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CIE AND MESOPIC PHOTOMETRY

The CIE is the leading international organization in the lighting field and is recognized by ISO as an international standardization body. To be internationally accepted and used, a photometric system has to be adopted and recommended by the CIE.

The CIE TC 1-58 'Visual Performance in the Mesopic Range' has now concluded its work, and the outcome is a recommended system for mesopic photometry based on visual performance. This will soon be published as a CIE Technical Report. The Technical Report will form the basis of a future joint ISO/CIE Standard which is being prepared at the moment.

The development of an effective system for mesopic photometry has been a topic of concern in the international lighting community for several decades. It is found encouraging within the CIE that, after more than 70 years of research the time has now come to publish a practical system of mesopic photometry, as this will be a major breakthrough for the CIE, too.

All lighting technology and practice is based on photometry, the measurement of visible radiation. Photometry provides a method to assess light in terms of human visual spectral sensitivity. Until now, the basis of all photometry has been the CIE photopic spectral luminous efficiency function, $V(\lambda)$, established in 1924. The CIE scotopic spectral luminous efficiency function, $V'(\lambda)$, was established in 1951, but it has not been used in practical photometry.

The mesopic luminance region covers a range of luminances between the scotopic and photopic regions. Mesopic lighting applications include road and street lighting, outdoor area lighting and other night-time traffic environments. So far, there has been no internationally accepted system of mesopic photometry. This means that suitable methods to evaluate the visual effectiveness of lighting products and installations in the mesopic region have not been available.

The task of the TC 1-58 was to adopt a visual performance based approach, which means that the underlying spectral sensitivity functions are based on criteria of visual task performance, i.e. on recognition, detection, reaction time tasks, not on brightness matching.

In the mesopic region the spectral sensitivity of the human visual system is not constant, but changes with light level. This is due to the changing contribution of the rods and cones on the retina. Thus, we need not only one mesopic spectral sensitivity function, but instead several functions, together with a defined procedure for using these functions in a photometric measurement system. The new mesopic system describes spectral luminous efficiency, $V_{mes}(\lambda)$, in the mesopic region as a linear combination of the photopic spectral luminous efficiency function, $V(\lambda)$, and the scotopic spectral luminous efficiency function, $V'(\lambda)$.

For applying the mesopic photometry, the S/P-ratio of the light source, derived from its spectral data, is needed as input value. This is the ratio of the luminous output evaluated according to the scotopic $V'(\lambda)$, to the luminous output evaluated according to the photopic $V(\lambda)$. The higher the S/P-ratio the higher the luminous efficacy of the light source in terms of the mesopic design.

IN THIS ISSUE

The use of mesopic dimensioning changes the luminous output and consequently the luminous efficacy orders of lamps. Many of the 'white light' sources currently used for applications such as road lighting have S/P-ratios between about 0,65 (high pressure sodium, for example) and 2,50 (certain metal halide lamps, for example). The S/P-ratios of warm white LEDs are around 1,15 and those of cool white LEDs around 2,15. The use of the new mesopic system to calculate the effective luminance of these white light sources results in significant changes in their apparent efficacy. For example, at a photopic luminance of 1 cd/m^2 the use of the recommended system results in a change between -5 % and +15 % for lamps with S/P-ratios between 0,5 and 2,5; at 0,3 cd/m^2 the change is between about –10 % and +30 %.

Due to their fast development, LEDs are increasingly penetrating the lighting markets. LEDs offer new solutions to various mesopic applications, too, not least because of the possibilities of producing light sources with varying spectral properties. Depending on the LED spectra, their ranking on a luminous efficiency scale may be subject to significant changes if mesopic luminous efficiency functions are used instead of the photopic. A CIE system for mesopic photometry will give manufacturers foundations on which to develop LEDs that are optimised for low light level applications. Consequently, the coming CIE publication on mesopic photometry may also have a major impact on the evolution and adoption of LEDs as the future light sources.

