ACTIVITY REPORT
DIVISION 1

VISION AND COLOR

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

January 2006

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This report represents an overview of the status of CIE Division 1 - Vision and Color since the last activity report that was issued in January 2005.

The annual meeting of Division 1 was held May 16th 2005 in León, Spain. The Division 1 Meeting was held in conjunction with the Interim meeting of the CIE. Divisions 2, 4, 5, and 6 also met at that time. In addition there was a one-day expert symposium on Lighting in Mesopic Conditions organized by TC1-58. The meeting was attended by all 5 officers, 18 country representatives from the 37 member nations and many guests (about 42 people in total attended). Six Technical Committees (TCs) met in conjunction with the meeting:

A summary of the status of each of the committees in Division 1 - Vision and Color is included in this report. The Reporterships and Liaison activities of Division 1 are also included. The order is first all the technical committees and reporterships of the Vision Section are presented. Then the technical committees and reporterships of the Color Section are presented. Next the Liaison reports are included. Finally, the recent publications are listed.

VISION SECTION

Active Technical Committees

TC1-30 (V) Luminous Efficiency Functions

Year Established: 1990

Terms of Reference:
To prepare a Technical Report on luminous efficiency functions which classifies and specifies the existing functions $V_{b,point}(\lambda)$, $V(\lambda)$, $V_{b,2}(\lambda)$, $V_M(\lambda)$ and $V_{b,10}(\lambda)$, and the color matching function $\bar{y}_{10}(\lambda)$ if appropriate, in their photometric use.

Chairman: Y Nakano JP

Members: M Ikeda JP, P K Kaiser CA, JA Kinney US, S Kokoschka DE, P Trezona GB, K Sagawa JP, H Yaguchi JP, F Viénot FR

Report:
No report.

TC1-36 (V) Fundamental Chromaticity Diagram with Physiologically Significant Axes

Year Established: 1991

Terms of Reference:
To establish a chromaticity diagram of which the coordinates correspond to physiologically significant axes.

Chairman: F Viénot FR

Members: P Lennie US, D MacLeod US, J D Mollon GB, J D Moreland GB, Y Nakano JP, J Pokorny US, L T Sharpe DE, A Stockman US, A Valberg NO, J J Vos NL, and P L Walraven NL

Consultants: H Scheibner DE, P Trezona GB, and H Yaguchi JP

Working Program:
Write a report with a clear statement on the choice of a set of color-matching functions and estimates of cone fundamentals for the normal observer. The committee will take into account the variability among normal and dichromatic observers.
1. Agreement should be reached on the following points:

a. Choice of a set of color-matching functions and evaluation of the consequence of this choice, compared to other possibilities.
b. Accordance with the 1988 $V_M(\lambda)$ luminous efficiency function.
c. Data on ocular media and macular pigment.
d. Use of Konig fundamentals. (Identity of the copunctal points with the fundamentals.)
e. None or little participation of S cones to luminance. If any, evaluation of the luminance discrepancy between a constant (L+M) diagram and a constant-luminance diagram.

2. Establish a chromaticity diagram.
3. Prospect the construction of a color space with significant axes. Basic stimuli and scaling of the axes should be discussed. Reference the literature where such color spaces are used in order to list the topics relevant to this color space.

Report:
As decided in San Diego, the preparation of the TC report has been split in two parts. Part I has been completed in early 2005 and circulated by the Central Bureau to the members of the Division. Remarks (mainly editorial comments and a few requests for details) were collected by the Central Bureau. A revised version has been prepared and sent back by the TC secretariat to the Central Bureau in November 2005.

A successful TC meeting was held during the ICVS 05 Conference in Lyon, France on July 10, 2005, where 6 TC-members attended. Important decisions have been made about the scientific content of Part II that deals with the relationship between cone fundamentals and photometry, and that will introduce a CIE-like chromaticity diagram. After discussion, it was agreed that for the two degree field, a synthesized luminous efficiency function VF(λ) in terms of quanta will be proposed, which is the weighted sum of the L- and M-cone fundamentals with a 1.55 L:M ratio. This ratio is published in a paper by the group of Stockman and Sharpe. A conversion of the ratio for the luminosity function in terms of energy will be given. For the ten degree field, it will not be possible to rely on the $\bar{y}_{10}(\lambda)$ function, but a close luminous efficiency function could probably be proposed. There is an active exchange on this aspect at the moment. When the L:M weights will be agreed on, the derivation of the CIE-like chromaticity diagram will start.

TC1-37 (V) Supplementary System of Photometry

Year Established: 1992

Terms of Reference:
To recommend a system of photometry to assess lights in terms of their comparative brightness relationships at any level.

Chairman: K Sagawa JP

Members: S Ashizawa JP, W B Cowan CA, C M Howard US, M Ikeda JP, J A S Kinney US, S Kokoschka DE, Y Nakano JP, D Piao CH, T Takeuchi JP, J Taylor GB, P W Trezona GB, F Viénot FR, H Yaguchi JP, and A Yujiri JP. Also, H J Schmidt-Clausen DE (Observer)

Working Program:
1. To list items on which photometric systems based on brightness matching are evaluated, such as the reference stimulus, linkage to the current CIE photometric and colorimetric systems, practical simplicity and the physiological basis of the system structure, etc. The numerical testing results from TC1-21 are to be included.
2. To evaluate the proposed systems according the items listed above.
3. To recommend a system from the proposed systems, or by some combination of them.
4. To prepare a report on the recommendation of a supplementary system of photometry.

Report:
The Chair is preparing a technical report in which a CIE supplementary system of photometry is proposed. At the Division 1 meeting at León, Spain in May 2005, a CIE Expert Symposium entitled "Vision and Lighting in Mesopic Conditions '05" was held and the proposed system was introduced and discussed. It was requested that the report makes clear that the supplementary system is based on brightness and is different from the one based on luminance or visual performance such as visual acuity.

TC1-41 (V) Extension of $V_M(\lambda)$ Beyond 830 nm

Year Established: 1993

Terms of Reference:
To write a report on the feasibility of the extension of $V_M(\lambda)$ beyond 830 nm, including modification of $V_M(\lambda)$ in the 660-780 nm region of the spectrum.

Chairman: P L Walraven NL

Members: D H Sliney US and J J Vos NL

Report:
As reported in earlier year reports, thought the text is close to completing, the present text is not ready for voting, because it waits for conformity with the report of TC 1-36, chapter 6 "Photometric aspects; the choice of the spectral luminous efficiency functions $VF_2(\lambda)$-and $VF_{10}(\lambda)$".

The TC 1-41 report deals only with the 2˚ case. In TC 1-36 there is (see report of TC 1-36) convergence of opinions that for the two degree field, a synthesized luminous efficiency function $VF(\lambda)$ in terms of quanta will be the weighted sum of the L- and M-cone fundamentals with a 1.55 L:M ratio. If TC 1-36 agrees, then TC 1-41 will proceed with those data, in the expectation that Division 1 will vote in favor of the draft of Chapter 6 of the TC 1-36 report.

TC 1-42 (V) Color Appearance in Peripheral Vision

Year Established: 1993

Terms of Reference:
To prepare a technical report on color appearance zones for colored lights in terms of unique hues in peripheral vision.

Chairman: M Ayama JP

Members: I Abramov US, H Chan US, G Derefeldt SE, L Eriksson SE, J Gorden US, S McFadden CA, K Okajima JP, S Otake JP, M.Pointer GB, M Takase JP, and A Yujiri JP

Report:
The committee had a meeting at the CIE Expert Symposium on June 11, 2004, held inTokyo, Japan. In the meeting, Ayama presented the proposal for the contents of Technical Report. Proposed report consists of following items:

Forward,
1. Introduction and history,
2. Principle of the method to evaluate color
3. Color zone map
4. Experimental conditions
5. Field eccentricity
6. Results
7. Conclusion

References

Above contents were basically approved by the members attended the TC meeting and the other attendees, while details in each chapter were precisely discussed.

The main issues discussed and agreed upon at the meeting are the following. In the results section (chap.6), the Color zone map from Ayama's lab should be presented, and then intra- and inter-laboratory variability, especially along the horizontal meridian, should be added. Figures representing hue shifts with eccentricity should also be included. In the reference section, all of the references in the proposal should be listed at least.

It would be desired that the first draft is sent to the members from Ayama by the end of December, possibly one chapter at a time.

The next TC meeting will be held in the next Division 1 meeting.

TC 1-46 (V) Concept and Application of Equivalent Luminance

Year Established: 1995

Terms of Reference:
To write a technical report describing the fundamental concepts of equivalent luminance and to provide guidelines on how to apply these concepts.

Chairman: Y Nakano JP

Members: J Moore GB, B Inditsky IL, R Tapalova CA, K Sagawa JP, Y Nayatani JP

Report:
This TC was closed in 2005 and a reportership on this topic R1-38 was opened in León, Spain.

TC1-54 (V) Age-Related Change of Visual Responses

Year Established: 1999

Terms of Reference:
To establish luminous efficiency, visual acuity, and contrast sensitivity as a function of age.

Chairman: K Sagawa JP

Members: H Bouma NL, L Halonen FI, W Iwai JP, D Kline CA, I Kucsera HU, A Monot FR, R Topalova CA, and J Werner US

Working Program:
1. To survey relevant data in the literature and ongoing studies as well for establishing data bases for the age-related change in spectral luminous efficiency, visual acuity, and contrast sensitivity functions.
2. To establish fundamental data bases for those functions as a function of age.
3. Write a report with those databases.

