



**SLOVENSKI STANDARD**  
**SIST EN 12464-1:2004**  
**01-september-2004**

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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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**Ta slovenski standard je istoveten z: EN 12464-1:2002**

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ICS 91.160.10

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 intérieur

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

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## Foreword

This document EN 12464-1:2002 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of an identical text or by endorsement, at the latest by May 2003, and conflicting national standards shall be withdrawn at the latest by May 2003.

Annex A is informative.

This document includes a Bibliography.

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

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## Introduction

To enable people to perform visual tasks efficiently and accurately, adequate and appropriate lighting should be provided. The illumination can 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.

## 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 (including amendments).

EN 12193		<i>Light and lighting - Sports lighting.</i>
EN 12665:2002		<i>Light and lighting - Basic terms and criteria for specifying lighting requirements.</i>
prEN 13032-1		<i>Lighting applications - Measurement and presentation of photometric data of lamps and luminaires - Part 1: Measurement.</i>
CIE 117	1995	<i>Discomfort glare in interior lighting.</i>

## 3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 12665:2002 and the following apply.

NOTE This clause defines terms and quantities that are in use and important to this standard, and which may not be given in IEC 60050-845.

### 3.1

#### **visual task**

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**

partial area in the work place in which the visual task is carried out. For places where the size and/or location of the task area is unknown, the area where the task may occur shall be taken as the task area

### 3.3

#### **immediate surrounding area**

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**

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)**

alphanumeric or graphic display screen, regardless of the display process employed [90/270/EEC]

### 3.7

#### **illuminance uniformity**

ratio of minimum illuminance to average illuminance on a surface (see also IEC 60050-845 / CIE 17.4: 845-09-58 Uniformity ratio of illuminance)

## 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 three 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,

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- glare,
- directionality of light,
- colour rendering and colour appearance of the light,
- flicker,
- daylight.

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

### 4.2 Luminance distribution

The luminance distribution in the field of view 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 view 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 and will be determined by the reflectance and the illuminance on the surfaces.

Ranges of useful reflectances for the major interior surfaces are:

- ceiling: 0,6 to 0,9
- walls: 0,3 to 0,8
- working planes: 0,2 to 0,6
- floor: 0,1 to 0,5

### 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 Recommended illuminances at the task area

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.

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

The required maintained illuminance should be increased, when:

- visual work is critical,
- errors are costly to rectify,
- accuracy or higher productivity is of great importance,
- the visual capacity of the worker is below normal,
- task details are of unusually small size or low contrast,
- the task is undertaken for an unusually long time.

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.

In continuously occupied areas, the maintained illuminance shall be not less than 200 lx.

#### 4.3.2 Illuminances of immediate surroundings

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 view.

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 task illuminance but shall be not less than the values given in Table 1.

**Table 1 — Uniformities and relationship of illuminances of immediate surrounding areas to task area**

Task illuminance lx	Illuminance of immediate surrounding areas lx
≥ 750	500
500	300
300	200
≤ 200	E <sub>task</sub>
Uniformity: ≥ 0,7	Uniformity: ≥ 0,5

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

### 4.3.3 Uniformity

The task area shall be illuminated as uniformly as possible. The uniformity of the task area and the immediate surrounding areas shall be not less than the values given in Table 1.

### 4.4 Glare

Glare is the sensation produced by bright areas within the field of view 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.

#### 4.4.1 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  $cd \times m^{-2}$ , 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  $cd \times m^{-2}$ ,

$\omega$  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.

#### 4.4.2 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 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 $\text{kcd} \times \text{m}^{-2}$	Minimum shielding angle
20 to < 50	15°
50 to < 500	20°
$\geq 500$	30°

#### 4.4.3 Veiling reflections and reflected glare

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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.

#### 4.5 Directional lighting

Directional lighting may be used to highlight objects, reveal texture and improve the appearance of people within the space. This is described by the term "modelling". Directional lighting of a visual task may also affect its visibility.

##### 4.5.1 Modelling

Modelling is the balance between diffuse and directional 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.

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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.

### 4.5.2 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.

## 4.6 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.

### 4.6.1 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 $T_{CP}$ K
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.

### 4.6.2 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 shall always be recognisable as such (see also ISO 3864).

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.

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

#### 4.7 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).

#### 4.8 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.

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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.

#### 4.9 Energy considerations

A lighting installation should meet the lighting requirements of a particular space without waste of energy. However, it is important not to compromise the visual aspects of a lighting installation simply to reduce energy consumption.

This requires the consideration of appropriate lighting systems, equipment, controls and the use of available daylight.

#### 4.10 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.