



SLOVENSKI STANDARD

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Svetloba in razsvetljava - Razsvetljava na delovnem mestu - 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 - Eclairage (des lieux de travail - Partie 1 : Lieux de travail intérieurs

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ICS:

91.160.10	Notranja razsvetljava	Interior lighting
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EUROPEAN STANDARD
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English Version

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

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

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

This European Standard was approved by CEN on 14 April 2011.

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EN 12464-1:2011 (E)**Foreword**

This document (EN 12464-1:2011) 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of an identical text or by endorsement, at the latest by December 2011, and conflicting national standards shall be withdrawn at the latest by December 2011.

This document supersedes EN 12464-1:2002.

The main technical changes in this revision are:

- importance of daylight is taken into account: Requirements for lighting are generally applicable independent if provided by artificial lighting, daylight or a combination of both;
- specification of a minimum illuminance on walls and ceilings;
- specification of cylindrical illuminance and detailed information on modelling;
- uniformity of illuminance is assigned to tasks and activities;
- definition of "background area" and lighting specification for this area;
- definition of an illuminance grid is in accordance with EN 12464-2;
- new luminance limits are set for luminaires used with Display Screen equipment (DSE), the description of display screens is according ISO 9214-307.

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

According to the CEN/CENELEC Internal Regulations, the national standards organizations 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, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

Adequate and appropriate lighting enables people to perform visual tasks efficiently and accurately. The degree of visibility and comfort required in a wide range of work places is governed by the type and duration of the activity.

It is important that all clauses of this European Standard are followed although the specific requirements are tabulated in the schedule of lighting requirements (see Clause 5).

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EN 12464-1:2011 (E)**1 Scope**

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

This European Standard 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.

This European Standard 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 153 of the EC treaty, although the lighting requirements, as specified in this European Standard, usually fulfil safety needs. Lighting requirements with respect to the safety and health of workers at work can be contained in Directives based on Article 153 of the EC treaty, in national legislation of member states implementing these directives or in other national legislation of member states.

This European Standard 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, artificial lighting or a combination of both.

This European 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.

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2 Normative references

The following referenced documents are indispensable for the application 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 12464-2, *Light and lighting — Lighting of work places — Part 2: Outdoor work places*

EN 12665, *Light and lighting — 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 and file format*

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 15193, *Energy performance of buildings — Energy requirements for lighting*

EN ISO 9241-307, *Ergonomics of human-system interaction — Part 307: Analysis and compliance test methods for electronic visual displays (ISO 9241-307:2008)*

EN ISO 9680:2007, *Dentistry — Operating lights (ISO 9680:2007)*

ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs in workplaces and public areas*

3 Terms and definitions

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

3.1

activity area

area within which a specific activity is carried out

3.2

background area

area adjacent to the immediate surrounding area

3.3

display screen equipment

DSE

alphanumeric or graphic display screen, regardless of the display process employed

NOTE Adapted from 90/270/EEC.

3.4

immediate surrounding area

band surrounding the task area within the visual field

3.5

roof light

daylight opening in the roof or a horizontal surface of a building

3.6

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

3.7

task area

area within which the visual task is carried out

3.8

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.

3.9

window

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

3.10

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.

3.11

work station

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

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NOTE Adapted from EN ISO 6385:2004.

4 Lighting design criteria**4.1 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.

Main parameters determining the luminous environment with respect to artificial light and daylight are:

- luminance distribution;
- illuminance;
- directionality of light, lighting in the interior space;
- variability of light (levels and colour of light);
- colour rendering and colour appearance of the light;
- glare;
- flicker.

Values for illuminance and its uniformity, discomfort glare and colour rendering index are given in Clause 5; other parameters are described in Clause 4.

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),
- intentionally improved and designed luminous environment, glare-free illumination, good colour rendering, high contrast markings and optical and tactile guiding systems can improve visibility and sense of direction and locality. See *CIE Guidelines for Accessibility: Visibility and Lighting Guidelines for Older Persons and Persons with Disabilities*.

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

4.2 Luminance distribution

4.2.1 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 which can 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.

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.

The lighting designer shall consider and select the appropriate reflectance and illuminance values for the interior surfaces based on the guidance below.

4.2.2 Reflectance of surfaces

Recommended reflectances for the major interior diffusely reflecting 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.

4.2.3 Illuminance on surfaces

In all enclosed places the maintained illuminances on the major surfaces shall have the following values:

- $\bar{E}_m > 50 \text{ lx}$ with $U_o \geq 0,10$ on the walls and
- $\bar{E}_m > 30 \text{ lx}$ with $U_o \geq 0,10$ on the ceiling.

NOTE 1 It is recognised that, in some places such as racked storage places, steelworks, railway terminals, etc., due to the size, complexity and operational constraints, the desired light levels on these surfaces will not be practical to achieve. In these places reduced levels of the recommended values are accepted.

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NOTE 2 In some enclosed places such as offices, education, health care and general areas of entrance, corridors, stairs, etc., the walls and ceiling need to be brighter. In these places it is recommended that the maintained illuminances on the major surfaces should have the following values: $\bar{E}_m > 75 \text{ lx}$ with $U_o \geq 0,10$ on the walls and $\bar{E}_m > 50 \text{ lx}$ with $U_o \geq 0,10$ on the ceiling.