As mesopic dimensioning favours 'white' light sources with high S/P-ratio, the extra benefits from using the mesopic design are good colour rendering characteristics of the lighting. This is expected to further pave way for the use of white LEDs in outdoor lighting.

The use of mesopic photometry will promote the development of mesopically optimised lighting products. It will give the manufacturers foundations on which to develop light sources that are optimised for low light level applications. This will result in better energy-efficiency and visual effectiveness in outdoor lighting conditions. The accuracy of photometric instrumentation used in mesopic applications can be increased by taking into account the actual spectral sensitivity at these levels. Industry and users should be strongly motivated to use a photometric method that is valid and functionally relevant.

The development of mesopic photometry is the outcome of a huge amount of research work carried out in several organisations and countries over several decades. It is a major breakthrough for the international scientific community and the CIE. Finally, in 2010 we will have a mesopic photometric system to accompany the photopic $V(\lambda)$, which has served since 1924.

Actions are now needed to get the new mesopic photometric system into practical use. What is now needed are design guidelines for mesopic lighting dimensioning, i.e. guidelines how to use the mesopic system for example in road, pedestrian way and urban area lighting. There are certain points that require consideration within the various specification organisations, road lighting authorities, designers and the international lighting community. For example, different specification criteria may be necessary in situations where there is a different weighting of on-axis and peripheral visual information to process. In order to reach the full benefits of the new mesopic photometric system, it is hoped that the development of the guidelines are included immediately within the CIE work in the form of a new TC.

Prof. Liisa Halonen & Dr. Marjukka Puolakka
Chairman & Secretary of CIE TC 1-58

✉ News from the Divisions

Division 1 – Vision and Colour
http://div1.cie.co.at/

Division 1 held its annual meeting in Princeton, USA on 17-18 June 2010. The Minutes of the meeting are already available at the Division Website.

The following new TCs have been established:

TC 1-81: Validity of Formulae for Predicting Small Colour Differences (Chair: Klaus Richter, DE).

Terms of Reference: 1.) To evaluate available formulae for small colour differences (<~2.0 CIELAB). 2.) To define a visual threshold colour difference.

TC 1-82: The Calculation of Colour Matching Functions as a Function of Age and Field Size (Chair: Jan Henrik Wold, NO).

Terms of Reference: 1.) Following on from TR CIE 170, to recommend a procedure for calculating XYZ-like colour matching functions from cone fundamentals, as a function of age and field size. 2.) To deliver a computer programme for the calculations.

The following TCs have been disbanded:

- TC 1-54: Age-related Change of Visual Response
- TC 1-56: Improved Colour Matching Functions

The following new Reporterships have been established:

- R1-51: Reconciling Maxwell vs. Maximum Saturation Colour Matches (Michael Brill, GB)
- R1-52: Spectral Data Interpolation (Hugh Fairman, US)

The following Reporterships have been disbanded:

- R1-19: Specification on Individual Variation in Heterochomatic Brightness Matching
- R1-43: Standard Deviate Observer

Division 2 – Physical Measurement of Light and Radiation

http://div2.cie.co.at/

The next meeting of CIE Division 2 will be held in Bern, Switzerland on 1-3 September 2010 in conjunction with the CIE Tutorial and Symposium on "Spectral and Imaging Methods for Photometry and Radiometry".

Division 3 – Interior Environment and Lighting Design

http://div3.cie.co.at/

The following new TC has been established:

TC 3-51: CIE Standard General Sky Guide (Chair: Stanislav Darula, SK).

Terms of Reference: To finalise a guide for the application of the CIE General Sky Standard for general users and designers. The guide will provide an explanation of the CIE General Sky Standard concept and its simplified use by practitioners with available references and recommended prediction methods/tools/computer programs.

