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TECHNICAL REPORT

GLARE AND UNIFORMITY IN ROAD LIGHTING INSTALLATIONS

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C.I.E. TECHNICAL COMMITTEE REPORTNOTE PRELIMINAIRE

Ce rapport a été préparé par le Comité Technique CIE 4.6 "Eclairage des voies publiques". Il a reçu l'approbation unanime du Comité, et il est recommandé pour étude et application.

Ce rapport n'est pas une Recommandation officielle de la CIE approuvée par les Comité Nationaux des Pays Membres. Il doit être noté que toute recommandation y figurant est donnée à titre de conseil et non d'obligation.

PRELIMINARY REMARK

This report has been prepared by CIE Technical Committee 4.6 "Road Lighting". It has been approved unanimously by the Committee and is recommended for study and application. This report is not an Officially Agreed CIE Recommendation approved by the National Committees of the Member Countries. It should be noted that any recommendations in this report are advisory and not mandatory.

VORBEMERKUNG

Dieser Bericht wurde vom Technischen CIE-Komitee 4.6 "Strassenbeleuchtung" ausgearbeitet. Er wurde uneingeschränkt vom Komitee angenommen und wird zum zukünftigen Studium empfohlen. Er ist keine Offiziell Anerkannte CIE-Empfehlung, die von den Nationalen Komitees der Mitgliedsländer anerkannt wurde. Es muss darauf hingewiesen werden, dass alle Empfehlungen dieses Berichts nur als Anleitung dienen und nicht verbindlich sind.

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SUMMARY

Glare in road lighting is distinguished in discomfort and disability glare. Discomfort glare is quantitatively described by a Glare Control Mark which can be calculated from the photometric and geometric quantities of a lighting installation. The evaluation of disability glare is based upon the Holladay formula and expressed by calculating the increment in the threshold of detection of the luminance difference between a relevant object and the road surface.

The uniformity of the road surface luminance is characterized by the overall uniformity and the longitudinal uniformity.

RESUME

Le présent rapport fournit les informations sur les méthodes pour calculer l'éblouissement et l'uniformité de luminance en éclairage public.

Le premier chapitre est consacré à l'éblouissement. Il définit les deux types d'éblouissement (inconfort et incapacité) et donne des abaques pour mesurer ou évaluer ces deux types d'éblouissement à partir des caractéristiques lumineuses des luminaires et des caractéristiques géométriques de l'implantation.

Le second chapitre traite de l'uniformité de luminance et fait la synthèse des travaux connus à ce jour. Limité pour l'instant aux cas des chaussées sèches, ce rapport justifie et conseille de l'emploi de l'uniformité générale et de l'uniformité longitudinale.

Si ce rapport donne les méthodes pour calculer différents critères, il ne précise pas les valeurs limites qui doivent être utilisées comme critère de qualité. Pour cela, il faut se référer au document CIE No. 12/2 (C.T. 4.6, 1975).

ZUSAMMENFASSUNG

Bei der Blendung durch Straßenbeleuchtungsanlagen wird zwischen psychologischer und physiologischer Blendempfindung unterschieden.

Die Blendbegrenzungszahl für psychologische Blendung wird aus den photometrischen und geometrischen Daten der Anlage bestimmt.

Die Blendbegrenzungszahl für physiologische Blendung beruht auf der Holladay-Formel und ergibt sich rechnerisch aus der Schwellenwerterhöhung für die Wahrnehmung des Leuchtdichteunterschiedes zwischen einem relevanten Sehobjekt und der Fahrbahn.

Die örtliche Gleichmäßigkeit der Fahrbahnleuchtdichte wird durch die Gesamtgleichmäßigkeit und die Längsgleichmäßigkeit gekennzeichnet.

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1. INTRODUCTION

The present report provides background information on glare and non-uniformity in road lighting installations and presents the methods for calculation to be applied for determining the degree of glare and non-uniformity in compliance with Document CIE 12/2 (TC-4.6), 1975. The present Report does not contain recommendations as to the restriction of glare and non-uniformity in an absolute sense. In this respect reference should be made to Document CIE 12/2 (TC-4.6), 1975.

2. METHODS FOR QUANTIFYING GLARE IN ROAD LIGHTING INSTALLATIONS

2.1. Introduction

It is generally accepted that both discomfort glare and disability glare should be restricted in fixed road lighting installations. Since a functional connection between the two kinds of glare is not at present known the two types of glare are most conveniently treated separately. The fundamentals as well as a survey of the essential research work carried out so far have been provided by Adrian (1974). In this report methods are given for their quantification. It should be noted that these methods are restricted to quantification only, and that they do not give an assessment of the levels of glare that may be tolerated in road lighting installations.

CIE Document No12/2 (TC-4.6), 1975 contains recommendations as to the acceptable degree of glare in road lighting installations, when determined in accordance with the methods given in this Technical Report.

2.2. Discomfort glare

The method for the quantification of discomfort glare is primarily based on the experimental work carried out by De Boer and Heemskerck Veeckens 1955, De Boer and Schreuder 1967, Adrian and Eberbach 1965, Adrian and Eberbach 1967, Adrian and Schreuder 1970 and 1971 and Adrian 1975.

Therein the discomfort from glare is described by a Glare Control Mark which expresses on an ordinal scale the subjective appraisal of the degree of discomfort experienced. Wordings have been used to describe the degree of glare corresponding to the values of this ordinal scale. The value of G associated to different sensations was as follows :

- G = 1 "unbearable glare"
- G = 3 "disturbing glare"
- G = 5 "just admissible glare"
- G = 7 "satisfactory glare"
- G = 9 "unnoticeable glare".

The wordings do not purport to indicate an absolute level of glare to be recommended. They have nevertheless been listed here as they have been used in the experiments. It should furthermore be noted that values $G < 1$ and $G > 9$ have no practical meaning.

The subjective appraisal of the glare, and thus the associated value of the Glare Control Mark is found to be dependent upon the following photometric and geometric quantities of the lighting installations :

I_{80} , I_{88} - the luminous intensities of the lanterns emitted in directions making an angle of 80° and 88° respectively to the downward vertical (I_{80} and I_{88} in cd). I_{80} is the value of the luminous intensity emitted under an angle of 80° with the downward vertical in the meridian plane parallel with the road axis (the C_0 -plane according to CIE publication No 27 (TC-2.4), 1973. I_{88} has to be determined in the same meridian plane.

In cases of strong toe-in of the light distribution, the Glare Control Mark determined on the basis of these luminous intensities might be higher than the value corresponding to the actual degree of glare.

In curves or in cases of very complicated geometries or of more than two rows of lanterns the luminous intensities have to be determined in meridian planes through the road user's eyes. For the exact calculation of G in these cases reference should be made to Adrian and Enzmann 1971. As to the limits of applicability of the luminous intensity values in the meridian plane parallel with the road axis in calculating the glare control mark for non-straight road sections and/or complicated lantern arrangements reference should be made to the Technical Report, Publication CIE No 30, (TC-4.6), 1976 entitled "Calculation and Measurement of Luminance and Illuminance in Road Lighting ; Computer Program for Luminance, Illuminance and Glare".

- h' - the reduced mounting height expressed in m.
of the lantern above the level of the observer's eye ;
 $h' = h - 1,5$ when h equals the mounting height of the lantern in m.
- F - the flashed area (in m^2) of the lantern projected in the direction of 76° with the downward vertical in the road axis parallel meridian plane.