Report:
The TC has collected data on the three visual functions, spectral sensitivity function, visual acuity, and contrast sensitivity function of the eye. The chair is preparing a report containing all those data. Meanwhile a working group was established in CIE CB to develop guidelines on accessible lighting design that deals with lighting for older people. The TC has established a liaison with this work in CB. The data collected in TC1-54 will be shared with the working group.

TC1- 58 (V) Visual Performance in the Mesopic Range

Year Established: 2000

Terms of Reference:
To define mesopic visual performance and related terms.
To investigate performance based photometry in the luminance region below approximately 10 cd/m^2.
To propose a model for the basis of performance based mesopic photometry.

Chairman: L Halonen FI

Members: M Eloholma FI (Sercretary). M Ayama JP, P Bodrogi HU, E C Burini jr BR, D Chen CN, D L Crawford US, O DaPos IT, G Derefeldt SE, K ChangSoon, DL Crawford US, KR, N Itoh JP, C S Kim KR, C Knight, L Leetzow, US, I Lewin US, Y Lin CN, S McFadden CA, M Nicholson GB, M Pointer GB, K Sagawa JP, J Schanda HU, W Simpson CA, F Viénot FR, S Völker DE, A Wang CN, and E Yandek GB

Report:
The second meeting of TC 1-58 was held in León Spain in May 2005 along the CIE Midterm Meeting and International Lighting Congress. The meeting was very successful with 30 participants attending.

The TC 1-58 has outlined the existing and forthcoming works in the mesopic field worldwide. Furthermore, after the León meeting an expert questionnaire was conducted in order to define mesopic visual performance and related terms. The questionnaire was sent to 24 members and altogether 15 answers were received from 10 different countries worldwide. The information gained is highly valuable and combines the top-knowledge in field of mesopic lighting.

TC 1-58 hosted the CIE Expert Symposium 'Vision and Lighting in Mesopic Conditions '05' in Léon Spain on May 2005. The Symposium gathered the experts and people engaged with mesopic lighting together. Three invited papers and altogether 14 presentations were given on the latest findings in the mesopic field. The presentations were followed by discussion, where a clear distinction was drawn between a practical additive system and a brightness-based system of mesopic photometry. It was concluded that the work presented at the Symposium and elsewhere is now sufficiently advanced to form a basis for a practical system and that this work is carried out under the auspices of TC1-58.

The TC1-58 web-site has been established at: http://www.lightinglab.fi/TC1-58.

TC1- 59 (V) Standard Photometric 10° Observer

Year Established: 2000

Terms of Reference:
To consider the adoption of the CIE $Y_{10}(\lambda)$ as the spectral luminous efficiency function of the standard photometric 10° observer.

Chairman: J Schanda HU

Members: C Andersen US, G Derefeldt SE**,** C S McCamy US, J R Moore GB, L Morren BE, Y Nakano JP**,** C Oleari IT, MR Pointer GB, M Rea US, A R Robertson CA, L Ronchi IT, K Sagawa JP, P W Trezona GB, A Valberg NO, P Walraven NL and K Wenzel HU.

Report:
This TC has completed its work and was closed at the Division 1 meeting in León, Spain in May 2005.

TC1-60 (V) Contrast Sensitivity Function (CSF) for Detection and Discrimination

Year Established: 2001

Terms of Reference:
To specify a baseline achromatic CSF with its reference conditions and reference observer and to specify CSF extensions based on discrimination thresholds, as well as chromatic CSFs for both detection and discrimination.

Chairman: E. Martinez-Uriegas, ES

Members: D Alleyson FR**,** J M. Artigas Verdes ES, P Barten* NL, T Carney, US, C Chen, US, M Fairchild US, R Jacobson UK, R V Klassen US, L MacDonald GB, J Malo ES, S McFadden CA, L Mohamed-Chaker FR, E Peli US, K Sagawa JP, A B. Watson US, S Wuerger HU, and H Yaguchi JP.
[* - deceased]

Report:
As a consequence of lower than expected participation, and just before Division 1 meetings in León in May 2005, the chairman called the committee members for voluntary renewal of membership. This resulted in a reduction from 16 to 10 TC members. With the addition of four new members, the committee has now fourteen members.

The committee has developed simple Matlab tools to compute and plot one of the CSF formulas (Peter Barten's) available in the literature. The emphasis given to this and other mathematical formulas and models of the CSF is to use the analytical plots as a reference to compare actual laboratory measurements without necessarily adopting any of the modeling assumptions of the formulas. So far, we have compared fourteen sets of CSF data from fourteen different labs. Twelve of those fourteen sets come from the Modelfest group from the US, where 12 different labs conducted the experiments in a coordinated fashion, using the same procedure, stimuli, testing conditions, and data processing.

We are in the process of analyzing this preliminary comparison that includes classical data from Campbell & Robson (1968), 1989 - 1995 data using sinusoidal gratings (Eugenio Martinez-Uriegas, 1995), and the more recent data from Modelfest labs, made public in 2001. Interestingly, classical data from sinusoidal gratings correlates well with more recent, Gabor patch results (like Modelfest's)

Our plans towards a technical report require to evaluate and define how much more data should we try to examine in search for a reasonable summary, and what should be considered a reasonable summary. We are planning to meet in conjunction with Division 1 meetings in Ottawa in May 2006 to discuss a draft of a technical report that covers at least the achromatic, detection threshold CSF.

Finally, we started looking into the chromatic dimension of the CSF (Sophie Wuerger has kindly provided key reference material).

During the meeting in León, 2005 and with the help of other Division 1 members, we are revamping our plan and schedule. We are also looking forward to the changes in CIE websites to find an alternative solution to the electronic site our committee has in the web,

because we have been given notice that such service is to be cancelled across the board within the company that kindly provided it for our use at no cost. For the time being we will maintain discussion and document exchange through conventional e-mail.

TC1-67 (V) The Effects of Dynamic and Stereo Visual Images on Human Health

Year Established: 2005

Terms of Reference:
To write a technical report on the physiological and psychophysical effects of dynamic and stereo visual images in terms of photosensitive seizures, visually induced motion sickness and eyestrain.

Chairman: H Ujike (JP)

Members: members are being sought.

Report:
This TC was formed at the Division 1 meeting in León, Spain in May 2005. The chair is currently undergoing the formation work of the committee.

Vision Reporterships

R1-16 (V) Visual Adaptation to Complex Luminance Distribution: H Shinoda JP

Year Established: 1996

Terms of Reference:
To survey state-of-the-art research on visual adaptation to complex luminance distribution and to judge whether CIE should establish a new Technical Committee on this issue.

Report:
This reportership was closed in May 2005 at the León meeting of Division 1.

R1-19 (V) Specification on Individual Variation in Heterochromatic Brightness Matching: H Yaguchi JP

Year Established: 1997

Terms of Reference:

To report on the possibility to develop a simple test of individual characteristics for heterochromatic brightness matching.

Report:
The reporter is preparing a report on heterochromatic brightness matching in terms of individual difference the possibility to develop a simple test of individual characteristics for heterochromatic brightness matching. The report will be delivered at the next Division meeting in Ottawa.

R1-23 (V) Guidelines on Planning a Mesopic Photometry Investigation:

P Trezona GB

Year Established: 1999

Terms of Reference:
With several new mesopic photometry investigations being contemplated, the impact of theory of other considerations on the experimental design will be reported.

Report:
The report prepared by Dr. Trezona has been reviewed by two referees. Dr. Vienot, the associate director for vision, has forwarded the comments from the referees to the reporter.

R1-35 (V) Irregularities in $\bar{y}_{10}(\lambda)$: P Walraven NL

Year Established: 2004

Terms of Reference:

To document the irregularities in $\bar{y}_{10}(\lambda)$ and, if necessary, to recommend the formation of a Technical Committee to consider possible modifications.

Report:
This work was supposed to be a working together with Donald MacLeod. However, the reporter has failed to get in touch with him, so will continue to do the work alone from now. Up to now the only progress is that the reporter has made a program for making the irregularities visible.

R1-36 (V) Action Spectra for Glare: J Fekete HU

Year Established: 2004

Terms of Reference:
To summarize the literature on the subject and make recommendation for terms of reference for a technical committee.

Report:

Introduction

It is well known that humans obtain approximately 85% of their information by means of visual perception. Good visibility is highly important when driving a motor vehicle. At night, and in mesopic conditions, poor visibility conditions result in a lack of information for drivers. Visual information decreases with decreasing luminance level producing more (fatal) accidents during nighttime.

In rural environments car drivers have to rely on car-headlamp lighting to see on the road, but with higher headlamp intensity also the glare produced in the eyes of the approaching other driver increases. The present report summarizes literature data on interrelationship between visibility and produced glare.

Papers presented during the past year

Characterizing Oncoming Headlamp Illumination by John D. Bullough, John Van Derlofske, Chenlu Zhang; Rensselaer Polytechnic Institute, USA, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 525-534.

Recommendations for Dimming Headlamps through AFS by Yukio Akashi, John Van Derlofske, John D. Bullough, Rensselaer Polytechnic Institute, USA, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 890-899.

