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TECHNICAL REPORT

GUIDE FOR LIGHTING EXTERIOR WORK AREAS

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Foreword

The following members of TC 5-13 Lighting of Exterior Work Areas of CIE Division 5 took part in the preparation of this technical report:

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Table of Contents

FOREWORD	III
CONTENTS	IV
SUMMARY	V
RESUME	V
ZUSAMMENFASSUNG	V
1. Introduction	1
2. Basic requirements	1
2.1 Illuminance and luminance	1
2.2 Uniformity of illuminance	1
2.3 Glare limitation	1
2.4 Colour quality	4
2.5 Maintenance	4
2.6 Environmental aspects	5
2.7 Design	6
2.8 Measurement	6
3. General values for exterior work areas	7
4 Application tables	9
4.1 Building sites	9
4.2 Canals and locks	9
4.3 Filling and service stations	9
4.4 Harbours	10
4.5 Industrial yards and storage areas	10
4.6 Parking lots	11
4.7 Petrochemical industries and other hazardous industries	11
4.8 Power, electricity, gas, and heat plants	12
4.9 Railway areas	12
4.10 Saw mills	14
4.11 Shipyards and docks	14
4.12 Water and sewage plants	15
5. Bibliography	16

Guide for lighting exterior work areas

Summary

The present document updates and replaces Publication CIE 68-1986 "Guide to the lighting of exterior working areas".

The values published are based on illuminance concept. Further to the average maintained illuminance and minimum to average ratio, the minimum to maximum ratio was introduced. Glare is limited by Glare Rating (GR). The values are "maintained" and determined to achieve efficient working conditions, safe movement and traffic and safety/security of people and property. Work areas are divided into twelve sections and listed in the Application Tables.

Attention is focused on design values. Other topics, as colour quality, maintenance, environmental aspects, design and measurement are only mentioned in this paper, detailed recommendations or standards are to be sought for in relevant CIE and ISO publications.

Guide pour d'éclairage des lieux de travail à l'extérieur

Résumé

Le présent document est une mise à jour de la publication CIE 68-1986 „Guide de l'éclairage des lieux de travail à l'extérieur", et la remplace.

Les valeurs indiquées sont basées sur le concept de l'éclairage. En plus de l'éclairage moyen à maintenir et du rapport entre les éclairages minimum et moyen, le rapport entre les éclairages minimum et maximum a été introduit. La notion d'éblouissement est définie par l'indice d'éblouissement d'incapacité (GR).

Les valeurs sont des valeurs „à maintenir" et fixées pour permettre l'accomplissement efficace du travail, la sécurité des déplacements et de la circulation, ainsi que la sécurité des personnes et des biens.

Les lieux de travail sont répartis en douze sections et indiquées dans le tableau d'application.

L'attention est attirée sur les valeurs à prendre lors de l'établissement du projet. D'autres sujets, comme la qualité des couleurs, la maintenance, les aspects environnementaux, l'étude et les mesures sont seulement mentionnées dans ce texte, les normes et recommandations détaillées sont à rechercher dans les publications CIE et ISO appropriées.

Leitfaden zur Beleuchtung von Arbeitsplätzen im Freien

Zusammenfassung

Das vorliegende Dokument ist eine Neuauflage und ersetzt die Publikation CIE 68-1986 "Leitfaden zur Beleuchtung von Arbeitsplätzen im Freien".

Die veröffentlichten Werte basieren auf dem Begriff *Beleuchtungsstärke*. Zusätzlich zur durchschnittlich aufrechterhaltenen Beleuchtungsstärke (Wartungswert) und zum Minimum-Durchschnitt-Verhältnis wurde das Minimum-Maximum-Verhältnis eingeführt. Blendung wird laut der Blendungsbemessungsformel (GR) begrenzt.

Die Werte sind als Wartungswerte zu verstehen, und wurden festgelegt, um effiziente Arbeitsbedingungen, sichere Fortbewegung und Verkehrssicherheit sowie Sicherheit von Personen und Eigentum zu erreichen. Die Arbeitsplätze werden in 12 Bereiche eingeteilt und in den Anwendungstabellen aufgelistet.

Besondere Aufmerksamkeit wird den Planungswerten gewidmet. Andere Themen, wie Farbqualität, Instandhaltung, Umweltaspekte, Planung und Messung, werden in dieser Arbeit nur erwähnt, für detaillierte Empfehlungen oder Normen sind die relevanten CIE und ISO-Publikationen zu konsultieren.

1. Introduction

The aim of this document is to provide guidance for the design of lighting for exterior work areas. It gives criteria for appropriate lighting values only. The designer must take into account all the other requirements of the authorities concerned.

The objectives of lighting for exterior work areas are to ensure:

- efficient working conditions,
- safe movement and traffic,
- safety and security of people and property.

2. Basic requirements

2.1 Illuminance and luminance

Visual performance improves with an increase in the size of details examined, the luminance contrast between details and the adaptation level (i.e. the average background luminance). Characteristics of the object examined can rarely be changed, but are worth considering, whenever possible. For example, larger signs, light colours against dark background or vice versa.