Change in Terms of Reference:

TC 3-39: Discomfort Glare from Daylight in Buildings (Chair: Werner Osterhaus, DK)

New Terms of Reference: To review existing discomfort glare assessment methods with respect to their suitability to daylight glare. To identify strengths/weaknesses and threats/opportunities in these existing methods. To make a recommendation on a provisional method for daylight glare assessment. To identify additional parameters that might influence the perception and assessment of discomfort and glare from daylight. To develop proposals for possible research directions and projects suitable to advance the understanding of these parameters.

Change in TC Chairmanship:

TC 3-25 Co-ordination of the IDMP and its data
New TC Chair: Norio Igawa (JP)

TC 3-44: Lighting for Older People and People with Visual Impairment in Buildings
New TC Chair: Yukio Akashi (JP)

Division 4 - Lighting and Signalling for Transport

http://div4.cie.co.at

The next meeting of CIE Division 4 will be held in Vienna, Austria from 5-9 September 2010 as joint meeting with Division 5.

Division 5 – Exterior Lighting and other Applications

http://div5.cie.co.at/

The next meeting of CIE Division 5 will be held in Vienna, Austria from 5-9 September 2010 as joint meeting with Division 4.

Division 6 – Photobiology and Photochemistry
http://div6.cie.co.at/

Division 6 held its annual meeting in Providence, USA on 10 June 2010. The Minutes of the meeting are already available at the Division Website.

The following TC has been disbanded:

- *TC 6-60: Spectral Weighting of Ultraviolet Radiation from Solar Surrogate Sources*

Division 8 – Image Technology
http://div8.cie.co.at/

Division 8 held its annual meeting in Vienna, Austria on 15 March 2010. The Minutes of the meeting are already available at the Division Website.

🕮 New CIE Publications

CIE Draft Standard DS 021.2/E:2010 Vehicle Headlighting Systems – Photometric Performance – Method of Assessment

CIE DS021.2/E:2010

This Draft Standard specifies a method to accurately and reliably assess the photometric performance of vehicle headlighting systems, to enable the performance of different systems to be compared. The requirements are given in relation to road scene illumination and the limitation of glare, and the performance is assessed using parameters relevant to lane guidance and the detection of pedestrians and objects.

The Draft Standard includes a measurement and calculation procedure. It does not specify the format of an assessment report.

The Draft Standard has been sent to CIE National Committees for comments and sales to interested parties. It is still subject to changes and

may not yet be referred to as a CIE Standard. When approved by the CIE NCs, it will be published as a CIE Standard and later on as a joint ISO/CIE standard.

The price of this Draft Standard is EUR 57,- (Members of the CIE National Committees get 50 % discount).

Calculation of Tunnel Lighting Quality Criteria

CIE 189:2010 **ISBN 978 3 901 906 85 5**

Experience of making road tunnel lighting designs in accordance with publication CIE 88:2004 has shown that there are some aspects of calculation of the different lighting criteria where more specific guidance to the designers is necessary. This document explains how the tunnel environment differs significantly from the open road situation. In particular, the presence of walls along the traffic road involves reflection effects between different surfaces. The variation of luminance level along the tunnel, the changes in the lighting installation along the entrance section of the tunnel and the use of different lighting systems in different parts of the tunnel introduce more complexity in the lighting calculations. The report gives guidance on determining the method for calculating the relevant lighting quality criteria for tunnel situations.

This Technical Report consists of 18 pages with 4 figures. The price of this publication is EUR 56,-- (Members of the CIE National Committees get 50 % discount).