Some studies also addressed the question of whether and how headlamp mounting height influences glare:

Recommendations for Dimming Headlamps through AFS by Yukio Akashi, John Van Derlofske, John D. Bullough, Rensselaer Polytechnic Institute, USA, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 890-899.

Evaluation of Discomfort Glare of Passing HID Headlamps by Working Paper No. GRE-gtr-8-7 (8th GRE-gtr informal meeting, Washington D.C., 31. May – 2 June 2005.)

During the last ten years gas discharge lamps became popular and in the future we will meet LED headlamps too. Lamp SPD (Spectral Power Distribution) can have considerable impacts on a driver's visual performance. These modern light sources have radically different spectral power distribution compared to that of the traditional incandescent lamp. Therefore researchers investigated some types of headlamps and carried out comparative examination (TH, HID, LED) to established maximum visibility and minimum of glare.

Spectral Dependence of Visibility and Glare by J. Fekete, F. Horváth, C. Sik-Lányi, J. Schanda, A. Szalmás, G. Várady , University of Veszprém, Hungary, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 430-436.

Spectral Effects of LED Forward Lighting by John Van Derlofske, John D. Bullough, Jennifer Watkinson, Rensselaer Polytechnic Institute, USA, ISAL 2005. International

Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 201-211.

Night-time driving – New light sources in car headlamps – visibility and glare by J. Fekete, C. Sik-Lányi, J. Schanda, University of Veszprém, Hungary, Lux Junior 2005, Dörnfeld September 23-25.

Night-time driving – new light sources in car headlamps by J Fekete, C Sik-Lányi, J Schanda. University of Veszprém, Hungary, CIE Midterm Meeting and International Lighting Congress (P), León, Spain, May 12-21, 2005, pp. 58-65.

Tailoring headlamp spectra by Van Derlofske, J, Lighting Design and Application (2005.), 35(8), 12 - 14.

The aim of several studies are only to give clear information to interested people and to develop a measuring system, which could offer potential buyers and drivers of automobiles on the market a relevant description of headlight performance with acceptable reliability and validity. The difficulty of forming one *simple* rule is a result of a random nature of the kinds of obstacles on the road, their size, place and visibility and the additional complicating factor – the nature of visual perception.

Integral Method of Front lighting Illumination Assessment by Tomasz Targosinski, Motor Transport Institute Warsaw, Poland, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 201-211.

Headlight performance – consumer information by Kåre Rumar, Sweden, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 15-25.

End User Expectations for Future Automotive Lighting – Aggregate Consumer Research by Izumi Sakai, Valeo Lighting Systems, France, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 37-46.

In this year two studies dealt with the blue content of LED. These studies evaluated the effect of blue content of headlamps on discomfort glare, in order to provide guidance regarding spectral compositions that would minimize driver complaints. They tested a few LED headlamps with different correlated color temperatures, as well as a tungsten-halogen headlamp and an HID headlamp. They found that when LED headlamps appeared bluer than current tungsten-halogen or HID headlamps – LED headlamps tended to produce more discomfort glare. The effect is probably due to the color appearance of the LED rather than to any inherent characteristic of LED sources. For the data they reported, ratings of discomfort glare were linearly related to the amount of blue content in the light output as weighted by the spectral sensitivity of the short-wavelength (blue) cone photoreceptors.

Blue Content of LED Headlamps and Discomfort Glare by Michael Sivak, Brandon Schoettle, Takako Minoda, Michael Flannagan, University of Michigan, USA, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 212-221.

Short-Wavelength Content of LED Headlamps and Discomfort Glare by Michael Sivak, PhD, Brandon Schoettle, Takako Minoda, and Michael J. Flannagan, Leukos, 2005, vol. 2 (2), pp. 145-154.

Dirt on the outer lens of a headlamp is a safety aspect for both the driver himself and for oncoming car drivers. Since the degradation of the transmission (due to the increased dirt level on the outer lens) is not perceived by the driver, the losses of performance can be dramatic. First, the dirt reduces the performance regarding the range and the area that is illuminated on the street. Second, the dirt on the outer lens scatters the light emitted by the headlamp and thereby increases the glare produced by the headlamp.

New Approaches in Headlamp Cleaning Systems by Gerd Bahnmueller, Automotive Lighting Reutlingen, Germany, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 613-617.

Effects of Soiling on the Photometric Properties of Headlamps by Andreas Chudaska, Hella KGaA Hueck & Co., Germany, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 698-707.

The question exists do new headlamps (HID, LED, AFS systems) lead to more safety or only to more glare. The articles prove that new technology can improve our safety, if we notice some details of the evaluation of headlamps.

New Headlamps – More Safety or Only More Glare? by Stephan Völker, L-LAB University of Paderborn, Germany, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 222-228.

Active Headlamps for Increased Traffic Safety by Jacek Roslak, Rainer Kauschke; Hella KGaA Hueck & Co., Germany Jörg Wallaschek, L-LAB, University of Paderborn, Germany, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 317-332.

Headlight performance – consumer information by Kåre Rumar, Sweden, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 15-25.

How Xenon HID Light has Improved and will Further Improve Traffic Safety by W. Schlager, Philips Business Center Automotive, Germany, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 966-995.

Global Headlamp Application with Dual Filament Bulbs by Michael Scholl, Automotive Lighting Reutlingen, Germany, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 618-630.

Zhuoying investigated: (1) mesopic contrast threshold under 3 kinds of background ($L = 0.032 \pm 0.003$ cd/m^2 without glare, $L = 0.10 \pm 0.01$ cd/m^2 with glare and $L = 0.10 \pm 0.01$ cd/m^2 without glare, corresponding to the brightness of automobile traffic at twilight or at night); (2) the effects of adaptation luminance and glare; and (3) the variation with adaptation time.

The Effect of Adaptation Time, Adaptation Luminance and Glare on Contrast Threshold of Human's Eye by Zhuoying Ji, Udan University, China, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 505-514.

Several new technology improvements have happened in the field of automotive front light illumination with a strong influence in styling, costs and light performance. New

halogen bulbs, clear outer lenses, high intensity discharge (Xenon) systems, PES and nowadays swiveled light pattern were introduced. These new technologies have improved the performance on the road and give new styling opportunities. Unfortunately these improvements cause an increase in part and application costs. Because of the increasing demand for cost reduction in automotive business, the car manufacturers are searching for opportunities to produce an economical, but good looking lighting devices with the basic functionality of illumination, vision, and safety.

One concept to realize this "low cost" headlamp is to use one bulb for the two functions of low and high beam. For application in the global market, headlamps have to be conformed to at least two different legal requirements regions: the so called "ECE and SAE region". Up to now dual filament systems are designed to fulfill either ECE R112 or FMVSS 108 requirements. An additional cost saving would be to use one reflector for both regions.

Global Headlamp Application with Dual Filament Bulbs by Michael Scholl, Automotive Lighting Reutlingen, Germany, ISAL 2005. International Symposium on Automotive Lighting (P), Darmstadt, BRD, September 27-28, 2005. pp. 618-630.

R1-37 (V) Definition of the Visual Field for Conspicuity: N Itoh JP

Year Established: 2004

Terms of Reference: To summarize the literature on the Visual Field for conspicuity and make a recommendation for terms of reference for a Technical Committee.

Report:
The previous studies of various functions of visual field are now have been investigated. Those visual fields were analyzed and classified into several functional fields such as: (1) Detection and Perception, (2) Discrimination, (3) Recognition, (4) Performance/Behavior. A part of the report was presented at the Division 1 meeting in León, Spain, and it was requested to prepare a written report. The work is ongoing for a full report now. At the same time, the useful field of view for the detectability of the visual information are being studied at AIST in Japan and the results of which could be included in the same report.

R1-38 (V) Concept and Application of Equivalent Luminance: Y. Nakano JP

Year Established: 2005

Terms of Reference:
The reporter is to prepare a report addressing this topic.

Report:
This reportership was formed when TC 1-46 was closed during the meeting of Division 1 in León Spain in May 2005.

COLOR SECTION

Active Technical Committees

TC1-27 (C) Specification of Color Appearance for Reflective Media and Self-Luminous Display Comparison

Year Established: 1990

Terms of Reference:
To study and make recommendations for the specification of a color appearance match between a reflective image and a self-luminous display image.

Chairman: P J Alessi US

Members: T F Chong HK, G Derefeldt SE, M Fairchild US, T Fuchida JP, A Hanson GB, M Ikeda JP, E Khoury FR, V Kojtcheva BU, M R Luo GB, D Rich US, K Richter DE, A R Robertson CA, T Suzuki JP, and J Walraven NL.

Consultants: R W G Hunt GB, Y Nayatani JP, and M R Pointer GB.

Working Program:
1. Investigate whether the CIELUV and CIELAB color spaces adequately specify a color appearance match between a reflective image and a self-luminous display image.
2. Investigate whether modifications to the CIELUV and CIELAB equations (such as white point color stimulus specification) would be adequate to specify a color appearance match between a reflective image and a self-luminous display image.
3. Investigate the use of the Hunt and Nayatani color appearance models to specify a color appearance between a reflective image and a self-luminous display image.

Report:
The Chair has stated that the final report will be completed in 2006.

TC1-38 (C) Compatibility of Tabular Data for Computational Purposes

Year Established: 1992

Terms of Reference:
To prepare guidelines for tabulating CIE spectral data to provide compatibility of sets of data for computational purposes, considering such factors as spectral range, spectral interval, function, truncations, interpolation, extrapolation and number of digits.

