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Light and lighting - Lighting of work places - Outdoor work places

Licht und Beleuchtung - Beleuchtung von Arbeitsstätten - Teil 2: Arbeitsplätze im Freien

Lumière et éclairage - Éclairage des lieux de travail - Lieux de travail extérieurs

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Light and lighting - Lighting of work places - Outdoor work places

Lumière et éclairage - Éclairage des lieux de travail - Lieux de travail extérieurs

Licht und Beleuchtung - Beleuchtung von Arbeitsstätten - Teil 2: Arbeitsplätze im Freien

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Foreword

This document (FprEN 12464-2:2013) 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 Unique Acceptance Procedure.

This document will supersede EN 12464-2:2007.

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

— Part 1: *Indoor work places*;

— Part 2: *Outdoor work places*

Significant changes between this document and EN 12464-2:2007 are:

- a) The terms and definitions were deleted to avoid duplication with EN 12665;
- b) Symbols were aligned with EN 12665;
- c) Figure 1 was corrected;
- d) 4.4.2 "Glare rating". the reflectance has a default value of $\rho = 0,15$;
- e) 4.7.3 "colour rendering", aligned with EN 12464-1; [2464-2:2014](https://standards.iteh.ai/catalog/standards/sist/b1a68cbc-1bdc-4ac2-89e7-123982765b5/sist-en-12464-2-2014)
- f) 4.10 "energy considerations", aligned with EN 12464-1 and extended;
- g) Sub-clause 5.1, insertion of requirements regarding routine cleaning of work spaces;
- h) Table 5.1 "General requirements for areas and for cleaning at outdoor work places", title changed and new activity added;
- i) Table 5.12 "Railways and tramways", updated and extended;
- j) Clause 6 "Verification procedures", revised and harmonised with EN 12464-1.

FprEN 12464-2:2013 (E)**Introduction**

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

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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 is not applicable for emergency lighting; see EN 1838 and EN 13032-3.

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 153 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 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 designer's freedom from exploring new techniques nor restricts the use of innovative equipment.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12665:2011, *Light and lighting — Basic terms and criteria for specifying lighting requirements*

EN 13201-2, *Road lighting — Part 2: Performance requirements*

EN 13201-3, *Road lighting — Part 3: Calculation of performance*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12665:2011 apply.

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:

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- luminance distribution,
- illuminance,
- glare,
- directionality of light,
- colour rendering and colour appearance of the light,
- 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 196:2011.

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

4.2 Luminance distribution

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

4.3 Illuminance**4.3.1 General**

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.

All illuminance average and uniformity values are dependent upon the grid definition (see 4.3.4).

4.3.2 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.

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. 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:

- 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.

4.3.3 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 visual field.

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.

The surrounding area should be a band with a width of at least 2 m around the task area within the visual field.

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

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

4.3.4 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:

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

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.

NOTE Formula (1) (coming from CIE x005:1992) has been derived under the assumption that p is proportional to $\log_{10} d$, where:

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

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

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

4.3.5 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

4.4.1 General

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

4.4.2 Glare rating

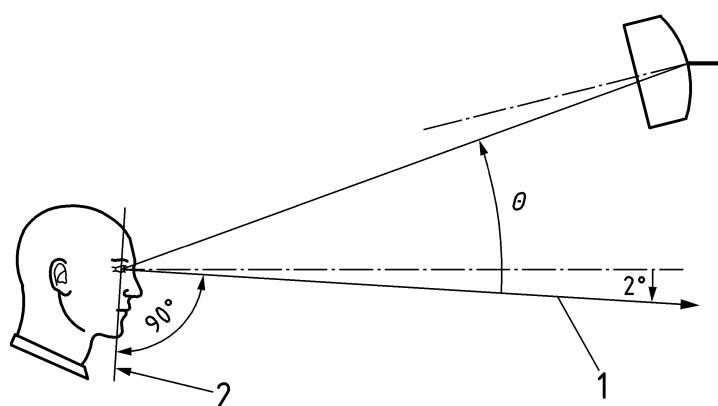
The glare directly from the luminaires of an outdoor lighting installation shall be determined using the CIE Glare Rating (R_G) method, based on the formula:

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

where

L_{vI} 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 ($L_{vI} = L_{v1} + L_{v2} + \dots + L_{vn}$). 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 Figure 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 $L_{ve} = 0,035 \cdot \rho \cdot E_{hav} \pi^{-1}$, in which ρ represents the average reflectance and E_{hav} the average horizontal illuminance of the area. If the value of reflectance is not known, ρ should be taken as 0,15.



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

R_G should be computed at grid positions as defined in 4.3.4, at 45° intervals radially about the grid points with 0° direction parallel to the long side of the task area.

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All assumptions made in the determination of R_G shall be stated in the scheme documentation. The R_G value of the lighting installation shall not exceed the R_{GL} -value given in Clause 5.

4.4.3 Veiling reflections and reflected glare

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:

- appropriate arrangement of luminaires and work places,
- surface finish (e. g. matt surfaces),
- luminance restriction of luminaires,
- increased luminous area of the luminaire.

4.5 Obtrusive light

To safeguard and enhance the night time environment it is necessary to control obtrusive light (also known as light pollution), which can present physiological and ecological problems to surroundings and people.

The limits of obtrusive light for exterior lighting installations, to minimise problems for people, flora and fauna, are given in Table 2 and for road users in Table 3.

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