4.3 Illuminance**4.3.1 General**

The illuminance and its distribution on the task area and on 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 European Standard are maintained illuminances and fulfil visual comfort and performance needs.

All maintained illuminance and uniformity values are dependent upon the grid definition (see 4.4).

4.3.2 Scale of illuminance

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

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

4.3.3 Illuminances on the task area

The values given in Clause 5 are maintained illuminances over the task area on the reference surface which can 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;
- contribution to functional safety;
- economy.

The value of illuminance may be adjusted by at least one step in the scale of illuminances (see 4.3.2), 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.

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.

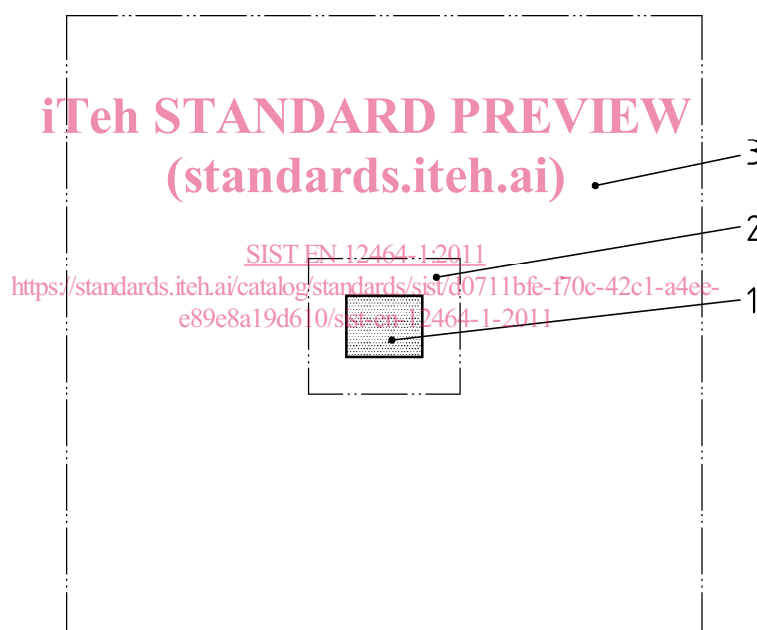
NOTE For visually impaired people special requirements can be necessary with regard to illuminances and contrasts.

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

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

- the whole area is treated as the task area or
- the whole area is uniformly ($U_o \geq 0,40$) 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 illuminances.

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



Key

- 1 task area
- 2 immediate surrounding (band with a width of at least 0,5 m around the task area within the visual field)
- 3 background area (at least 3 m wide adjacent to the immediate surrounding area within the limits of the space)

Figure 1 — Minimum dimensions of immediate surrounding and background area in relation to task area

EN 12464-1:2011 (E)**4.3.4 Illuminance on the immediate surrounding area**

Large spatial variations in illuminances around the task 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 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 within the 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 1.

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

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

Table 1 — Relationship of illuminances on immediate surrounding to the illuminance on the task area

Illuminance on the task area E_{task} lx	Illuminance on immediate surrounding areas lx
≥ 750	500
500	300
300	200
200	150
150	E_{task}
100	E_{task}
≤ 50	E_{task}

Figure 1 illustrates the minimum dimension of immediate surrounding area in relation to task area.

4.3.5 Illuminance on the background area

In indoor work places, particularly those devoid of daylight, a large part of the area surrounding an active and occupied task area needs to be illuminated. This area known as the “background area” should be a band at least 3 m wide adjacent to the immediate surrounding area within the limits of the space and shall be illuminated with a maintained illuminance of 1/3 of the value of the immediate surrounding area.

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

Figure 1 illustrates the minimum dimension of immediate background area in relation to task area.

4.3.6 Illuminance uniformity

In the task area, the illuminance uniformity (U_0) shall be not less than the minimum uniformity values given in the tables of Clause 5.

For lighting from artificial lighting or roof lights the illuminance uniformity:

- in the immediate surrounding area shall be $U_o \geq 0,40$;
- on the background area shall be $U_o \geq 0,10$.

For lighting from windows:

- in larger areas, activity areas and background areas the available daylight decreases rapidly with the distance from the window; the additional benefits of daylight (see 4.12) can compensate for the lack of uniformity.

4.4 Illuminance grid

Grid systems shall be created to indicate the points at which the illuminance values are calculated and verified for the task 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:

$$p = 0,2 \times 5^{\log_{10}(d)} \quad (1)$$

where

$$p \leq 10 \text{ m}$$

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 grid points in the other dimension. This will give a ratio of length to width of a grid cell close to 1.

A band of 0,5 m from the walls is excluded from the calculation area except when a task area is in or extends into this border area.

An appropriate grid size shall be applied to walls and ceiling and a band of 0,5 m may be applied also.

NOTE 1 The grid point spacing should not coincide with the luminaire spacing.

NOTE 2 Formula (1) (coming from CIE x005-1992) has been derived under the assumption that p is proportional to $\log(d)$, where:

$$p = 0,2 \text{ m for } d = 1 \text{ m};$$

$$p = 1 \text{ m for } d = 10 \text{ m};$$

$$p = 5 \text{ m for } d = 100 \text{ m}.$$

NOTE 3 Typical values of grid point spacing are given in Table A.1.