Chairman: M R Pointer GB

Members: F W Billmeyer* US, J Campos ES, H Fairman US, R W G Hunt GB, T Kehlibarov BU, C McCamy US, K Okubo JP, D C Rich US, A R Robertson CA, J Schanda, HU, R Sève FR, H Tersteige* DE, J Verrill* GB, K Witt DE and J C Zwinkels CA
[* - deceased]

Report:
With the publication of CIE Publication 167:2005: Recommended practice for tabulating spectral data for use in colour computations, the work of this TC is now complete. This TC will be formally disbanded at the Division 1 meeting in 2006.

TC1-44 (C) Practical Daylight Sources for Colorimetry

Year Established: 1995

Terms of Reference:
1. To compare existing daylight simulators for color measuring instruments and color matching booths
2. On the basis of this intercomparison, to recommend practical methods for simulating daylight sources.

Chairman: R. Hirschler HU

Members: A Bristow SE, P Chong US, W Czepluch DE, D Hinks US, H Fairman US, R Hunt GB, T Kehlibarov BU, T Ichijo JP, J van Kemenade NL, H Lara US, M R Luo GB, C McCamy US, M Pointer GB, Y Ohno US, B Powell AU, C Puebla DE, M L Rastello IT, A Rodrigues US, J Schanda HU, K Witt DE, R Young US, and J Zwinkels CA

Consultants: P Bradfield US, G Dakin GB, R Harold US, C Hughes US, K Imura JP, N Lena US, G Lorditch US, D Rich US, R Schiele US, and H Stepper US

Working Program:
1. Obtain spectral irradiance data on existing simulators for both color-matching booths and color measuring instruments, either directly from the manufacturer or from spectroradiometric measurements performed by the committee members, under standardized conditions.
2. Evaluate the performance of these existing simulators according to various criteria, including: 1.) quality of simulation based on CIE Publication no.51; 2.) integrity of simulation (e.g. stability, insensitivity to instrument geometry and polarization effects, optical throughput); 3.) practicality of implementation (e.g. simplicity of fabrication, economy, compatibility with existing instrumentation)
3. Prepare a CIE technical report on these findings and provide recommendations for practical methods of simulating daylight sources for different applications (e.g. based on allowable color-difference errors). It is expected that more than one method will be required to satisfy practical considerations. This is likely because, for example, it is not possible to have as stable or reproducible a daylight simulation with pulsed lamps as

continuum lamps, but they are preferred for on-line measurements; so this reality must be accommodated in the recommendations.

Report:
The chair is working on a Technical Report for this TC. It will contain the spectral power distributions and CIE Publication 51 ratings of actual daylight sources satisfying the recommendations of ASTD D1729, ISO 3664 and other relevant standards. The sources include filtered tungsten and dichroic lamps, fluorescent lamps, tuned lasers and filtered Xenon arc used in visual colour evaluation and pulsed Xenon lamps used in one-monochromator spectrophotometers.

TC1-48 (C) Revision of CIE Document 15.2 Colorimetry

Year Established: 1997

Terms of Reference:
To produce a revised edition of CIE Document 15.2 taking into consideration other relevant CIE recommendations

Chairman: J Schanda HU

Members: P Alessi US, E Carter US, M Fairchild US, RWG Hunt GB, CS McCamy US, B Kránicz HU, J Moore GB, L Morren BE, J Nobbs GB, Y Ohno US, M Pointer GB, D Rich US, A Robertson CA, T Seim NO, R Sève FR, P Trezona GB, and K Witt DE

Report:
The report has been finished, balloted, and was published in November 2004 as CIE Publication 15:2004, 3rd Edition. Therefore the TC was closed in May 2005 at the León meeting of Division 1.

TC1-52 (C) Chromatic Adaptation Transform

Year Established: 1998

Terms of Reference:
To review the chromatic adaptation transforms with a view to make a recommendation.

Chairman: MR Luo GB

Members: O DaPos IT, M Fairchild US, K Hashimoto JP, R W G Hunt GB, Y Nayatani JP, M Pointer GB, K Richter DE, B Rigg GB, H Sobagaki JP, and M Stokes US

Report:

The technical report of TC1-52 has been published as CIE Publication 160:2004, A review of chromatic adaptation transforms. Thus the work of this TC is now complete. The TC was disbanded at the Division 1 meeting in León, Spain in May 2005.

TC1-53 (C) A Standard Method of Assessing the Quality of Daylight Simulators

Year Established: 1998

Terms of Reference:
To prepare a CIE Standard for the assessment of daylight simulators

Chairman: M R Pointer GB

Members: D H Alman US, R Hirschler HU, T Ichijo JP, J T C van Kemenade NL, M R Luo GB, J Schanda HU, and J C Zwinkels CA

Report:
With the publication of CIE Standard S 012/E:2004, Standard method of assessing the spectral quality of daylight simulators for visual appraisal and measurement of colour, the work of this TC is now complete. The TC was disbanded at the Division 1 meeting held in León, Spain in May 2005.

TC1-55 (C) Uniform Color Space for Industrial Color Difference Evaluation

Year Established: 1999

Terms of Reference:
To devise a new uniform color space for industrial color-difference evaluation using existing experimental data.

Chairman: M Melgosa ES

Members: D Alman US, R Berns US, E Carter US, G Cui GB, M D Fairchild US, R Kuehni US, M R Luo GB, J Nobbs GB, C Oleari IT, M R Pointer GB, D Rich US, K Richter DE, B Rigg (GB), A R Robertson CA, J Romero ES, M Vik CZ, K Witt DE, J H Xin CN, and H Yaguchi JP

Advisor:
R Huertas ES

Report:

Upon the resignation of the J Nobbs as chair, Manuel Melgosa was appointed the new chair following the Division 1 meeting in León, Spain in 2005. The TC is revising the combined dataset used for the development of the CIEDE2000 color difference formula. A meeting of this TC will be held during CGIV´2006 (June 19-22, 2006. University of Leeds, UK).

TC1-56 (C) Improved Color Matching Functions

Year Established: 1999

Terms of Reference:

1. To compare results based on the current CIE color matching functions, color matching functions proposed by Dr. W. Thornton's laboratory, and those of CIE TC1-36.
2. To initiate experiments to obtain data for such comparison in different laboratories.
3. To report to CIE Division 1 on the results of the above investigation and make an eventual recommendation for future CIE color matching functions.
4. To report to CIE Division 1 an eventual recommendation for the use of the new color matching functions in specifying color spaces and color-difference formulas.

Chairman: M Brill US

Members: M Fairchild US, H Fairman US, K Houser US, R Kuehni US, R Luo UK, Y Nakano JP, B Oicherman GB, C. Oleari IT, D Oulton GB, D Rich US, A R Robertson CA, J Schanda HU, A Stockman US, A Tarrant UK, W A Thornton US, P W Trezona GB, J H Wold NO, K Wenzel HU, and J Zoido ES

Report:

After my 2004 report proposing to dissolve CIE TC1-56 for lack of progress, considerable interest emerged, culminating in the 16 May 2005 meeting in León. Three groups indicated that they were doing relevant work: Ronnier Luo and Boris Oicherman (m.r.luo@leeds.ac.uk) at about 3 cd/m^2, Claudio Oleari (Oleari@fis.unipr.it) at about 30 cd/m^2, and Yasuhisa Nakano (ynakano@bio.im.hiroshima-cu.ac.jp) at about 300 cd/m^2. It is the intention that the UK observer should visit the other laboratories to make measurements using their apparatus. After the TC meeting, Kevin Houser (University of Nebraska; Khouser@UNL.edu) expressed interest in the TC's goal. He will represent a fourth group contributing experiments to the TC, and I invited him to be a member of the TC.

As of the León meeting, TC1-56 down-scoped its goals relative to the stated terms of reference: Henceforth, the main goal is not to find better colour-matching functions, but to test the transformability of primaries for many trials on a single observer. Also, rather than try to insist on a single experimental design for the colour matching (as was attempted at the 2001 meeting), the TC agreed to receive and synthesize the results of all participating laboratories into a single recommendation. Diversity in the luminance levels of the first three laboratories was already a step forward.

Despite the title of TC1-56, the new main goal does not require the measurement of colour-matching functions. Only the following are strictly needed for a meaningful result: A least 7 lights, comprising an independent test light and 2 sets of 3 primaries each. The primary sets need not be even nearly monochromatic. For each of the primaries in a set,

statistical robustness requires measuring the match at least 10 times with the opposite set of primaries. Then the seventh light must be repeatedly matched using both sets of primaries. Transformability will be verified if, by averaging the primary matching data (iterates for a single observer), the inferred coordinates of the test light under the two sets of primaries match the coordinates obtained from direct matching. This goal, which agrees with the subsidiary goal agreed upon at the 2001 meeting of TC1-56, is now the main mission of the TC.

The target date for completion of the newly defined mission is 2009, and an interim committee meeting will probably be held in 2007. A continuation of the effort beyond the newly defined mission would include the following: (a) Extension of the findings to more than one observer; and (b) a side study to determine whether single iterates of the matches produce as much failure of transformability as was observed by Thornton.

TC1-57 (C) Standards in Colorimetry

Year Established: 2000

Terms of Reference:
To prepare a series of CIE/ISO/IEC Standard(s) that describe:
1. The method of calculating CIE tristimulus values and chromaticity coordinates
2. A uniform color space and its associated metrics
3. A formula for industrial color difference evaluation.

