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LIGHT the official NEWSLETTER

of the **indian society of lighting engineers**

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FROM THE PRESIDENT'S DESK

The results of the election for the new Governing Body have been declared and the present incumbents will hand over charge in the next AGM which will be called shortly. In the next issue the new President will be using this column to reach out to members. I will of course continue to be available to members in my capacity as Past President and will continue to help take forward the endeavours of the Society.

One important project that is taking off presently is the next Light India International Exhibition and Conference scheduled for February next year. The industry has asked that we organize the exhibition during the winter months instead of September as we usually do so that there is no clash with other international exhibitions and also because the weather is more congenial for extended visits to the exhibition. This gives us a much shorter lead time than usual.

I would request members to give their support to Lii2008 so that we can have an event with the level of success that matches if not surpasses our previous ones. Please encourage your contacts both in India as well as internationally to participate in the exhibition which is now widely acknowledged as one of the most glamorous and successful events in the exhibition calendar.

The conference format is in the process of being finalized and I do hope that this time we will have a greater participation of ISLE members than in 2005. I look forward to seeing you there.

The ISLE Newsletter has become the only voice of technical lighting in India and is under great demand in India and abroad. The time has now come to see how we can increase its readership to University and Reference libraries and to Architects, Consultants and Contractors. In this connection I want to specially thank the International Lighting Review and CIE News for allowing us to reproduce their articles.


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In closing, I would like to thank all of you, especially my colleagues in the GB for their help and support in our common goal of spreading the message of good lighting.

S. Venkataramani

President

EDITORIAL

This issue has a number of important and interesting reports.

There is the visit of the CIE President, Prof. Wout van Bommel. As a friend and colleague for many years, I always find it a great pleasure to meet him especially since he communicates the passion for lighting that so many of us also feel. We have reproduced two papers by him that detail the ideas that were presented by him in his talks in Delhi and Mumbai.

Prof. van Bommel spoke to ISLE members on the subject of Light and Health. The importance of this topic is reflected by the fact that apart from his paper, this issue also carries information on the recently released Proceedings of the 2nd CIE Symposium on this subject. In addition, Dr. Sastri's R&D Update on the LRC developments in this area adds to Anool Mahidharia's information on the subject in his WebWatch in the last issue.

The first part of the EU Light India programme has concluded with the training programme in Bangalore in February. The Karnataka State Centre has done a great job in coordinating and running this project. This issue carries a report that covers the Delhi and Bangalore sessions.

The Pune Local Centre continues to reach out to the student community. We have a report of their programme for students at MIT Pune.

The ISLE funded research programme at Jadavpur is underway and a report is included in this issue. There is also an update on the National Lighting Code and we look forward to its completion and publication in this year.

Among the CIE Publications you will find the CIE Standard on Emergency Lighting. It is a matter of pride for us that one of the members of this TC was from ISLE, Mr. P.K. Bandyopadhyay. I would like to add my request to Prof. van Bommel's that more ISLE members take active part in the technical work of the CIE and be part of the network of the 1000 odd international experts that do the CIE work.

H.S. Mamak

Editor

ISLE ACTIVITY

Election

As already reported in the last issue, the process for the election was begun and a Scrutiny Committee appointed with Mr. N. Nagarajan (F.0307) as the Convener and Dr. Mrs. Savitri Ramamurthy (F.0419L) and Mr. A.K. Jain (F.0476) as members. Mr. Anurag Roy was nominated but unable to accept owing to his other commitments.

