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CIE

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

TECHNICAL REPORT

CIE GUIDE TO INCREASING ACCESSIBILITY IN LIGHT AND LIGHTING

Vision Data and Design Considerations for Better Visibility and Lighting for Older People and People with Disabilities

CIE 196:2011

UDC: 612.843.35
612.843.355
612.843.632
612.845.5

Descriptor: Colour contrast. Luminance contrast
Contrast. sensitivity
Visual acuity
Defects of colour vision

THE INTERNATIONAL COMMISSION ON ILLUMINATION

The International Commission on Illumination (CIE) is an organisation devoted to international co-operation and exchange of information among its member countries on all matters relating to the art and science of lighting. Its membership consists of the National Committees in about 40 countries.

The objectives of the CIE are:

1. To provide an international forum for the discussion of all matters relating to the science, technology and art in the fields of light and lighting and for the interchange of information in these fields between countries.
2. To develop basic standards and procedures of metrology in the fields of light and lighting.
3. To provide guidance in the application of principles and procedures in the development of international and national standards in the fields of light and lighting.
4. To prepare and publish standards, reports and other publications concerned with all matters relating to the science, technology and art in the fields of light and lighting.
5. To maintain liaison and technical interaction with other international organisations concerned with matters related to the science, technology, standardisation and art in the fields of light and lighting.

The work of the CIE is carried on by seven Divisions each with about 20 Technical Committees. This work covers subjects ranging from fundamental matters to all types of lighting applications. The standards and technical reports developed by these international Divisions of the CIE are accepted throughout the world.

A plenary session is held every four years at which the work of the Divisions and Technical Committees is reviewed, reported and plans are made for the future. The CIE is recognised as the authority on all aspects of light and lighting. As such it occupies an important position among international organisations.

LA COMMISSION INTERNATIONALE DE L'ECLAIRAGE

La Commission Internationale de l'Eclairage (CIE) est une organisation qui se donne pour but la coopération internationale et l'échange d'informations entre les Pays membres sur toutes les questions relatives à l'art et à la science de l'éclairage. Elle est composée de Comités Nationaux représentant environ 40 pays.

Les objectifs de la CIE sont :

1. De constituer un centre d'étude international pour toute matière relevant de la science, de la technologie et de l'art de la lumière et de l'éclairage et pour l'échange entre pays d'informations dans ces domaines.
2. D'élaborer des normes et des méthodes de base pour la métrologie dans les domaines de la lumière et de l'éclairage.
3. De donner des directives pour l'application des principes et des méthodes d'élaboration de normes internationales et nationales dans les domaines de la lumière et de l'éclairage.
4. De préparer et publier des normes, rapports et autres textes, concernant toutes matières relatives à la science, la technologie et l'art dans les domaines de la lumière et de l'éclairage.
5. De maintenir une liaison et une collaboration technique avec les autres organisations internationales concernées par des sujets relatifs à la science, la technologie, la normalisation et l'art dans les domaines de la lumière et de l'éclairage.

Les travaux de la CIE sont effectués par 7 Divisions, ayant chacune environ 20 Comités Techniques. Les sujets d'études s'étendent des questions fondamentales, à tous les types d'applications de l'éclairage. Les normes et les rapports techniques élaborés par ces Divisions Internationales de la CIE sont reconnus dans le monde entier.

Tous les quatre ans, une Session plénière passe en revue le travail des Divisions et des Comités Techniques, en fait rapport et établit les projets de travaux pour l'avenir. La CIE est reconnue comme la plus haute autorité en ce qui concerne tous les aspects de la lumière et de l'éclairage. Elle occupe comme telle une position importante parmi les organisations internationales.

DIE INTERNATIONALE BELEUCHTUNGSKOMMISSION

Die Internationale Beleuchtungskommission (CIE) ist eine Organisation, die sich der internationalen Zusammenarbeit und dem Austausch von Informationen zwischen ihren Mitgliedsländern bezüglich der Kunst und Wissenschaft der Lichttechnik widmet. Die Mitgliedschaft besteht aus den Nationalen Komitees in rund 40 Ländern.

