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ISO 8995-3

CIE S 016/E

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Lighting of work places —

Part 3: Lighting requirements for safety and security of outdoor work places

Éclairage des lieux de travail —

Partie 3: Exigences requises de l'éclairage des lieux de travail extérieurs en matière de sûreté et de sécurité

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

ISO 26182 was prepared as Standard CIE S 016 by the International Commission on Illumination, which has been recognized by the ISO Council as an international standardizing body. It was adopted by ISO under a special procedure which requires approval by at least 75 % of the member bodes casting a vote, and is published as a joint ISO/CIE edition.

The International Commission on Illumination (abbreviated as CIE from its French title) is an organization devoted to international cooperation and exchange of information among its member countries on all matters relating to the science and art of lighting.

ISO 8995-3 was prepared by Division 5 of the CIE.

ISO 8995 consists of the following parts, under the general title *Lighting of work places*:

— *Part 1: Indoor*

— *Part 2: Outdoor*

— *Part 3: Lighting requirements for safety and security of outdoor work places*

COMMISSION INTERNATIONALE DE L'ECLAIRAGE
INTERNATIONAL COMMISSION ON ILLUMINATION
INTERNATIONALE BELEUCHTUNGSKOMMISSION

CIE S 016/E:2005

Standard

Lighting of Outdoor Work Places - Lighting Requirements for Safety and Security

Beleuchtung von Arbeitsplätzen im Freien — Anforderungen hinsichtlich Arbeitssicherheit und Anlagenschutz

Éclairage des lieux de travail extérieurs — Exigences requises de l'éclairage en matière de sûreté et de sécurité

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FOREWORD

Standards produced by the Commission Internationale de l'Eclairage (CIE) are a concise documentation of data defining aspects of light and lighting, for which international harmony requires such unique definition. CIE Standards are therefore a primary source of internationally accepted and agreed data, which can be taken, essentially unaltered, into universal standard systems.

This document CIE S 016/E:2005 has been prepared by CIE Division 5 and should be read in conjunction with CIE S 015/E:2005.

TABLE OF CONTENTS

LIGHTING OF OUTDOOR WORK PLACES - LIGHTING REQUIREMENTS FOR SAFETY AND SECURITY

INTRODUCTION

To enable people to perform 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.

1. SCOPE

This standard specifies the lighting requirements which will contribute to the visual needs for safety and security within outdoor work places.

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.

CIE S 015/E:2005. *Lighting of outdoor work places.*

CIE 112-1994. *Glare evaluation system for use within outdoor sports- and area lighting.*

3. TERMS AND DEFINITIONS

For the purposes of this standard, the terms and definitions given in IEC 60050-845/CIE 17.4[1] and the following apply.

3.1 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.

3.2 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[1]; 845-09-58 uniformity ratio of illuminance.

3.3 glare rating limit (GR_L) – see also Annex A

upper limit of glare by the CIE Glare Rating system

3.4 colour rendering index (R_a) – see also Annex A

a measure of the colour rendering capabilities of a lamp, which affect the colour appearance of objects and persons illuminated by that lamp

4. LIGHTING REQUIREMENTS FOR SAFETY AND SECURITY

NOTE: In the following Table 1:

- Column 2 gives the maintained illuminance $\bar{E}_m$ on the reference surface for the area, task or activity given in column 1.
- Column 3 gives the minimum illuminance uniformity U_o on the reference surface for the area, task or activity given in column 1.
- Column 4 gives the Glare Rating limits (GR_L) where these are applicable to the situations listed in column 1.
- Column 5 gives the minimum colour rendering indices (R_a) for the situation listed in column 1.

