SLOVENSKI STANDARD

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Svetloba in razsvetljava - Razsvetljava delovnih mest - 1. del: Notranji delovni prostori

Light and lighting - Lighting of work places - Part 1: Indoor work places

Licht und Beleuchtung - Beleuchtung von Arbeitsstätten - Teil 1: Arbeitsstätten in Innenräumen

Lumière et éclairage - Éclairage des lieux de travail - Partie 1: Lieux de travail intérieurs

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Light and lighting - Lighting of work places - Part 1: Indoor work places

Lumière et éclairage - Éclairage des lieux de travail - Partie 1 : Lieux de travail intérieurs

Licht und Beleuchtung - Beleuchtung von Arbeitsstätten - Teil 1: Arbeitsstätten in Innenräumen

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 12464-1:2021) has been prepared by Technical Committee CEN/TC 169 "Light and lighting", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2022, and conflicting national standards shall be withdrawn at the latest by February 2022.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12464-1:2011.

The original standard EN 12464-1:2002 was already further developed in its first revision EN 12464-1:2011. It specifies the requirements for good lighting solutions rather than giving design guidelines. With the experience of applying the standard next steps are taken in the development of this new edition and human and user needs are given broader acknowledgement. Lighting requirements for task areas to fulfil visual tasks are given a close relation to the space in which they are carried out. Technologically LED has taken over as the main light source from previous technologies. The main changes with respect to the previous edition are:

— The recommendations given in the tables in Clause 7 take user needs more into account than in the past. Thus, the requirements for necessary illuminance according to Clause 7 are more differentiated.

— The impact of visual and non-visual (non-image forming) effects of light on people's performance and well-being are elaborated in the new informative Annex B.

— Requirements for walls, ceilings and cylindrical illuminances are moved from the main text to the tables in Clause 7 for increased visibility and usability.

— A new chapter on design considerations (Clause 6) gives advice on how to apply the requirements when designing lighting for visual tasks and activities within a space.

— Relation between task area and its immediate surround and the background area is more detailed (5.3.3, 5.3.4, 5.3.5).

— Glare requirements have been clarified for improved usability including clarification for shielding in 5.5 and recommended practices for UGR in non-standard situations has been added in a new informative Annex A.

— Flicker and stroboscopic effect is updated (5.8).

— A new informative Annex C is introduced including examples on how to derive the requirements in different applications (office/industry) for designing lighting.

— A new informative Annex D is introduced to provide additional information on the specific requirements for railway installations that are given in Table 61.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Adequate and appropriate lighting enables people to perform visual tasks efficiently and accurately including tasks performed over a prolonged time period or of a repetitive nature. The degree of visibility and comfort required in a wide range of work places is governed by the type and duration of the activity. The lighting also affects circadian rhythms and mood as well as improving our performance and well-being.

The final designed, installed and operated lighting system should provide efficient and effective good quality lighting for the user needs tailored to their visual capacity, e.g. elderly users in workplaces.

It is important that all clauses of this document are followed although the target values for lighting criteria and specific requirements, depending of each type of task/activity, are tabulated in the schedule of lighting requirements (see Clause 7).

This document reflects the generally recognized best practice.

1 Scope

This document specifies lighting requirements for humans in indoor work places, which meet the needs for visual comfort and performance of people having normal, or corrected to normal ophthalmic (visual) capacity. All usual visual tasks are considered, including Display Screen Equipment (DSE).

This document specifies requirements for lighting solutions 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 including visual and non-visual (non-image forming) lighting needs. This document does not specify lighting requirements with respect to the safety and health of people at work and has not been prepared in the field of application of Article 169 of Treaty on the Functioning of the European Union although the lighting requirements, as specified in this document, usually fulfil safety needs.

NOTE Lighting requirements with respect to the safety and health of workers at work can be contained in Directives based on Article 169 of Treaty on the Functioning of the European Union, in national legislation of member states implementing these directives or in other national legislation of member states.

This document neither provides specific solutions, nor restricts the designers' freedom from exploring new techniques nor restricts the use of innovative equipment. The illumination can be provided by daylight, electric lighting or a combination of both.