The visual environment is generally too complex to allow a calculation of luminance. As luminance is defined as an effect of illuminance on a surface with certain reflection properties, illuminance is generally used as design criterion. Illuminance values in this guide are generally considered as horizontal values at the height of the work task. If it is not known, use 1 m above ground level. For traffic areas all the values are specified at ground level. As visual tasks often refer to planes other than horizontal, the typical elevation angle of the object examined should be used.

2.2 Uniformity of illuminance

Since it takes time to adapt to low luminance levels, large luminance differences in the visual field reduce visibility, particularly by alternating bright and dark visual objects. Uniformity ratio is generally defined as the ratio of minimum to average illuminance values ($E_{\min}/E_{av}$). It is necessary to limit the ratio of maximum to minimum values ($E_{\max}/E_{\min}$) as well, as contrast perception becomes difficult with large luminance ratios generated by excessive illuminance difference in the visual field. Recommended values for uniformity ratios of illuminance are given in Tables 3.1. and 4.

However, some industrial areas can conveniently be divided into work and non-work areas (e.g. storage), so it is possible to light the work and non-work areas to different illuminance levels, but both to the same uniformity and glare limit standards. It is recommended that the ratio of the average illuminance of the work area to that of the adjacent non-work area should not be greater than 3:1.

A mast with its associated wiring and foundation is relatively expensive if compared with the cost of a luminaire. It is, therefore, logical to cluster two or more luminaires on a single mast. The idea is to space luminaires as far apart as possible whilst maintaining acceptable uniformity ratios and not exceeding the glare limit.

2.3 Glare limitation

Limitation of glare on exterior working areas is carried out by the method given in the Technical Report CIE 112 - 1994. It limits glare produced by luminaires to an acceptable level, thus preventing the glare in the installation from hampering safety and security, movement and traffic, and task performance. The glare situation is at its worst, when an installation is new. Therefore all the values concerning glare rating must be calculated from initial (not-maintained) values.

Veiling luminance caused by one light source for a given observer position, and a given viewing direction (2° below horizontal plane at eye level) is calculated with the formula:

$$L_v = 10 (E_{\text{eye}} / \theta^2)$$

where

L_v is the equivalent veiling luminance produced by the light source (cd/m^2).

E_{eye} is the illuminance at the observer's eye, on a plane perpendicular to the line of sight to the light source (lx).

θ is the angle between the observer's line of sight and direction of the light incident from the light source to the eye in degrees, $1,5^\circ < \theta < 60^\circ$ (Figure 1).

Eye level is the level referring to the position of the observer's eye. For example, this for a standing person on exterior work areas is 1,5 metres.

The total veiling luminance produced by the installation is the sum of the veiling luminances produced by the individual luminaires;

$$L_{v1} = L_{v1} + L_{v2} + \dots + L_{vn}$$

L_{v1} is the equivalent veiling luminance (cd/m^2) caused by the luminaires of the installation.

When the illuminated area is the background observed producing L_{ve}

L_{ve} is the equivalent veiling luminance (cd/m^2) produced by the environment (the illuminated area).

GR is the Glare Rating describing the degree of glare

$$GR = 27 + 24 \cdot \log (L_v / L_{ve}^{0,9})$$

With the earth reflectance assumed as totally diffuse, the equivalent veiling luminance

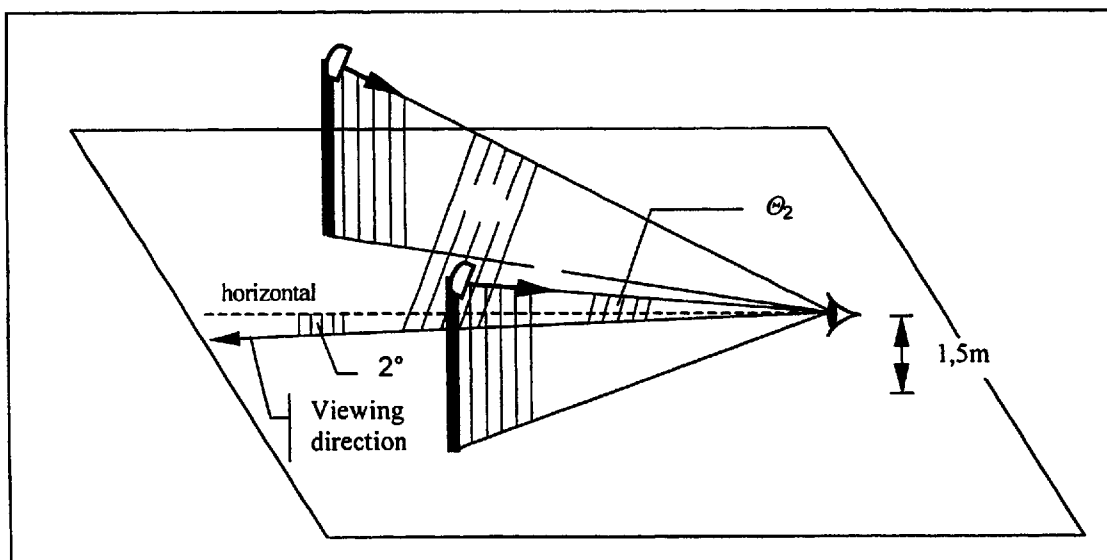


Figure 1. θ is the angle between the observer's line of sight and direction of the light incident from the light source to the eye.