Die Ziele der CIE sind :

1. Ein internationaler Mittelpunkt für Diskussionen aller Fragen auf dem Gebiet der Wissenschaft, Technik und Kunst der Lichttechnik und für den Informationsaustausch auf diesen Gebieten zwischen den einzelnen Ländern zu sein.
2. Grundnormen und Verfahren der Messtechnik auf dem Gebiet der Lichttechnik zu entwickeln.
3. Richtlinien für die Anwendung von Prinzipien und Vorgängen in der Entwicklung internationaler und nationaler Normen auf dem Gebiet der Lichttechnik zu erstellen.
4. Normen, Berichte und andere Publikationen zu erstellen und zu veröffentlichen, die alle Fragen auf dem Gebiet der Wissenschaft, Technik und Kunst der Lichttechnik betreffen.
5. Liaison und technische Zusammenarbeit mit anderen internationalen Organisationen zu unterhalten, die mit Fragen der Wissenschaft, Technik, Normung und Kunst auf dem Gebiet der Lichttechnik zu tun haben.

Die Arbeit der CIE wird in 7 Divisionen, jede mit etwa 20 Technischen Komitees, geleistet. Diese Arbeit betrifft Gebiete mit grundlegendem Inhalt bis zu allen Arten der Lichtanwendung. Die Normen und Technischen Berichte, die von diesen international zusammengesetzten Divisionen ausgearbeitet werden, sind auf der ganzen Welt anerkannt.

Alle vier Jahre findet eine Session statt, in der die Arbeiten der Divisionen überprüft, berichtet und neue Pläne für die Zukunft ausgearbeitet werden. Die CIE wird als höchste Autorität für alle Aspekte des Lichtes und der Beleuchtung angesehen. Auf diese Weise unterhält sie eine bedeutende Stellung unter den internationalen Organisationen.

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This Technical Report has been prepared by a Working Group (Ad-hoc) in the CIE Board of Administration in cooperation with TC 1-54 “Age-related change of visual response” and TC 3-44 “Lighting for the elderly” and has been approved by the Board of Administration of the Commission Internationale de l'Eclairage for study and application. The document reports on current knowledge and experience within the specific field of light and lighting described, and is intended to be used by the CIE membership and other interested parties. It should be noted, however, that the status of this document is advisory and not mandatory.

Ce rapport technique a été élaboré par un groupe de travail (Ad-hoc) du Conseil d'Administration de la CIE en coopération avec TC 1-54 “Age-related change of visual response” et TC 3-44 “Lighting for the elderly” et a été approuvé par le Conseil d'Administration de la Commission Internationale de l'Eclairage, pour étude et emploi. Le document expose les connaissances et l'expérience actuelles dans le domaine particulier de la lumière et de l'éclairage décrit ici. Il est destiné à être utilisé par les membres de la CIE et par tous les intéressés. Il faut cependant noter que ce document est indicatif et non obligatoire.

Dieser Technische Bericht ist durch eine Ad-hoc-Arbeitsgruppe des CIE-Vorstands in Zusammenarbeit mit TC 1-54 “Age-related change of visual response” und TC 3-44 “Lighting for the elderly” ausgearbeitet und vom Vorstand der Commission Internationale de l'Eclairage gebilligt worden. Das Dokument berichtet über den derzeitigen Stand des Wissens und Erfahrung in dem behandelten Gebiet von Licht und Beleuchtung und ist zur Verwendung durch CIE-Mitglieder und durch andere Interessierte bestimmt. Es sollte jedoch beachtet werden, dass das Dokument eine Empfehlung und keine Vorschrift ist.

Any mention of organisations or products does not imply endorsement by the CIE. Whilst every care has been taken in the compilation of any lists up to the time of going to press, these may not be comprehensive.

Toute mention d'organisme ou de produit n'implique pas une préférence de la CIE. Malgré le soin apporté à la compilation de tous les documents jusqu'à la mise sous presse, ce travail ne saurait être exhaustif.

Die Erwähnung von Organisationen oder Erzeugnissen bedeutet keine Billigung durch die CIE. Obgleich große Sorgfalt bei der Erstellung von Verzeichnissen bis zum Zeitpunkt der Drucklegung angewendet wurde, besteht die Möglichkeit, dass diese nicht vollständig sind.