TABLE 1

Risk level	$\bar{E}_m$ **lx**	U_o **–**	GR_L **–**	R_a **–**	**Remarks**
Very low risks, i.e. ▪ Storage areas with occasional traffic in industrial yards; ▪ Coal fields in power plants; ▪ Timber storage, sawdust and wood chip fields in saw mills; ▪ Occasionally used service passages and stairs, waste water cleaning and aeration tanks, filter and sludge digestion tanks in water and sewage plants.	5	0,25	55	20	
Low risks, i.e. ▪ General lighting in harbours; ▪ Areas of risk free process and occasionally used platforms and stairs in petrochemical and other hazardous industries; ▪ Sawn timber storage areas in saw mills.	10	0,40	50	20	In harbours, U_o may be 0,25
Medium risks, i.e. ▪ Vehicle storage areas and container terminals with frequent traffic in harbours, industrial yards and storage areas; ▪ Vehicle storage areas and conveyors in petrochemical and other hazardous industries; ▪ Oil stores in power plants; ▪ General lighting and storage areas for prefabricated goods in shipyards and docks; ▪ Regularly used stairs, basins and filters of clean water plants in water and sewage plants.	20	0,40	50	20	In shipyards and docks, U_o may be 0,25

Risk level	$\bar{E}_m$ lx	U_o –	GR_L –	R_a –	Remarks
High risks, i.e. ▪ Element mould, timber and steel storage, building foundation hole and working areas on sides of the hole at building sites; ▪ Fire, explosion, poison and radiation risk areas in harbours, industrial yards and storage areas; ▪ Oil stores, cooling towers, boilers compressors, pumping plants, valves, manifolds, operating platforms, regularly used stairs, crossing points of conveyors, electric switch-yards in petrochemical and other hazardous industries; ▪ Switch yards in power plants; ▪ Crossing points of conveyors, fire risk areas in saw mills.	50	0,40	45	20	At building sites and in saw mills, GR_L may be 50

NOTE Lighting control may be required to achieve adequate flexibility for the variety of tasks performed.

5. VERIFICATION PROCEDURES

Verification of the lighting installation shall be by measurement, calculation or inspection of data.

5.1 Illuminance

Verification of illuminances and uniformities that relate to specific tasks shall be measured in the plane of the task and the measurement points chosen shall coincide with the design points or grid used.

NOTE When verifying illuminance, account should be taken of the calibration of the light meters used, the conformity of the lamps and luminaires to the published photometric data, and of the design assumptions made about surface reflectances, etc., compared with the real values.

The average illuminance and uniformity shall be not less than the values given in Table 1.

5.2 Glare rating

Verification shall be by inspection of the design data and parameters provided for the scheme. All assumptions shall be declared.

5.3 Colour rendering index

Authenticated R_a data shall be provided for the lamps in the scheme by the manufacturer of the lamps. The lamps shall conform to the requirements.

ANNEX A (NORMATIVE): LIGHTING DESIGN CRITERIA

A.1 Glare rating

The glare directly from the luminaires of an outdoor lighting installation shall be determined using the CIE Glare Rating (*GR*) method according to CIE 112-1994, based on the formula:

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

where:

L_{vl} is the total veiling luminance in cd·m^{-2} caused by the lighting installation and is the sum of the veiling luminances produced by each individual luminaire ($L_{vl} = L_{v1} + L_{v2} + \ldots . L_{vn}$). 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 cd·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.

NOTE *GR* should be computed at grid positions, 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.

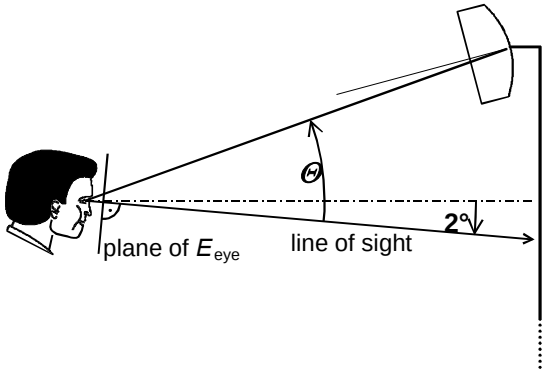

Figure 1. The angle between the observer's line of sight and the direction of the light incident from the individual luminaire.

A.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.

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.

Safety colours shall always be recognisable as such and therefore light sources shall have colour rendering indices ≥20 (see also ISO 3864[2]).

BIBLIOGRAPHY

[1] IEC 60050-845/CIE 17.4-1987. *International Electrotechnical Vocabulary - Chapter 845: "Lighting".*

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

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