Chairman: A R Robertson CA

Members: A Bristow SE, J Campos Acosta ES, R Connelly US, J F Decarreau FR, R Harold US, R Hirschler HU, H Ikeda JP, D McDowell US, P McGinley AU, Y Ohno US, M Pointer GB, K Richter DE, G Roesler DE, J Schanda HU, R Sève FR, K Witt DE, H Yaguchi JP, and J Zwinkels CA

Liaison members:
IEC TC100/TA2, H Ikeda; ISO TC 6, A Bristow; ISO TC35/SC9/WG22, G Rösler; ISO TC38/SC1/WG7(UK), M Pointer; ISO TC38/SC1/WG7 (US), R Harold; ISO TC42, D. McDowell; ISO TC130, D. McDowell; ISO/IEC/JTC1/SC28, K Richter

Report:
A formal committee vote has been conducted on the 6th draft of the standard on CIELAB (DS 014-4.1). A number of comments were received, most of which can be resolved easily. No negative votes were received but two positive votes were conditional on changes to the draft. The Chair is working to resolve the issues that were raised with the expectation that the vote can become unanimous and the standard can be submitted to the Division for approval early in 2006. The lessons learned in preparing this standard will then be applied to the development of the standards on CIELUV (DS 014-5.1), the calculation of tristimulus values (DS 014-3.1), and CIEDE2000 (DS 014-6.1).

TC1- 61 (C) Categorical Color Identification

Year Established: 2001

Terms of Reference:
To prepare a report describing a color categorization map for the photopic and mesopic illumination levels.

Chairman: T Ishida JP

Members: O Da Pos IT, N Johnson US, M R Luo GB, K Okajima JP, M Pointer GB, L Ronchi IT, K Sagawa JP, J Schanda HU, H Shinoda JP, and H Yaguchi JP

Report:
This TC has not been active in 2005. The chair hopes to prepare the first draft document in 2006 and circulate it to the TC members.

TC1- 62 (C) Color Rendering of LED Light Sources

Year Established: 2002

Terms of Reference:
To investigate by visual experiments color rendering properties of white LED light sources and to test the applicability of the CIE color rendering index to white LEDs.

Chairman: P Bodrogi, HU

Members: P Alessi US, I Ashdown CA, P Csuti HU, W Davis US, L Halonen FIN, G Heidel DE, R Hirschler HU, F-C Hwang TW, A D Jackson US, C S Kim KR, K Kohmoto JP, B Kránicz HU, Y Kwak KR, C Li CN, M R Luo GB, K Muray US, Y Nakano JP, Y Ohno US, K Oshima JP, M Pointer GB, E Radkov US, D Rich US, N Sándor HU, J Schanda HU, R Stolyarevskaya RU, J van Kemenade NL, R Stolyarevskaya RU, F Viénot FR, S Weintraub US, H Yaguchi JP, T Yano JP, and R Young US.

Advisors: O da Pos IT, A de Visser NL and F Viénot FR

Report:
The third meeting of the TC was held at the CIE Midterm Meeting, in León, Spain, on 17 May 2005. Following work items were presented: “Suggestions for the direction of a new colour rendering metric”; “Application of a multi-spectral camera to a colour rendering simulator”; “Discriminating colours under LED illumination”; and ”High Quality White Light With Near-UV LED Chips”. Draft 1 of the Technical Report was discussed in the 3rd meeting. The Committee is currently working on Draft 2.

TC members presented papers related to the subject of the TC, on the CRT simulation of colour rendering of white LED light sources in the CIE Midterm Meeting, in León (Spain), in May 2005. They presented papers on the NIST facility for color rendering simulation, on the application of a multi-spectral camera to colour rendering simulation, and on the discriminating of colours under LED illumination in the 10th Congress of the AIC, in Granada (Spain), in May 2005.

TC1- 63 (C) Validity of the Range of CIEDE2000

Year Established: 2003

Terms of Reference:
To investigate the application of the CIEDE2000 equation at threshold, and to CIELAB color differences>5 units.

Chairman: K Richter, DE

Members: K R Gegenfurtner DE, T Holtsmark NO, M R Luo GB, M Melgosa ES, J Nobbs GB, C Oleari IT, M Pointer GB, D Rich US, P Walraven NL, and H Yaguchi JP

Report:
A research project for large color differences between both white and black and the three primary and three secondary colors of offset printing has been finished. Only relative color differences on a relative visual scale have been studied. Visual representations of the three test charts is under the three URL's: http://www.ps.bam.de/ME25/10L/L25E00NP.PDF; http://www.ps.bam.de/ME26/10L/L26E00NP.PDF; http://www.ps.bam.de/ME27/10L/L27E00NP.PDF. The questionaire to fill out is in on page 2 of each file output.

Basic colours and visual experiments. The standard offset colors defined and used in available test charts of ISO/IEC 15775:1999 define the two end colors of the produced 3 and 5 step color series (see above). The CIELAB color differences ΔE^*_{ab} are in the range 50 to 80 between the two end colors. The mean deviation compared to the standard colors ΔE^*_{ab} equals 2.2.

The experiments have been done with 17 observers using corresponding viewing and measurement conditions to get a high correlation between visual and colorimetric results. A lighting booth with a D65 simulator and the luminance 300 cd/m^2 for the white paper, the 45/0 geometry and the 2˚ observer have been used.

Preliminary results. A Relative Colour Difference Index (RCDI) has been defined which uses the the relative color differences of the visual results (numbers between 0.00 and 1.00) and the calculated relative color diffences according to the different color difference formulae.

If for the 3-step scales the visual (ideal) value for the intermediate color is near 0.5 and the relative calculated color difference is near 0.5, then the RCDI has the value zero. The preliminary RCDI values of different CIE colour difference formulas are: CIELAB 1976: 0.041; CIELUV 1976: 0.059; CIEDE1994: 0.074; CIEDE2000: 0.090.

The interpretation may be as follows: The deviation between visual and calculated results is about 4% for CIELAB 1976 and 9% for CIEDE2000. Therefore CIELAB is more appropriate for the large color difference calculation compared to CIEDE2000. All test samples have color difference in the range delta ΔE^*_{ab} between 10 and about 40.

The next steps of TC are to repeat the experiments at different places with the same sample series which will to be delivered for free on request from the chairman of CIE TC1-63.

The results for large sample differences are only one part of the terms of reference of CIE TC1-63. For threshold sample differences a new research project has been started to make visual experiments at threshold with a 256-step gray scale (delta L* = 0.3) along the lightness axis and perpendicular in red-green and yellow-blue direction.

TC1- 64 (C) Terminology for vision, color, and appearance

Year Established: 2003

Terms of Reference:
To monitor the terminology requirements of Division 1 including the revision of the present ILV terms and the addition of new terms.

Chairman: S. McFadden, CA

Members: E Carter (US), O Da Pos (IT), J. Gardner, (AU), Y Nakano (JP), M Pointer (GB), J Schanda, (HU), and R. Sève (FR)

Report:
The Chair of TC1-64 attended the International Harmonizing Committee for the ILV in León, Spain. The discussion centered on terms with multiple definitions and what remained to be done. Some terms have been defined differently by different Divisions. These terms can be roughly divided into two types: 1) terms with a general definition for use in a wide range of applications and also a restricted definition for a specific application, and 2) terms where the different definitions are very similar, but there are slight differences in wording. In the first case, it was recommended that the restricted meaning appear as a note to the general definition. In the second case, consensus will be necessary.

The Harmonizing Committee agreed that each Division representative would review the terms that their Division had been responsible for to ensure that the entries were accurate and complete. Once this process is complete and agreement has been reached on the duplicate entries, the ILV will be published. The plan is to initially publish it on the web as a searchable document. It will probably have to be reformatted to publish it as a joint IEC/CIE document. Once the ILV has been published, TC1-64 can actively pursue its remaining tasks of proposing new terms and reviewing exiting terms.

TC1-65 (C) Visual Appearance Measurement

Year Established: 2003

Terms of Reference:
To study, develop, and recommend a soft-metrology framework for measuring visual appearance. This should include potential measurement areas, psychophysical procedures and real applications.

Chairman: M R Pointer, GB

Members: There are three levels of membership: full, corresponding, and liaison members.

Full members:
P Bodrogi HU, E Burini BR, J Campos ES, A Chalmers NZ, S Cheung KO, P Clarke GB, O da Pos IT, G Derefeldt SE, P Hanselaer BE, R Harold US, J Hutchings GB, , T Kolas NO, S Lindberg SE, D Lozano AR, M R Luo GB, L MacDonald GB, S McFadden CA, T Newman US, J Nobbs GB, C Oleari IT, G Rossi IT, K Sagawa JP, J Schanda HU, D Simmons GB, and F Viénot FR

Corresponding members:
M Brill US, J Veitch CA, C Williamson GB

Report:
This TC was established in 2003 in San Diego, US. It has met in Tokyo, Japan in 2004 and in León, Spain in 2005. The work program was discussed, and it was decided to concentrate on writing a technical report while considering some vocabulary issues in parallel. There have been five circulars to the members of the TC during 2005.

