



SLOVENSKI STANDARD

oSIST prEN 12464-1:2019

01-september-2019

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 - Éclairage des lieux de travail - Partie 1: Lieux de travail intérieurs

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Ta slovenski standard je istoveten z: prEN 12464-1

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ICS:

91.160.10 Notranja razsvetljava Interior lighting

oSIST prEN 12464-1:2019

en,fr,de

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

DRAFT
prEN 12464-1

July 2019

ICS 91.160.10

Will supersede EN 12464-1:2011

English Version

**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

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 169.

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.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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prEN 12464-1:2019 (E)**European foreword**

This document (prEN 12464-1:2019) has been prepared by Technical Committee CEN/TC 169 “Light and lighting”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede 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 taking over as the light source from conventional lamps. The main changes with respect to the previous edition are:

- User needs are better reflected by adding an additional level of recommendations in the tables in Clause 6 next to the minimum requirements. This gives more emphasis to already existing requirements in 4.3.3.
- The impact of visual and non-image forming effects of light are elaborated in the new Annex C.
- Requirements for walls, ceilings and cylindrical illuminances are moved from the main text to the tables in Clause 6 for increased visibility and usability.
- A new chapter on design considerations (Clause 5) 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 (4.3.3, 4.3.4, 4.3.5).
- Glare requirements have been clarified for improved usability including clarification for shielding in 4.5 and recommended practices for UGR in non-standard situations has been added in a new Annex B.
- Flicker and stroboscopic effect is updated (4.8).
- A new Annex D is introduced including examples on how to derive the requirements in different applications (office/industry) for designing lighting.

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 specific requirements are tabulated in the schedule of lighting requirements (see Clause 6).

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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, artificial 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.

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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 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 15193-1, *Energy performance of buildings - Energy requirements for lighting - Part 1: Specifications, Module M9*

EN 17037, *Daylight in buildings*

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

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*

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 <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://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 may contain one or more activity areas.

Note 3 to entry: An activity area is usually a horizontal area. Otherwise the orientation needs to be specified by the designer.

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.

The 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 on task or activity areas, illuminances in the space, discomfort glare and colour rendering index are given in Clause 6; other parameters are described in Clause 4.

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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 227 *Lighting for Older People and People with Visual Impairment in Buildings.*)

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 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 and will be 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 6). Annex C provides further details of possible measures.

Although luminance requirements would be more accurate, this standard lists illuminance requirements as luminance requirements are not practical due to their dependence on exact material characteristics and viewing positions.

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

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

- 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 reflectance values should be defined as close to the real surfaces as possible taking into account the variation in reflectance across the surface.

4.2.3 Illuminance on surfaces

Clause 6 provides minimum requirements for the illuminance on walls ($\bar{E}_{m,wall}$) and ceiling ($\bar{E}_{m,ceiling}$) depending on the tasks and/or activities being performed in the space. Uniformity for walls and ceiling shall be $U_o \geq 0,10$ (see 4.3.6).

Illuminances on walls and ceilings together with surface reflectances (see 4.2.2) are indicators for perceived room brightness.

NOTE Additional guidance can be found in Clause 5.

4.3 Illuminance

4.3.1 General

Areas to be lit are task and activity areas, the immediate surrounding 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 specified in this European Standard are maintained illuminances and fulfil visual comfort and performance needs.

For calculation and measurement of illuminance averages and uniformities the grid specification in 4.4 shall be used.

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 or activity area

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

The values for $\bar{E}_{m,r}$ and $\bar{E}_{m,u}$ in Clause 6 give an indication of a suitable band of maintained illuminance values for the task or activity area. The average illuminance for each task shall not fall below the chosen value, regardless of the age and condition of the installation (see 5.3).

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.

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The value of maintained 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 task 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, *Lighting for Older People and People with Visual Impairment in Buildings*.

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

The size and position of the task or the activity area should be stated and documented, see Figure 1.

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

- the whole area is treated as the task area, or
- the whole area is uniformly ($U_0 \geq 0,40$) 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.

When multiple tasks take place in the area, requirements for all these tasks shall be complied with.

This applies also to an activity area.

4.3.4 Illuminance on the immediate surrounding area

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

The illuminance of the immediate surrounding area shall be related to the illuminance of the task or activity area and should provide a well-balanced luminance distribution in the visual field. The immediate surrounding area should be a band with a width of at least 0,5 m around the task area 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 and activity 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 or activity area