Calculation and Presentation of Unified Glare Rating Tables for Indoor Lighting Luminaires

CIE 190:2010 **ISBN 978 3 901906 87 9**

This report has been prepared to assist luminaire suppliers and lighting designers in the production of UGR tables for luminaires in preset arrays at 1:1 spacing to height ratio. This data is needed for the verification of conformity to the limiting UGR by the UGR tabular method specified in clause 6.2 of the Standard ISO 8995-1:2002(E)/CIE S 008/E:2001 “Lighting of Workplaces – Part 1: Indoor”. The limiting UGR values are recommended in clause 5 of this standard. The report makes use of the basic UGR equation, described in CIE 117-1995, gives tables of preset values for the standard conditions and in step by step describes the calculation process needed to generate the uncorrected UGR table. The process is further demonstrated by a worked example of UGR calculation for a disymmetric distribution luminaire in a room $2H \times 4H$. The report also gives the uncorrected UGR table for this luminaire which can be used to validate software designed for the production of the UGR table.

This Technical Report consists of 29 pages with 4 figures and 8 tables. The price of this publication is EUR 72,-- (Members of the CIE National Committees get 50% discount).

Lighting of Roads for Motor and Pedestrian Traffic

CIE 115:2010, 2nd Ed. **ISBN 978 3 901906 86 2**

This report is a revision and update of CIE 115-1995 “Recommendations for the Lighting of Roads for Motor and Pedestrian Traffic”. Since it was issued in 1995 power consumption and environmental aspects have become more important and at the same time, the improved performance of luminaires and lamps, and especially the introduction of electronic control gear, has made it possible to introduce adaptive lighting for roads for motorised traffic, conflict areas and areas for pedestrians. A structured model has been developed for the selection of the appropriate lighting classes (M, C, or P), based on the luminance or illuminance concept, taking into account the different parameters relevant for the given visual tasks. Applying for example time dependent variables like traffic volume or weather conditions, the model offers the possibility to use adaptive lighting systems.

The publication replaces CIE 115-1995 "Recommendations for the Lighting of Roads for Motor and Pedestrian Traffic".

This Technical Report consists of 43 pages with 1 figure and 18 tables. The price of this publication is EUR 80,-- (Members of the CIE National Committees get 50 % discount).

From the Lighting Journals

Lighting Design + Application

www.iesna.com

May 2010	Renewal through Relighting
June 2010	Stark Power: RPI’s New Performing Arts Center
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www.svetotekhnika.com

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An Initiative of the Russian Corporation of Nanotechnologies (Rosnano)
Concerning Development of the Light-Emitting Diode Industry
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OLED Lighting – Light where it never has been before

M. Klein, K. Heuser

Light-Emitting Diode Modules based on Electrodynamics' Systems with Quantum Threads and Points

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Soffit Metal-Halogen Lamps of 70, 100 and 150 W Power for Colour Decorative and Architectural Illumination

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www.ile.co.uk

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For your Diary

Date	Title of Meeting	Organizer	Place of Meeting
2010			
August 30-31	CIE Tutorial and Expert Symposium on Spectral and Imaging Methods for Photometry and Radiometry	SLG Office reto.abaecherli@bvmberatung.net	Bern, Switzerland
September 8-10	2nd CIE Expert Symposium on Appearance: When Appearance meets Lighting…	Light & Lighting Laboratory KaHo Sint-Lieven lichttechnologie@kahosl.be	Gent, Belgium
October 18-20	Licht 2010	LTG, Lichttechnische Gesellschaft Österreichs, Ilse Neyder ilse.neyder@ltg.at	Vienna, Austria
November 10	Light & Care 2010 Symposium on the Impact of Healthy Lighting in Healthcare	Light & Health Research Foundation SOLG schoutens@solg.nl www.solg.nl	Eindhoven, The Netherlands
November 11-12	NordLED 2010	DCL Kenneth Munck km@centerfolys.dk	Copenhagen, Denmark
2011			
July	27th CIE Session	www.cie.co.at (click on Conferences)	Sun City, South Africa

CIE NEWS is published by the CIE Central Bureau
Kegelgasse 27
1030 Vienna - Austria
tel.: +43 1 714 31 87 0
fax: +43 1 714 31 87 18
e-mail: ciecb@cie.co.at
www.cie.co.at