This document 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

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12193, *Light and lighting — Sports lighting*

EN 12665, *Light and lighting — Basic terms and criteria for specifying lighting requirements*

EN 17037:2018, *Daylight in buildings*

EN 60601-2-41:2009,[1] *Medical electrical equipment — Part 2-41: Particular requirements for basic safety and essential performance of surgical luminaires and luminaires for diagnosis*

EN ISO 9680, *Dentistry — Operating lights (ISO 9680)*

ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*

ISO/CIE TS 22012, *Light and lighting — Maintenance factor determination — Way of working*

[1] As impacted by EN 60601-2-41:2009/A11:2011 and EN 60601-2-41:2009/A1:2015.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12665, EN 17037 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
activity area
area which contains one or more visual tasks

Note 1 to entry: Visual tasks can be different in type and/or position.

Note 2 to entry: A room can contain one or more activity areas.

Note 3 to entry: The spatial orientation needs to be specified by the designer.

Note 4 to entry: An activity area is not to be considered as aggregation of a number of distinct task areas across a larger area.

3.2
modelling
effect of directional lighting to reveal the depth, shape and texture of an object or person

[SOURCE: CIE S 017:2020, 17-29-170]

4 Symbols and abbreviations

$\bar{E}_{m,wall}$	maintained illuminance on walls	5.2.3
$\bar{E}_{m,ceiling}$	maintained illuminance on ceiling	5.2.3
U_o	illuminance uniformity	5.2.3
$\bar{E}_m$	maintained illuminance[2]	5.3.3
α	shielding angle	5.5.2
γ	vertical photometric angle	5.5.2
DGP	Daylight Glare Probability	5.5.3.1
R_{UG}	CIE Unified Glare Rating (UGR)	5.5.3.2
R_{UGL}	R_{UG} limit value	5.5.3.2
$\bar{E}_z$	average cylindrical illuminance[3]	5.6.2
$\bar{E}_{m,z}$	maintained average cylindrical illuminance	5.6.2

[2] According to EN 12655, $\bar{E}_m$ is the value below which the average illuminance on a specified area shall not fall.

[3] approximation of the average of the four main directions

T_{cp}	correlated colour temperature	5.7.2
R_a	colour rendering index	5.7.3
R_i	special colour rendering index	5.7.3
TLA	temporal light artefacts	5.8.1
P_{st}^{LM}	IEC short-term light modulation/flicker indicator	5.8.2
SVM	Stroboscopic Visibility Measure	5.8.3
$\bar{E}$	average illuminance	5.8.3
DSE	Display Screen Equipment	5.9
L	luminance	5.9.2
f_m	maintenance factor	6.3
$\bar{E}_i$	initial illuminance	6.3
LENI	lighting energy numeric indicator	6.4

5 Lighting design criteria

5.1 Luminous environment

For good lighting practice it is essential that as well as the required illuminances, additional qualitative and quantitative needs are satisfied.

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

— visual comfort, where the workers have a feeling of well-being; in an indirect way this also contributes to a higher productivity level and a higher quality of work;

— visual performance, where the workers are able to perform their visual tasks, even under difficult circumstances and during longer periods;

— safety.

The main criteria determining the luminous environment with respect to electric lighting and daylighting are:

— luminance distribution;

— illuminance;

— glare;

— directionality of light, lighting in the interior space;

— colour rendering and colour appearance of the light;

— flicker;

— variability of light (levels and colour of light).

These criteria are further detailed in Clause 5 and 6, requirements and recommendations are given in Clause 7.

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

— the intrinsic task properties (size, shape, position, colour and reflectance properties of detail and background),

— ophthalmic capacity of the person (visual acuity, depth perception, colour perception) (see CIE 227),

— for the visually impaired, for example those who are sensitive to glare, have visual field defects, adaptation and decreased contrast and colour vision where dimming, protection against glare and colour rendering are especially important factors to consider, see CIE 227.

5.2 Luminance distribution

5.2.1 General

The luminance distribution in the visual field 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 visual field also affects visual comfort. The following should be avoided for the reasons given:

— too high luminances and luminance contrasts which can give rise to glare;

— too high luminance variation 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.