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

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

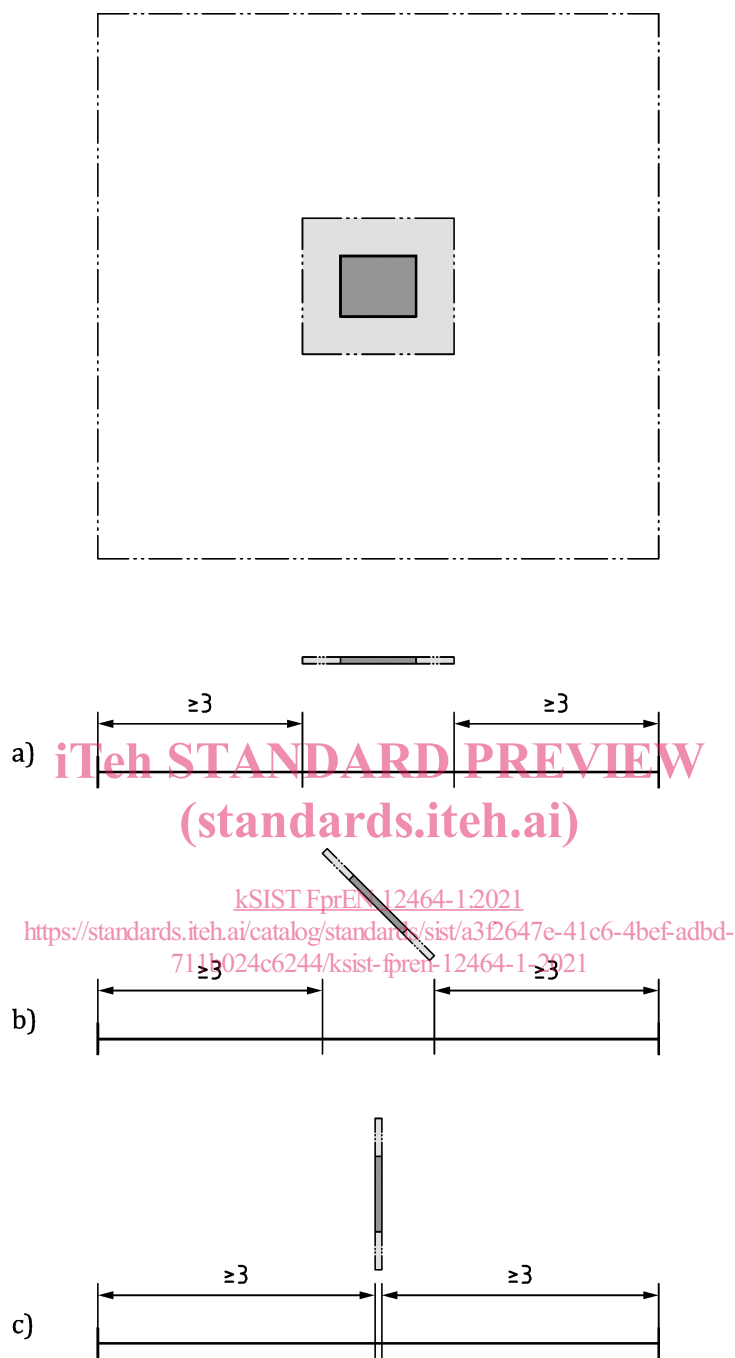
4.3.5 Illuminance on the background area

In indoor work places, particularly those devoid of daylight, a large area outside the immediate surrounding area needs to be illuminated. The area known as the “background area” should be a band 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. For larger rooms the band should be at least 3 m wide. The background area is a horizontal area on floor level.

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

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

Dimensions in *m*



Key




-  task or activity area (not true to scale) in a specified size and position (see 4.3.3)
 -  immediate surrounding (band with a width of at least 0,5 m around the task or activity area within the visual field)
 -  background (adjacent to the immediate surrounding area up to the limits of the space, for larger rooms at least 3 m wide) horizontal on floor level
- a) horizontal task or activity area b) inclined task or activity area
- c) vertical task or activity area

Figure 1 — Minimum dimensions of immediate surrounding and background area in relation to task and activity area (figure is not true to scale)

4.3.6 Illuminance uniformity

In the task or activity area, the illuminance uniformity (U_o) shall be not less than the minimum uniformity values given in the tables in 6.3.

For light from artificial lighting or Daylight opening in the ceiling 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 light from vertical daylight openings:

- in larger areas, activity areas and background areas the available daylight decreases rapidly with the distance from the window; the additional benefits of daylight can compensate for the lack of uniformity. More information on the benefits of daylight can be found in 5.4 and Annex C.

Uniformity for walls and ceiling shall be $U_o \geq 0,10$.

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 and activity area(s), immediate surrounding area(s) and background area(s).

Grid cells approximating to a square are preferred, the ratio of length to width of a grid cell shall be kept between 0,5 and 2 (see also EN 12193 and EN 12464-2). The maximum grid size shall be:

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

where

- $p \leq 10$ m <https://standards.iteh.ai/catalog/standards/sist/a3f2647e-41c6-4bef-adbd-711b024c6244/ksist-fpren-12464-1-2021>
- 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 the task or activity area is in or extends into this border area. For narrow spaces (width < 2 m) the excluded band may not be wider than 10 % of the floor width. An appropriate grid size shall be applied to walls and ceiling and a band of 0,5 m may be applied also.

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

NOTE 1 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 2 Typical values of grid point spacing are given in Annex A, Table A.1.