The first draft of a Technical Report was circulated to TC members in February 2005. Over 200 comments were received from 11 members: in addition, two members indicated their approval of the report as distributed. Many of these comments were resolved by the TC chair, but over 50 required further committee discussion. The second draft of the Technical Report, which had been updated to take into consideration the responses to all of the comments, was circulated to TC members in November 2005 with a request for approval to send it to the Division for international ballot. It is appreciated that both of these ballots will raise a number of further points for discussion, and these will be dealt with by the TC after the ballot process is complete. The hardest challenge for the TC members has been to devise an acceptable definition for the term ‘appearance’ and, after much email correspondence, this has now been achieved.

Françoise Viénot agreed to organize a CIE Expert Symposium in Paris in October 2006. The meeting will span two days and include invited papers, as well as opportunities to present current work orally or by poster. See http://visualappearance06.free.fr.

TC1-66 (C) Indoor Daylight Illuminant

Year Established: 2004

Terms of Reference: To prepare a CIE recommendation on an Indoor Daylight Illuminant and a corresponding Indoor Daylight Source, considering the needs of the partner international standards organizations.

Chairman: J. Schanda, HU

Members: A Bristow SE, C Chain FR, F Clarke (advisor) GB, M K Gunde SI, R Hirschler HU, B Jordan CA, J T C van Kemenade NL, E Pierson FR, K Richter DE, G. Rösler DE, T Tarzali HU, and J Zwinkels CA

Report:
In TC 1-66 Indoor daylight illuminant unfortunately not too much happened since the León meeting of the TC. During that meeting the chair proposed a possible outline of the draft technical report. Ensuing discussion included the following items: 1) whether the report should include artificial office illumination as well or not - it was concluded that the Terms of Reference called for describing the spectral power distribution of natural daylight in interiors and electrical lighting should not be included, even if it is used as supplementary illumination in many office environments; 2) whether only sky-light should be considered or whether direct sunlight should be also considered - consensus was reached that CIE D illuminants filtered by the window glass is the only data needed; 3) the type of window glass to consider - sub-sections should deal with not only plain window glass, but also with tint, coated, thermo- and electro-chromic glass.

After the discussion the Chair thought that the first part of the report dealing with the illuminants could be ready in a year's time. After that the committee could deal with the question of the standard source.

In June 2006 the chair received written comments from Dr. Frank Clark. In addition the chair contacted Pilkington, but has not received a reply yet. If no reply by end of the year, the chair will collect glass samples from around the world by the help of the TC members, and will do the spectral transmission measurement his laboratory in order to get representative data.

TC1-68 (C) Effect of Stimulus Size on Color Appearance

Year Established: 2005

Terms of Reference: To compare the appearance of small (<2°) and large (>20°) uniform stimuli on a neutral background.

Chairman: Peter Bodrogi (HU)

Members: K F Anter SE, I-P Chen TW, O da Pos IT,C S Kim KR, G Kutas HU, M. R. Luo GB, M Nicholson GB, M R Pointer GB, J Schanda HU, R Űnver TR

Advisor: G Derefeldt SE

Report:

A website of the TC was established for TC members and advisors only. They can download the following documents from this site: the TC Worksheet, this Activity Report, members'/advisors' answers to the Survey, and articles related to the subject.

TC 1-68 members/advisors have answered to the following survey:

What literature do you know on the Color Size Effect?
What is your own experience on the Color Size Effect?
What experiments do you intend to carry out?
What are the relevant real situations and applications?
What are the physiological and/or psychological reasons of the Color Size Effect?
How do temporal factors influence the Color Size Effect?
How can we quantify the Color Size Effect to find out a usable method for practice?

TC 1-68 has the following work-plan for 2006:

Task	Description	2006-1	2006-2
1	Visual Experiments to Explore the Color Size Effect	X	X
2	Quantify the Color Size Effect (Mathematical Modelling)	X	X
3	Explore the Reasons of the Color Size Effect	X	X

We intend to have the first physical meeting during or after the CIE Expert Symposium on Visual Appearance, Paris, France, October 19-20, 2006. However, this is still subject to discussion among the TC members/advisors.

Color Reporterships

R1-11 (C) Cognitive Aspects of Color: G Derefeldt SE

Year Established: 1994

Terms of Reference:
To survey and present a report on cognitive functions of color in terms of behavioral, neuropsychological and neurophysiological data

Report:
The publication of CIE Publication 166: Cognitive Colour marks the completion of this reportership. Thus it will most likely be disbanded at the next Division 1 meeting in Ottawa in 2006.

R1-32(C) Emotional Aspects of Color: G Derefeldt SE

Year Established: 2003

Terms of Reference:
To review the literature on various non-image related effects of color and light.

Report:
The reporter hopes to finish the reportership in time to the next CIE Congress in 2007 at the meeting in China.

R1-33 (C) Color Difference Evaluation: M R Luo, GB

Year Established: 2003

Terms of Reference:
To monitor the response to CIEDE2000, including receiving comments, reviewing relevant literature, and recommending future activity.

Report:
Not many articles were published in the evaluation of color differences this year.

Sharma et al [G. Sharma, W. Wu and E. N. Dalal, The CIEDE2000 color-difference formula: Implementation notes, supplementary test data, and mathematical observations, Col. Res. Appl., 30, 21-30, 2005] worked on the implementation of CIEDE2000 color-difference formula found that a mathematical discontinuity in the formula was reported due to the calculation of the mean hue angle. The extent is very small, about 5% and 1% for colour differences of 5 and 1 respectively.

Few papers [G. Cui, M. R. Luo and B. Rigg, Colour difference evaluation under illuminant A, The Proceedings of the AIC05, Granada, Spain, 575-578; B. Han, M. R. Luo and E. J. J. Kirchner, Assessing colour differences for automobile coatings using CRT colours. Part II: Evaluating colour difference of textured colours, The Proceedings of the AIC05, Granada, Spain, 583-586; R. Huertas, M. Melgosa and E. Hita, Parameters for colour differences of samples with simulated texture, The Proceedings of the AIC05, Granada, Spain, 587-590] were published in the Proceedings of AIC Colour 05, Granada. The results showed that CIEDE2000 gave similar performance as CMC, CIE94 in predicting experimental data but outperformed CIELAB. It has been well understood that CIEDE2000 predicts more accurately than the other formulae only in the blue and close to neutral regions.

Liaisons

Association International de la Couleur: P J Alessi

The members of the new AIC Executive Committee serving from January, 2006 until December, 2009 are:

Professor Jose Caivano (Argentina) - President
Berit Bergstrom (Sweden) - Vice President
Professor Javier Romero (Spain) - Secretary/Treasurer
Mr. Nick Harkness (Australia) - Regular EC member
Professor Dr. Roy Berns (USA) - Regular EC member
Professor Osvaldo da Pos (Italy) - Regular EC member
Professor Dr. Ye Guanrong (China) - Regular EC member

Having completed the very successful Quadrennial Meeting in Granada in May 2005, the following meetings are scheduled for the next quadrennium:

- The 2006 AIC Interim Meeting will be hosted by the Color Group of South Africa from October 25-27,2006 in Johannesburg. The topic will be Color in Culture, Color in Fashion.
- The 2007 AIC Mid-term Meeting will be hosted by the Color Association of China from July 12-14, 2007 in Hangzhou. The topic will be Color Science and Industrial Applications.
- The 2008 AIC Interim Meeting will be hosted by th Swedish Color Center Foundation from June 15-18 in Stockholm, The topic will be Color in Inner and Outer Space.
- The 11th AIC Congress will be held from September 20-25,2009. It will be hosted by the Color Society of Australia.

More information concerning AIC can be found on its website at www.AIC-COLOR.org.

CCPR (Comite Consultatif de Photometrie et Radiometrie), BIPM: M. Stock

The CCPR and its working groups met at the BIPM on 23-26 October 2005. Most of the detailed technical discussions were held in the working group meetings.

The key comparison working group (WG-KC) initiates key comparisons in the field of radiometry and photometry. These are the technical foundation for the mutual recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes in the framework of the CIPM MRA (Mutual Recognition Arrangement). The working group also reviews and approves the comparison reports. The first series of key comparisons, testing the principal techniques of the field, is now nearing completion. A list of the comparisons and their status and results can be found in the key comparison database (KCDB) on the BIPM webpage (http://kcdb.bipm.org/AppendixB/).

The working group on calibration and measurement capabilities (WG-CMC) coordinates the international review of the declared calibration and measurement capabilities (CMCs) of national metrology institutes. The outcome of this review process is a list of internationally recognized CMCs, which are listed in appendix C of the key comparison database (http://kcdb.bipm.org/AppendixC/). For radiometry and photometry, calibrations of 37 countries are listed, the total number of recognized calibrations is larger than 800.

The UV working group studies measurement problems in the UV and encourages coordination of the work of national metrology institutes in this field. The working group has initiated a comparison of spectral responsivity from 10-20 nm and has proposed a bilateral comparison of spectral responsivity from 110-200 nm between the NIST and the PTB.

A new working group on strategic planning (WG-SP) was created at the CCPR meeting. The working group will advise the CCPR on future directions and will monitor developments with respect to possible future modifications of the SI system of units.

The CCPR made an official recommendation “On the importance of SI traceable measurements to monitor climate change”, which strongly recommends relevant bodies to take steps to ensure that all measurements used to make observations for climate studies are made fully traceable to SI units. It further recommends to funding bodies to support the development of techniques which are necessary to reach this goal for space-based measurements.

