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Lighting of work places - Part 2: Outdoor work places

Beleuchtung von Arbeitsstätten - Teil 2: Arbeitsplätze im Freien

Lumière et éclairage - Éclairage des lieux de travail - Partie 2 : Lieux de travail extérieurs

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EUROPEAN STANDARD
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English Version

Lighting of work places - Part 2: Outdoor work places

Lumière et éclairage - Eclairage des lieux de travail - Partie
2 : Lieux de travail extérieurs

Beleuchtung von Arbeitsstätten - Teil 2: Arbeitsplätze im
Freien

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Foreword

This document (EN 12464-2:2007) 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of an identical text or by endorsement, at the latest by January 2008, and conflicting national standards shall be withdrawn at the latest by January 2008.

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.

EN 12464 *Light and lighting - Lighting of work places* is published in 2 parts:

— Part 1: *Indoor work places*;

— Part 2: *Outdoor work places*

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, 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 the United Kingdom. (standards.iteh.ai)

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EN 12464-2:2007 (E)**Introduction**

To enable people to perform outdoor visual tasks efficiently and accurately, especially during the night, adequate and appropriate lighting has to be provided.

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

This standard specifies requirements for lighting of tasks in most outdoor 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 outdoor work places, which meet the needs for visual comfort and performance. All usual visual tasks are considered.

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.

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

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 1838, *Lighting applications — Emergency lighting*.

EN 12193, *Light and lighting — Sports lighting*.

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

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 13201 (all parts), *Road lighting*.

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

CIE 150:2003 — *Guide on the limitation of the effects of obtrusive light from outdoor lighting installations*.

CIE 154:2003 — *Maintenance of outdoor lighting systems*.

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 12665 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/ CIE 17.4 [3].

3.1

curfew

time during which stricter requirements (for the control of obtrusive light) will apply; often a condition of use of lighting applied by a government controlling authority, usually the local government

3.2

diversity

U_d

ratio of minimum illuminance (luminance) to maximum illuminance (luminance) on (of) a surface

3.3

glare rating limit

GR_L

upper limit of glare by the CIE Glare Rating system

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

obtrusive light

spill light, which because of quantitative, directional or spectral attributes in a given context, gives rise to annoyance, discomfort, distraction or a reduction in the ability to see essential information

3.6

spill light (stray light)

light emitted by a lighting installation which falls outside the boundaries of the property for which the lighting installation is designed

3.7

surrounding area

band surrounding the task area within the field of vision

NOTE This band should have a width of at least 2 m.

3.8

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 are unknown, the area where the task may occur is the task area

3.9

illuminance uniformity

U_o

ratio of minimum illuminance (luminance) to average illuminance (luminance) on (of) a surface

NOTE See also IEC 60050-845/ CIE 17.4 [3]; 845-09-58 uniformity ratio of illuminance.

3.10

upward light ratio

ULR

proportion of the flux of the luminaire(s) that is emitted above the horizontal, when the luminaire(s) is (are) mounted in its (their) installed position and attitude

EN 12464-2:2007 (E)**3.11****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.

3.12**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

3.13**work station**

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

4 Lighting design criteria**4.1 Luminous environment**

For good lighting practice it is essential that, in addition to the required illuminance, other 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,
- glare,
- directionality of light,
- colour rendering and colour appearance of the light,
- flicker.

Values for illuminance, glare rating 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 luminance distribution 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.).

The luminance distribution in the field of view also affects visual comfort. Sudden changes in luminance should be avoided.

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, visual performance and safety needs.

4.3.1 Illuminance on 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.

NOTE 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.

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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. The recommended scale of illuminance (in lx) is:

5 – 10 – 15 – 20 – 30 – 50 – 75 – 100 – 150 – 200 – 300 – 500 – 750 – 1 000 – 1 500 – 2 000

The required maintained illuminance should be increased, when:

- visual work is critical,
- visual task or worker is moving,
- 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:

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

4.3.2 Illuminance of surroundings

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

Table 1 — Relationship of illuminances of surrounding areas to task area

Task illuminance lx	Illuminance of surrounding areas lx
≥500	100
300	75
200	50
150	30
$50 \leq \bar{E}_m \leq 100$	20
< 50	no specification

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

4.3.3 Illuminance grid

A grid system shall be created for the task and surrounding areas 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:

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

where:

d is the longer dimension of the area, in 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 in m.

The value of p should be that $p \leq 10$ m.

4.3.4 Uniformity and diversity

The task area shall be illuminated as uniformly as possible. The illuminance uniformity of the task area shall be not less than the values given in clause 5. The uniformity of the surroundings shall not be less than 0,10.

In some cases e.g. railways, illuminance diversity is also an important quality criterion.

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 the users to avoid errors, fatigue and accidents.

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

4.4.1 Glare rating

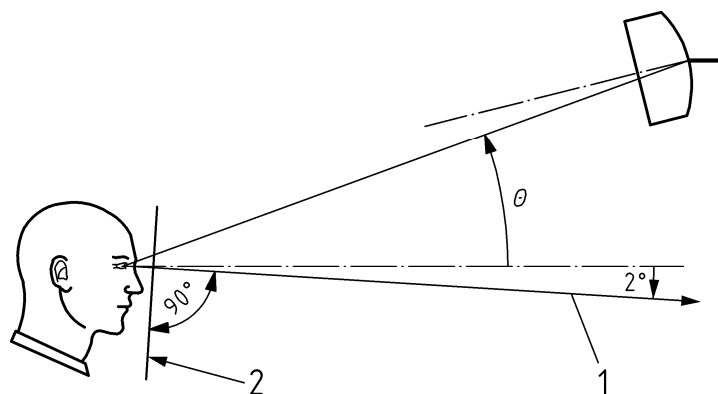
The glare directly from the luminaires of an outdoor lighting installation shall be determined using the CIE Glare Rating (*GR*) method, based on the formula:

$$GR = 27 + 24 \log_{10} \left(\frac{L_{vl}}{L_{ve}^{0,9}} \right) \quad (2)$$

where:

L_{vl} is the total veiling luminance in $\text{cd}\cdot\text{m}^{-2}$ caused by the lighting installation and is the sum of the veiling luminances produced by each individual luminaire ($L_{vl} = L_{v1} + L_{v2} + \dots + L_{vn}$). The veiling luminance of the individual luminaires is calculated as $L_v = 10 \cdot (E_{eye} \cdot \theta^2)$, in which E_{eye} is the illuminance at the observer's eye in a plane perpendicular to the line of sight (2° below horizontal, see Fig. 1) and θ is the angle between the observer's line of sight and the direction of the light incident from the individual luminaire.

L_{ve} is the equivalent veiling luminance of the environment in $\text{cd}\cdot\text{m}^{-2}$. From the assumption that the reflection of the environment is totally diffuse, the equivalent veiling reflection from the environment may be calculated as $L_{ve} = 0,035 \cdot \rho \cdot E_{hav} \cdot \pi^{-1}$, in which ρ represents the average reflectance and E_{hav} the average horizontal illuminance of the area.



Key:

- 1 line of sight
- 2 plane of E_{eye}

Figure 1 — The angle between the observer's line of sight and the direction of the light incident from the individual luminaire

NOTE *GR* should be computed at grid positions as defined in 4.3.3, at 45° intervals radially about the grid points with 0° direction parallel to the long side of the task area.

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