80	In lecture halls 750 lx.
6.2.6	Art rooms	500	19	0,6	80	
6.2.7	Art rooms in art schools	750	19	0,7	90	$T_{CP} \geq 5000$ K.
6.2.8	Technical drawing rooms	750	16	0,7	80	
6.2.9	Practical rooms and laboratories	500	19	0,6	80	
6.2.10	Handicraft rooms	500	19	0,6	80	
6.2.11	Teaching workshop	500	19	0,6	80	
6.2.12	Music practice rooms	300	19	0,6	80	
6.2.13	Computer practice rooms (menu driven)	300	19	0,6	80	DSE-work: see clause 4.11.
6.2.14	Language laboratory	300	19	0,6	80	
6.2.15	Preparation rooms and workshops	500	22	0,6	80	
6.2.16	Entrance halls	200	22	0,4	80	
6.2.17	Circulation areas, corridors	100	25	0,4	80	
6.2.18	Stairs	150	25	0,4	80	Note: Lichtrichtung… s. auch 1.1
6.2.19	Student common rooms and assembly halls	200	22	0,4	80	
6.2.20	Teachers rooms	300	19	0,6	80	
6.2.21	Library: bookshelves	200	19	0,6	80	
6.2.22	Library: reading areas	500	19	0,6	80	
6.2.23	Stock rooms for teaching materials	100	25	0,4	80	
6.2.24	Sports halls, gymnasiums, swimming pools	300	22	0,6	80	See EN 12193.
6.2.25	School canteens	200	22	0,4	80	
6.2.26	Kitchen	500	22	0,6	80	

Table 5.6: Educational premises (continued)

Table 5.7: Health care premises

7.1	Rooms for general use					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
						All illuminances at floor level.
7.1.1	Waiting rooms	200	22	0,4	80	
7.1.2	Corridors: during the day	200	22	0,6	80	… Orientierungshinweise …
7.1.3	Corridors: during the night	50	22	0,4	80	
7.1.4	Day rooms	200	22	0.6	80	
7.1.5	Elevators, lifts	100?				Lifts in hospitals: 200 Lx? during daylight and 50 Lx? during night time.

7.1	Rooms for general use					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.1.1	Waiting rooms	200	22	0,4	80	
7.1.2	Corridors: during the day, cleaning	100	22	0,4	80	… Orientierungshinweise illuminance at floor level
7.1.3	Corridors: during the night	50	22	0,4	80	illuminance at floor level
	Multi-purpose corridors	200	22	0,6	80	illuminance at task/activity level, ref. NEW 4.4.3.1. Vertical ill.…
7.1.4	Day rooms	200	22	0.6	80	
7.1.5	Elevators, lifts	100?				Lifts in hospitals: 200 Lx? during daylight and 50 Lx? during night time.

7.2	Staff rooms					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.2.1	Staff office	500	19	0.6	80	
7.2.2	Staff rooms	300	19	0.6	80	

7.3	Wards, maternity wards					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
						Prevent too high luminances in the patients' field of vision.
7.3.1	General lighting	100	19	0.4	80	Illuminance at floor level.
7.3.2	Reading lighting	300	19	0.7	80	
7.3.3	Simple examinations	300	19	0.6	80	
7.3.4	Examination and treatment	1000	19	0.7	90	
7.3.5	Night lighting, observation lighting	5	-	-	80	
7.3.6	Bathrooms and toilets for patients	200	22	0.4	80	

Table 5.7: Health care premises (continued)

7.4	Examination rooms (general)					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.4.1	General lighting	500	19	0.6	90	
7.4.2	Examination and treatment	1000	19	0.7	90	

7.5	Eye examination rooms					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.5.1	General lighting	300	19	0.6	80	
7.5.2	Examination of the outer eye	1000	-	-	90	
7.5.3	Reading and colour vision tests with vision charts	500	16	0.7	90	

7.6	Ear examination rooms					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.6.1	General lighting	300	19	0.6	80	
7.6.2	Ear examination	1000	-	-	90	

7.7	Scanner rooms					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.7.1	General lighting	300	19	0.6	80	
7.7.2	Scanners with image enhancers and television systems	50	19	-	80	DSE-work: see clause 4.11.

7.8	Delivery rooms					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.8.1	General lighting	300	19	0.6	80	
7.8.2	Examination and treatment	1000	19	0.7	80	

7.9	Treatment rooms (general)					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.9.1	Dialysis	500	19	0.6	80	Lighting should be controllable.
7.9.2	Dermatology	500	19	0.6	90	
7.9.3	Endoscopy rooms	300	19	0.6	80	
7.9.4	Plaster rooms	500	19	0.6	80	
7.9.5	Medical baths	300	19	0.6	80	
7.9.6	Massage and radiotherapy	300	19	0.6	80	

Table 5.7: Health care premises (continued)

7.10	Operating areas					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.10.1	Pre-op and recovery rooms	500	19	0.6	90	
7.10.2	Operating theatre	1000	19	0.6	90	
7.10.3	Operating cavity			-		$\bar{E}_m$: 10 000 to 100 000 lx.