The new, 8th edition of the SI brochure, to be published in 2006, will contain a new appendix on units for photochemical and photobiological quantities, which involve spectral weighing functions (action spectra). This appendix was prepared by a CCPR task group.

The next CCPR meeting will take place on 18-22 June 2007. The working groups will already meet in October 2006 in Queretaro, Mexico.

IALA: M. Nicholson and I. Tuttle

Two committees whose work links closely with that of CIE are the Aid to Navigation Management (ANM) Committee and the Engineering, Environmental, Preservation (EEP) Committee. Within the EEP Committee, Working Group 4 (WG4) has responsibility for light related matters.

ANM Work.

Blue Lights. The ANM Committee is currently considering introducing the use of blue signal lights within the IALA signaling system. This will make a total of five signal colors, white, red, green, yellow and blue.

There is concern over the possibility of color confusion between blue and white or blue and green. There is additional concern that blue marine aid-to-navigation (AtoN) signals will be confused with blue flashing beacons used by emergency services and police.

Ensuring that the minimum flash length of blue signals is greater than one second or by restricting blue signals to isophase or occulting rhythms could possibly reduce confusion.

In principle the CIE Standard S 004/E-2001 for signal colors should be adhered to. However, most white LED signals already in use fall outside the specified white boundary. Furthermore, there is anecdotal evidence to suggest that mariners prefer white LED signals to conventional filament lamp types because they are more conspicuous. A compromise is likely to be sought, possibly in consultation with CIE D-1.

Wreck Marker Buoy. An emergency wreck marker buoy system is being considered and some trials have already been undertaken. It is envisaged that a lightweight buoy, quickly deployed, could help prevent ships colliding with a newly sunken wreck (or similar hazard) not yet charted. Such a buoy would have sufficient battery power to provide light beacons and radar beacons (racons) to mark the wreck until a more permanent means of marking is available.

One possibility for a conspicuous light signal is the use of alternating blue and yellow flashing lights. Trials have shown that this type of light is conspicuous and that color confusion is much reduced by alternating reciprocal colors such as blue and yellow. Because ruggedness is a requirement of such a buoy, LED lights would be the preferred choice of light source.

Conspicuity of Flashing Lights (LED). Due to the large amount of anecdotal evidence suggesting that LED signal lights are more conspicuous than their tungsten filament equivalents, the ANM Committee is keen to explore the underlying reasons. To this end, a collaborative study on visual conspicuity by the Research and Development Department and National Physical Laboratory-UK is being closely followed by IALA.

EEP Work

Two of the guidelines that are currently being drafted by WG4 of the EEP Committee are relevant to CIE Division 1.

Guidelines on sectors, sector lights and sector projection lights. These guidelines will give details on the use of marine AtoN signal lights that have different colored sectors within their arc of utilization. There has been some work within IALA industrial members to investigate the use of LED's for such signals.

Guidelines on ambient light levels at which AtoN lights should switch on and off. These guidelines will give information on the use of devices that control the switching on and off of marine AtoN's at dawn and dusk. With the present concern for conservation of energy, it is important that signals do not waste power by operating unnecessarily during daylight. It is suggested in the guide that light signals should be turned on below an ambient light level of 20lux, which immediately places the observer in the high mesopic region. Manufacturers are to be encouraged to quote the scotopic/photopic ratio as part of their data sheets.

ISO/TC6/W3: Paper, Board and Pulp - Optical Properties: J C Zwinkels

In August 2005, Dr. Anthony Bristow submitted his final report to ISO/TC6 on the activities of Working Group 3 (WG3), and Dr. Byron Jordan (Canada) commenced his term as the new convenor of this working group.

In the recent development of standards, there has been increasing recognition of the importance of having more strict terminology in accordance with CIE definitions. For example, it was recently agreed that the term "luminance factor" is better than the term "luminous reflectance factor and that the illuminant must also be specified.

WG3 is responsible for 12 standards based on reflectance measurements. Seven standards are in various stages of balloting. ISO 2469 on diffuse reflectance and ISO 22891-Transmittance are being balloted at the DIS level (closing date: 2005-08-31 and 2005-10-13, respectively.) The following ones have been submitted to the ISO/TC6 secretariat for CD ballot: ISO 2470-2-D65 brightness, ISO 2471-Opacity, ISO 5631-2-Colour, D65/10°, ISO 5631-3-Colour, D50/2°, ISO 9416-Kubelka-Munk coefficients, and ISO 22754-ERIC.

The current status of the other standards is, as follows:

ISO 11475 – CIE Whiteness (D65/10°), revised version, was published in November 2004 and is not scheduled for review until 2009. Issues that will need to be resolved before then are fluorescence terminology that is consistent with CIE definitions and the problem of negative values of the fluorescent component when materials contain very little FWA.

Of the 3 standards on gloss determination that WG3 is responsible for, ISO 8254-1 Gloss at 75°, TAPPI has been submitted to the ISO/TC6 secretariat for CD ballot.

A new work item for publication as a Technical Report on "Basic equations for optical properties" has been submitted to the ISO/TC6 secretariat for voting.

WG3 maintains an active liaison with CIE TC 1-57 (Dr. A. Bristow) on the development of colorimetric standards and CIE TC 1-66 (Dr. B.Jordan) on the development of a defined indoor illuminant. It was also actively involved in the development of CIE publication 15 on Colorimetry and highlighting the need of ISO/TC6 to have traceable data defining CIE Illuminant C. ISO/TC6 has liaisons with CIE, ISO/TC130-Graphic Arts, and ISO/TC38-Textiles. It is also planning to establish a liaison with the ICC.

ISO/TC38/SC1: Textiles: Colour Fastness & Measurement: M R Luo GB

The last meeting was held on 12-14 July 2004. There are 70 delegates from 12 countries. Various working items in WG7 Colour Measurement were discussed. Only the following relevant items are summarized below:

- A method will be developed on the inter-instrument calibration procedure of the ultraviolet content of light sources of spectrophotometers for measurement of white or coloured materials containing fluorescent whitening agent. An international round robin trial will be conducted.
- A method for predicting colour inconstancy was proposed based on CMCCON02 which includes the CAT02 chromatic adaptation transform used in CIECAM02. The document is prepared to become the DIS.
- An existing work item is in the comparison of the CMC and CIEDE2000 colour difference formulae. It was found no significant difference between the two formulae from some studies. A ring trial will be carried out to assess sample pairs particularly prepared in the neutral and blue areas, which showed larger differences between the two formulae.
- A standard viewing condition for a viewing cabinet was written and will become a NWI to be discussed.
- A method for assessing colour fastness grades by digital imaging technique was proposed. The method includes an illumination cabinet for capturing images of objects and two formulae for converting colour measurement data to colour fastness grades for colour change and staining respectively.

ISO/TC42: Photography: J Holm US

The work of ISO TC42 related to color is primarily carried out in joint working groups with ISO TC130 (Graphic technology) and IEC TC100 (Multimedia systems and equipment). The group responsible for the administration of each standard is listed in parentheses. Standards exclusively developed in ISO TC130 or IEC TC100 are not listed

Also note that the ISO TC42 Secretariat has posted a link to the ICC white papers on the ISO TC42 members web site, to increase awareness of the contents of the white papers.

Probably the most significant event that has happened is the publication of ISO 22028-1:2004, Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange — Part 1: Architecture and requirements (TC42 JWG23) This standard has broad implications for digital color management, providing the architecture and requirements for the unambiguous communication of digital color content data.

Also, the following parts of ISO 22028 are being published as Technical Specifications: 1) ISO/TS 22028-2, Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange — Part 2: Reference output medium metric RGB colour image encoding (ROMM RGB) (TC42 JWG23)
ROMM RGB is commonly known in the user community as "ProPhoto RGB", and is output-referred with the same reference medium and viewing conditions as the ICC v4 perceptual intent. 2)ISO/TS 22028-3, Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange — Part 3: Reference input medium metric RGB colour image encoding (RIMM RGB) (TC42 JWG23)
RIMM RGB is scene-referred, making it the second scene-referred colour encoding to be standardized (after IEC/ISO 61966-2-2 - scRGB).

Technical Specifications are approved for a period of three years, after which time they can be converted to International Standards, extended for a maximum of another three years, or withdrawn.

Discussions about the need to revise IEC 61966-2-1:1999, Multimedia systems and equipment - Colour measurement and management - Part 2-1: Colour management - Default RGB colour space - sRGB (TC100 TA2) have also begun. TC42 will participate in the anticipated maintenance work.