The following members of the Working Group took part in the preparation of this Technical Report.

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CIE GUIDE TO INCREASING ACCESSIBILITY IN LIGHT AND LIGHTING

Summary

This guide was written primarily for writers of CIE Standards and Technical Reports to assist them in taking account of the needs of older persons and persons with disabilities. The guide was developed in accordance with ISO/IEC Guide 71:2001 “Guidelines for standard developers to address the needs of older persons and persons with disabilities” and its technical guidelines ISO/TR 22411:2008 “Ergonomics data and guidelines for the application of ISO/IEC Guide 71 to products and services to address the needs of older persons and persons with disabilities” in order to implement accessible design in the field of light and lighting. Some content has been shared with those two documents. Although this guide is intended for use by standard writers in CIE, it is also available for lighting designers and engineers, as well as scientists of light, colour, and vision. The guide was prepared by a Working Group (Ad-hoc) in the CIE Board of Administration in cooperation with TC 1-54 “Age related change of visual response” and TC 3-44 “Lighting for the elderly”.

GUIDE CIE POUR L'AMELIORATION DES LUMIERES ET DE L'ECLAIRAGE

Résumé

Ce guide a été principalement rédigé à l'intention des rédacteurs de normes CIE et de Rapports Techniques, dans le but de prendre en compte les besoins des personnes âgées et des personnes handicapées. Ce guide a été mis au point en respectant le Guide 71:2001 ISO/IEC “Principes directeurs pour les normalisateurs afin de répondre aux besoins des personnes âgées et de celles ayant des incapacités" et ses directives techniques ISO/TR 22411:2008 “Données d'ergonomie et lignes directrices pour l'application du Guide ISO/CEI 71 aux produits et services afin de répondre aux besoins des personnes âgées et de celles ayant des incapacités” de manière à favoriser une conception satisfaisante des lumières et des éclairages. Certaines parties sont communes avec celles de ces deux documents. Bien que ce guide soit destiné aux rédacteurs de normes de la CIE, il est également destiné aux concepteurs en éclairage, aux ingénieurs, aussi bien qu'aux scientifiques du domaine de la lumière, de la couleur et de la vision. Ce guide a été préparé par un groupe de travail (ad-hoc) du Conseil d'Administration de la CIE en coopération avec le TC 1-54 “Modification des réponses visuelles avec l'âge” et le TC 3-44 “Eclairage pour les personnes âgées".

CIE LEITFADEN ZUR VERBESSERUNG DER ZUGÄNGLICHKEIT DURCH LICHT UND BELEUCHTUNG

Zusammenfassung

Dieser Leitfaden wurde in erster Linie für Autoren von CIE Standards und Technischen Berichten geschrieben, um die Bedürfnisse älterer Menschen und von Menschen mit Behinderungen zu berücksichtigen. Der Leitfaden wurde in Übereinstimmung mit ISO/IEC Guide 71:2001 “Guidelines for standard developers to address the needs of older persons and persons with disabilities” und seinen technischen Richtlinien ISO/TR 22411:2008 “Ergonomics data and guidelines for the application of ISO/IEC Guide 71 to products and services to address the needs of older persons and persons with disabilities” geschrieben, um eine behindertengerechte Planung im Bereich von Licht und Beleuchtung einzuführen. Einige Teile des Inhalts wurden mit diesen Dokumenten abgeglichen. Obwohl dieser Leitfaden für die Nutzung durch Autoren von Standards innerhalb der CIE vorgesehen ist, steht er ebenso Lichtplanern, Ingenieuren und Wissenschaftlern im Bereich Licht, Farbe und Sehen zur Verfügung. Der Leitfaden wurde von einer Adhoc-Arbeitsgruppe innerhalb des CIE-Vorstands in Zusammenarbeit mit TC 1-54 “Age-related change of visual response” und TC 3-44 “Lighting for the elderly” erstellt.