To create a well-balanced luminance distribution the luminances of all surfaces shall be taken into consideration. They are determined by the reflectance of 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. Room brightness is considered by specifying illuminances on walls and ceiling (see Clause 7) and by recommending reflectances. Annex B provides further details of possible measures.

Although luminance requirements would be a representative way of describing the visual environment, this document lists illuminance requirements as luminance requirements are more complex due to their dependence on exact material characteristics and viewing positions.

The lighting designer shall consider and select appropriate reflectance (5.2.2) and illuminance requirements for the interior surfaces (5.2.3) based on the guidance below.

5.2.2 Reflectance of surfaces

High surface reflectances contribute to energy savings and can lead to better visual comfort. For choice of materials, the following ranges of reflectances are recommended:

— ceiling: 0,7 to 0,9;

— walls: 0,5 to 0,8;

— floor: 0,2 to 0,6.

The reflectance of major objects (like furniture, machinery, etc.) should be in the range of 0,2 to 0,7.

NOTE Clear interior glass has a typical reflectance of 0,1.

In design calculations, surface reflectances should be defined as close to the real surfaces as possible taking into account the variation in reflectance across the surface.

5.2.3 Illuminance on surfaces

Illuminances on walls and ceilings together with surface reflectances (see 5.2.2) contribute to luminances and are indicators for perceived room brightness.

Clause 7 provides minimum requirements for the maintained illuminance on walls ($\bar{E}_{\mathrm{m,wall}}$) and ceiling ($\bar{E}_{\mathrm{m,ceiling}}$) depending on the tasks and/or activities being performed in the space. Uniformity for walls and ceiling shall be $U_0 \geq 0{,}10$ (see 5.3.6).

NOTE Additional guidance can be found in Clause 6.

5.3 Illuminance

5.3.1 General

Areas to be lit are task and activity areas, the immediate surrounding area and background area, walls, ceiling and objects in the space.

The illuminance and its distribution on the task area and on its immediate 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 given in this document are maintained illuminances specified to fulfil visual comfort and performance needs.

Designing for higher illuminances allows enough capacity for applying context modifiers (see Table 1 and Table 2) and controls. Higher illuminances shall be used when relevant, e.g. only parts of the day.

For calculation and measurement of illuminance averages and uniformities the grid specification in 5.4 shall be used.

5.3.2 Scale of illuminance

To give a perceptual difference the recommended steps of illuminance (in lx) are according to EN 12665:

5 - 7,5 - 10 - 15 - 20 - 30 - 50 - 75 - 100 - 150 - 200 - 300 - 500 - 750 - 1 000 - 1 500 - 2 000 - 3 000 - 5 000 - 7 500 - 10 000

5.3.3 Illuminances on the task area or activity area

The maintained illuminance value shall at least meet the requirement as given in Clause 7 ($\bar{E}_{\mathrm{m}}$, required) and shall be used for normal visual conditions taking into account the following factors:

— psycho-physiological aspects such as visual comfort and well-being;

— requirements for visual tasks;

— visual ergonomics;

— practical experience;

— contribution to functional safety;

— economy.

The values given in Clause 7 are maintained illuminances over the task area or activity area on the reference surface which can be horizontal, vertical or inclined.

However, it is recommended to increase the maintained illuminance (by one or two steps in the scale of illuminances (see 5.3.2)), depending on the context modifiers given in Table 1 if the assumptions differ from the normal visual conditions.

As an example an increase of one step is recommended if one or two of the conditions listed in Table 1 apply and an increase of two steps is recommended if more than two of these conditions apply. For examples see Annex C.

A modified value which considers common context modifiers is given in Clause 7 ($\bar{E}_{\mathrm{m}}$, modified). This modified value shall not be seen as an upper limit.

Table 1 — Context modifiers for increase of maintained illuminance

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 task area or activity area has a low daylight provision;
the visual capacity of the worker is below normal.

NOTE 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.

NOTE 2 Daylight provision is considered in 6.5.

The required $\bar{E}_{\mathrm{m}}$ in 7.3 is a minimum 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 illuminance

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