The status of the digital camera color characterization work is as follows: 1) ISO 17321-1 Graphic technology and photography -- Colour characterisation of digital still cameras (DSCs) – Part 1: Stimuli, metrology and test procedures (TC42 JWG20)
DIS ballot in progress. Annex D includes a table of in-situ measured spectral radiances for some commonly occurring objects which may be of interest. 2) ISO 17321-2 Graphic technology and photography — Colour characterisation of digital still cameras (DSCs) — Part 2: Methods for determining transforms from raw DSC to scene-referred image data (TC42 JWG20) - Withdrawn as an active item of work. Consensus that the method for determining these transforms cannot be standardized, because it depends on the camera spectral sensitivities, the spectral radiances of the colors to be analyzed, and various tradeoffs (e.g. colorimetric accuracy vs. noise amplification). However, some results of current research on the use of digital cameras to determine scene colorimetry continues. If at some point in the future there is renewed desire to develop a standard, a NP will be required

Other standards work of possible interest to CIE Division 1 includes: 1) ISO 5, Densitometry (ISO TC42 JWG21) - Revision has been stalled for about a year. The ISO Central Secretariat has indicated that ISO 5-3 is overdue, although it remains available for sale on the ISO web site. Progress is needed soon on this foundational series of standards, which are widely referenced. 2) ISO 3664:2000, Viewing conditions – Graphic technology and photography (ISO TC42 JWG24) - Work to develop Ed. 3 has begun, with the preparation of a WD. Comments were reviewed at the first meeting, held the 8th of November. The primary technical issue is a need to tighten up UV tolerances. 3) ISO 13655:1996, Graphic technology -- Spectral measurement and colorimetric computation for graphic arts images (TC130 JWG8) Joint work with TC42 to develop Ed. 2 has begun. One objective is to coordinate with ISO 3664. 4) ISO 15076-1:2005, Image technology colour management -- Architecture, profile format and data structure -- Part 1: Based on ICC.1:2004-10 (TC130 JWG7) - The ICC profile format specification has been published as an ISO standard. 5) ISO 12231:2005 (Ed. 2) Photography -- Electronic still picture imaging -- Vocabulary (TC42 WG18) was recently published. It includes a number of new color-related terms and definitions.

Also recently published is the following three-part series on subjective evaluation: 1) ISO 20462-1, Photography – Psychophysical experimental methods for estimating image quality – Part 1: Overview of psychophysical elements (TC42 WG18); 2) ISO 20462-1, Photography – Psychophysical experimental methods for estimating image quality – Part 2: Triplet comparison method (TC42 WG18); and 3) ISO 20462-1, Photography – Psychophysical experimental methods for estimating image quality – Part 3: Quality ruler method (TC42 WG18)

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ISO/TC130: Graphic Technology: D C Rich

The ISO TC 130 met for their plenary session 26-30 September 2005 in Sao Paulo, Brazil. Several working groups met during that meeting. Of primary interest to CIE Division 1 will be the activities to revise ISO 3664 on the sources for visual evaluation of graphic arts materials and the revision of ISO 13655 on the procedures for measurement and computation of color in graphic arts materials.

Of particular concern to the graphic arts and color management committee is the effect of substrates containing fluorescent brightener additives. ISO 3664 currently cites Publication CIE 51 for the method for assessing the quality of D50 simulators. The current proposal for revision would recommend removal of all UV radiance from a viewing source - thus creating a new illuminant /source of UV-deficient D50. There is a new Joint Working Group (JWG8) setup between ISO TC 130 and TC 42 (photography) to develop this new draft. ISO 13655 standard (on the measurement of the color of print) references Publication CIE 15 and CIE 51 as well as ASTM E308. Again, there is a recommendation to either force all instruments to be equipped with AB D50 simulators or to exclude all UV radiance in the instrument source. This is because the recommended geometry is 45:0 where it is difficult to create a UV-rich source that can be attenuated to match the output of D50. Thus this working group is also recommending that instruments be equipped with UV cut-off filters. Of more interest is the concern among users of color management that lack of reproducibility between measurement devices is limiting the usability of interchanged and embedded device profiles. There is a need for better tools to assess the level of agreement in terms of a visually based metric. Currently, CIEDE2000 is being evaluated but it seems only appropriate to judgments of printed materials viewed under the default CIE reference conditions that include D65 and 2500 Lux. However, these are not the conditions of viewing of graphic reproductions. They have identified a need to determine the appropriate weights for graphic arts viewing conditions.

These two new working groups met in Scottsdale, AZ prior to the IS&T Color Imaging Conference on 8 November 2005.

ISO/IEC JTC1/SC28 Office Equipment: K Richter

ISO/IEC JTC1/SC28: "Office equipment" is dealing with some CIE related projects, for example in the field of color copiers, printers and scanners. At present SC28 has four Working Groups: an Advisory Group on Strategic Issues, and Groups on Yield, on Image Quality (New), and on Productivity (New), see http://www.jbmia.or.jp/sc28/. For this report see (2 pages, 1 kByte) http://www.ps.bam.de/SC28CIE5.PDF.

The following is a selection of International Standards and Technical Reports of ISO/IEC JTC1/SC28 "Office equipment", which are related to CIE Division. 1. They each follow the form of: ISO-Number Editor Status Title

1) ISO/IEC Takshi Ito published Addendum to ISO/IEC 15775:1999 - 15775 JAPAN 2005-03 Method of specifying image reproduction of colour Amd/1 copying machines by analog test charts – Realization and application
2) ISO/IEC Klaus Richter published Device Output for 16-Step Colour Scales, output - TR 19797 GERMANY 2004-09 linearization method (LM) and specification of the reproduction properties
3) ISO/IEC Paul Jeran FCD Method for the Determination of Toner Cartridge - 19798 USA 2005-09 Yield for Colour Electrophotographic Printers

4) ISO/IEC Yee Ng FCD Method of Measuring Gloss Uniformity for 19799 USA 2005-09 Printed Pages
5) ISO/IEC Paul Jeran FCD ballot Method for the Determination of Ink Cartridge Yield 24711 USA 2005-12 for Color Ink Jet Printers
6) ISO/IEC Paul Jeran FCD ballot Color Test Pages for Measurement of Office 24712 USA 2006-02 Equipment Supply Yield
7) ISO/IEC Klaus Richter published Method of Specifying Image Reproduction of TR 24705 GERMANY 2005-10 Colour Devices by Digital and Analog Test Chart
8) ISO/IEC Eric Zeise NWI Appearance-based image quality standards for 19751-1 USA 2005-09 printers – Part 1: Overview, procedure and methods

For the last available public draft version ISO/IEC DTR 24705 see the URL (80 pages, 1 Mbyte) http://www.jbmia.or.jp/sc28/sc28docs/j28n689.zip. For more information on available test charts for ISO/IEC TR 19797 and 24705 see http://www.ps.bam.de/4STAE.

Five new projects have been recommended unanimously by about 20 experts during the last Advisory Group meeting of ISO/IEC JTC1/SC28 in Amsterdam, March 2005: 1) Test Method for Determining Printer Resolution of Inkjet Printers and Laser Printers, Korea, IS, 2) Colour Photo Test Pages for Measurement of Office Equipment Supply Yield, Korea, IS; 3) Standard Test Method for Determining Energy Consumption of Copiers, MFDs with Copying Capability and Similar Office Imaging Equipment, Japan, IS; 4) Method and equations for the transformation between the device independent absolute coordinates LAB* (CIELAB) and the device dependent relative colorimetric coordinates olv* and cmy* in both directions based on eight device colors CMYOLVNW, Germany, TR; and 5) Linearization method for scanning systems, which scan the analog ISO/IEC-test charts according to ISO/IEC 15775 with 16 steps equally spaced colour scales, Germany, TR. The country for IS = International Standard or TR = International Technical Report is mentioned. All five New Work Items failed in SC28 by the international ballot in Sept. 2005. Therefore there is a large gap between the recommendations of the experts of the SC28 Advisory Group and the final vote on the five topics. If one studies the final voting results of the different countries and the discussions afterwards on the five topics, there seem to be a high voting influence by some global companies in the area of printer and copier systems and their representatives in the many different countries. The companies seem to fear both International Standards and informative Technical Reports in this area which may be contrary to solutions used up to now within their hardware or software products.

Up to now an example solution was the informative International Technical Report. ISO/IEC TR 24705:2005 “Method of Specifying Image Reproduction of Colour Devices by Digital and Analog Test Chart” and the corresponding National Standards DIN 33866-1 to -5:2000 for colour image reproduction properties with digital and analog test charts. The above New Work Items 4 and 5 of Germany have been proposed as informative Technical Report (TR) but failed by the international ballot voting. Therefore the German National Body of SC28 has decided and
expressed in SC28 NOT to re-submit the above New Work Items 4 and 5 in SC28 (Res. 29/2005)

For information about the projects no. 4 and 5, which are related to working areas of ISO TC42/WG18, IEC TC100 TA2, CIE Division 1 and 8 the following information may be useful: 1) “Linear relationship between CIELAB and Device Coordinates for a new Colorimetric Image Technology (CIT)”, see the URL (6 pages, 120 kByte) http://www.ps.bam.de/CIE05.PDF K. Richter, 2005, Natural Colour Connection Space (NCCS) between input and output for office systems, see the URL (1.0 MByte, 20 pages) and published: International Seminar on

Information Office Equipment Standardization, Korean Agency for Technology and Standards, pages 71-92 http://www.ps.bam.de/BAMAG1.PDF. 2) "Transformation between absolute LAB* (CIELAB) and device dependent relative lab* data", see the URL (5 pages, 81 kByte, above New Work Item Project no. 4) http://www.ps.bam.de/NWI05DC.PDF. 3) "Relative Colour Image Technology (RCIT) and RLAB lab* (2005) Colour Image Encoding", see the URL (74 pages, 850 kByte) http://www.ps.bam.de/RLABE05.PDF.

Recent Publications

CIE Publication 165-2005 CIE 10 degree photopic photometric observer (TC1-59)
CIE Publication 166: Cognitive Colour
CIE Publication 167: Recommended Practice for Tabulating Spectral Data for Use in Colour Computations
ISO/CIE Standard - ISO 23603:2005(E) / CIE S012/E:2004.