Introduction

With the global increase in the proportion of older people in the population, and awareness of the rights of persons with disabilities, care for older persons and persons with disabilities is becoming a worldwide concern in governmental, social, and industrial affairs. This global movement reflects on international standards organizations, such as ISO, IEC, ITU, and CIE, in their development of international standards. The design concept that is inclusive of older persons and persons with disabilities as users of products, services, or environments is called Accessible Design, Accessibility or Inclusive Design.

This document provides guidelines for implementing accessible design into the light and lighting field, furthering the concepts addressed in ISO/IEC Guide 71 [1] for Standards design. As pointed out in the Guide 71, there are many factors to be considered in providing better lighting and visible signs that meet the needs of older persons and persons with disabilities. CIE has developed considerable expertise in light and lighting since its establishment in the early 20th century and is ideally placed to deliver the technical information on normal visual abilities of older persons and persons with disabilities that are indispensable in assessing (visual) accessibility. This CIE Guide therefore provides extensive data on visual abilities and design considerations that are useful for writers of CIE standards and technical reports as well as lighting designers who wish to take into account the needs of older persons and persons with disabilities.

The data presented here have been selected from the literature using the criterion that statistical features and variabilities, individual or conditional, were available and based on a large number of samples. Methods of applying this data to lighting design have been presented where possible as formulae or tables to inform good practice.

This Guide is based on a number of technical documents relevant to accessible design in light and lighting. CIE Publication 123 “Low vision – Lighting needs for the partially-sighted” [2] is an excellent report with useful information concerning physiology and lighting needs for low vision. The ISO Technical Report ISO/TR 22411 [3] also contains relevant information for implementing accessible design into the lighting field. Some parts of those documents are directly cited in this Guide. Inevitably, due to the wide range of issues involved in accessible design, information is still missing, particularly on persons with disabilities. The information contained in this document is not exhaustive, and the collection of data and design considerations is ongoing.

1 Scope

This CIE Guide provides fundamental knowledge and data on vision of older people and people with disabilities, as well as design considerations based on that data, in order to facilitate consideration of the needs of older people and people with disabilities.

While there is no clear definition for “older people”, this Guide presents data that include samples taken mainly from people over 60 years old. In addition, the visual disabilities addressed are low vision and colour vision defects. Care for totally blind people is not considered as light and lighting issues have no relevance for them, although non-visual issues such as tactile or auditory information for increasing accessibility are vitally important.

2 Terms and Definitions

For terms and definitions concerning vision and lighting used in this document the International Lighting Vocabulary [4] applies.

For terms and definitions concerning accessible design ISO/IEC Guide 71 [1] and ISO/TR 22411 [3] apply.

3 General Remarks on Vision of Older People and People with Disabilities

The pathway of the human visual system extends from the retina of the eye to the central brain, and is finely structured and coordinated to detect light and to recognize the information conveyed by the light. As with other sensory organs the abilities of the visual system change with age both physiologically and behaviourally, which makes the visual environment perceived by older people different from that perceived by younger people.

In addition to the ageing effects, various types of impairments, inherent or acquired, may occur in the visual pathway, which also makes the perceived visual world different from that of people with no impairment. A variety of forms of difficulty in visual perception are caused by different types of impairments, and depend on the site in the visual pathway where the impairment occurs.

The differences in perceived visual environment between younger people with normal vision on the one hand, and older people or people with visual disabilities on the other hand, should be taken into account in designing lighting and the visual environment. In the following sections the change of the visual system as a function of age and of impairments is described.

3.1 Age-related Change of the Visual System

At the very early stage of visual information processing, the light transmittance of the ocular media of the eye change with age, which is due to the absorption and scattering of light caused by opacification of crystalline lens of the eye [5]. This reduces the total amount of light reaching the retina, and consequently lowers visibility for older people.

The absorption and scattering in the ocular media also depend on the spectrum of the light [6]. The absorption and scattering of light in the shorter wavelength band (coloured violet to bluish) has much more effect than that in the longer wavelength band (reddish), which means that a violet or bluish light has lower efficiency or visibility for older people. This also causes a shift of appearance of colour to the more yellowish region. It has been reported, however, that the macular pigment, which covers the central part of the retina, has no change in its density with ageing [7].