7.11	Intensive care unit					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.11.1	General lighting	100	19	0.6	90	At floor level.
7.11.2	Simple examinations	300	19	0.6	90	At bed level.
7.11.3	Examination and treatment	1000	19	0.7	90	At bed level.
7.11.4	Night watch	20	19	-	90	

7.12	Dentists					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.12.1	General lighting	500	19	0.6	90	Lighting should be glare-free for the patient.
7.12.2	At the patient	1000	-	0.7	90	
7.12.3	Operating cavity	5000	-	-	90	Values higher than 5000 lx may be required.
7.12.4	White teeth matching	5000	-	0.7	90	$T_{CP} \geq 6000$ K.

7.13	Laboratories and pharmacies					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.13.1	General lighting	500	19	0.6	80	
7.13.2	Colour inspection	1000	19	0.7	90	$T_{CP} \geq 6000$ K.

7.14	Decontamination rooms					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.14.1	Sterilisation rooms	300	22	0.6	80	
7.14.2	Disinfection rooms	300	22	0.6	80	

7.15	Autopsy rooms and mortuaries					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
7.15.1	General lighting	500	19	0.6	90	
7.15.2	Autopsy table and dissecting table	5000	-	-	90	Values higher than 5000 lx may be required.

Table 5.8: Transportational areas

8.1	Airports					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
8.1.1	Arrival and departure halls, baggage claim areas	200	22	0.4	80	For high-bay: see clause 4.6.2.
8.1.2	Connecting areas, escalators, travolators	150	22	0.4	80	
8.1.3	Information desks, check-in desks	500	19	0.7	80	DSE-work: see clause 4.11.
8.1.4	Customs and passport control desks	500	19	0.7	80	Vertical illuminance is important.
8.1.5	Waiting areas	200	22	0.4	80	
8.1.6	Luggage store rooms	200	25	0.4	80	
8.1.7	Security check areas	300	19	0.6	80	DSE-work: see clause 4.11.
8.1.8	Air traffic control tower	500	16	0.6	80	1. Lighting should be dimmable. 2. DSE-work see clause 4.11. 3. Glare from daylight shall be avoided. 4. Avoid reflections in windows, especially at night.
8.1.9	Testing and repair hangars	500	22	0.6	80	For high-bay: see clause 4.6.2.
8.1.10	Engine test areas	500	22	0.6	80	For high-bay: see clause 4.6.2.
8.1.11	Measuring areas in hangars	500	22	0.6	80	For high-bay: see clause 4.6.2.

8.2	Railway installations					
Ref. no.	**Type of interior, task or activity**	**$\bar{E}_m$**	**UGR_L**	**U_o**	**R_a**	**Remarks**
8.2.1	Covered platforms and passenger subways (underpasses)	50	28	0.5	40	
8.2.2	Ticket hall and concourse	200	28	0.5	40	
8.2.3	Ticket and luggage offices and counters	300	19	0.5	80	
8.2.4	Waiting rooms	200	22	0.5	80	

6 Verification procedures

Specified design criteria which are listed in this standard shall be verified by the following procedures.

Conformity shall take into account the uncertainties of measurement. With regards to variable flux installations, measurements shall be carried out under the operating conditions as specified by the designer.

6.1 Illuminances

When verifying a lighting design, the measurement points shall coincide with any design points or grids used.

For subsequent measurements, the same measurement points shall be used.

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

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

The average illuminance and uniformity shall be calculated and shall be not less than the values given in clause 5.

6.2 Unified Glare Rating

Authenticated UGR data produced by the tabular method as described in CIE-publication 117 shall be provided for the luminaire scheme by the manufacturer of the luminaire. Manufacturers publishing UGR-tables, calculated at spacing to height ratios other than the ratio described in CIE-publication 117, shall declare this ratio. The installation lay-out and the surface finishes shall be checked against the design assumptions.

The installation shall be in accordance with the design assumptions.

6.3 Colour Rendering Index

Authenticated R_a data shall be provided for the lamps in the scheme by the manufacturer of the lamps. The lamps shall be checked against the design specifications.

The lamps shall be as specified in the design.

6.4 Luminaire luminance (see also 4.12.1)

The average luminance of the luminous parts of the luminaire shall be measured and/or calculated in the C-plane at intervals of 15° starting at 0° and the elevation in γ -angles of 65°, 75° and 85°. Normally the manufacturer of the luminaire shall provide these data based on maximum (lamp/luminaire) output.

The values shall not exceed the limits specified in table 4 (see also -EN 13032-1 and -2).

6.5 Maintenance schedule

The maintenance schedule should be based on the results from the calculations under item 4.9.

ANNEX A (informative): Bibliography

CIE Publication 29.2/1986 Guide of interior lighting; second edition

CIE Publication 40/1978 Calculations for interior lighting; basic method

CIE Publication 60/1984 Vision and the visual display unit work station

CIE Publication 97-2/2005 Maintenance of indoor electric lighting systems

CIE Guidelines for Accessibility: Visibility and Lighting Guidelines for Older Persons and Persons with Disabilities, Draft 4, 25-06-2007.

ISO 8995 Principles of visual ergonomics - The lighting of indoor work systems

ISO 9241-6 Ergonomic requirements for office work with visual display terminals (VDTs) - Part 6 Guidance on the work environment

ISO 9241-7 Ergonomic requirements for office work with visual display terminals (VDTs) - Part 7: Requirements for display with reflections

ISO 9241-307

90/270/EEC Council directive of 29 May 1990 on the minimum safety and health requirements for work with display screen equipment

ANNEX B: Index of interiors (areas), tasks and activities