The Scrutiny Committee met on February 9, 2007 to receive the nomination forms from the Hon Gen Secretary. 19 nominations were received, of which 18 were found to be valid. They were:

Mr. Gulshan Aghi F.0345
Mr. I.M. Asthana F.0361(L)
Mr. P.C. Barjatia F.0179
Mr. Chira Ranjan Datta F.0497
Mr. Bipin Dattani F.0338(L)
Mr. Sisir Kumar Gangopadhyay F.0083(L)
Mr. Sajjan Gupta F.0117
Mr. P.C. Jain F.0427(L)
Dr. Avinash D. Kulkarni F.0011
Mr. Pradip Kumar Majumdar F.0410(L)
Ar. Rohini Mani F.0496
Prof. Dr. Saswati Mazumdar F.0435(L)
Mr. Onkar Mitra F.0277(L)
Mr. Rathinasamy Nagarajan F.0351(L)
Mr. R. Nandakishore F.0355
Mr. Dinesh H. Patel F.0236(L)
Mr. Rajat Roy F.0241(L)
Mr. Raj K. Sahgal F0284(L)

One candidate, Mr. Onkar Mitra withdrew his nomination subsequently.

Ballot papers were sent out to 992 candidates by registered post in India and 20 abroad. 88 ballot papers were returned undelivered by the post office. 24 were resent to new addresses provided by State Centres in some cases by courier service. 5 Duplicate Ballots were sent at the request of voters who indicated that the original ballots were not received.

NEW MAILING ADDRESS

Address for mailing and all queries:

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A-88, 2nd Floor, Sector IV
NOIDA 201 301
Tel: 0120 4242783/4242784
Fax: 0120 4242780
E-mail: isledel@vsnl.com; www.isleind.org

Registered Office: C/o Philips Electronics India Ltd.
Technopolis Knowledge Park, Mahakali Caves Road, Chakala, Andheri (E), Mumbai 400 093

On April 23 at 5 p.m. the Scrutiny Committee met at the ISLE office. After allowing half an hour grace period, the opening of the ballot box was sealed.

On April 28 the Scrutiny Committee met at the ISLE office at 11 a.m. for scrutiny and counting of ballots.

The ballot box was unsealed and opened and the ballot papers examined. A total of 313 ballots were received. Of these 300 were found to be in order and 13 were declared invalid. While checking the ballots a further 4 were declared invalid. In 2 cases of disputed membership status, the ballots were set aside and examined later. One was found to be valid and the other invalid making a total of 295 valid ballots.

The following observers were present: Mr. Bipin Dattani as candidate, Mr. H.S. Mamak on behalf of Dr. Avinash Kulkarni, Mr. P.K. Bandyopadhyay on behalf of Ar. Rohini Mani, Mr. Vishal Handa on behalf of Mr. Gulshan Aghi and the Hon. General Secretary, Mr. H. Mukherjee.

After the counting of votes the following candidates were declared elected.

Dr. Avinash Kulkarni
Dr. Saswati Mazumdar
Mr. Gulshan Aghi
Mr. R. Nagarajan
Mr. I.M. Asthana
Mr. Rajat Roy
Ar. Rohini Mani
Mr. C.R. Datta
Mr. Pradip Kumar Majumdar

CIE President's Visit

The CIE President, Prof. Wout van Bommel at our request made a brief visit to India on his way to the Far East. We were fortunate that he was able to make time for programmes organised by ISLE in both Delhi and Mumbai.

Actively involved in the technical work of CIE for many years, Prof. Van Bommel has published more than a hundred papers in international journals. He began his career in fundamental lighting application research and some of the concepts he proposed are now applied internationally. In recent years he has focused his attention on the non visual biological effects of light on humans. He is a visiting professor at Fudan University in Shanghai.

On the morning of March 19 in Delhi Mr. van Bommel made a presentation to the Bureau of Indian Standards on CIE and Standardization, outlining the process within CIE for developing standards. The meeting was well attended with 20 officials including the Deputy Director General.

After lunch Mr. van Bommel visited the School of Planning and Architecture where he spoke to the students on the subject of Lighting and Emotion in the context of the relationship between lighting and architecture. Prof. Mandeep Singh, Head of the Industrial Design department coordinated the lecture and introduced Mr. van Bommel. There were over one hundred students of the lecture. The ideas put forward in the lecture are contained in the paper published on page 26 and contain many important issues that are especially relevant in the context of the forthcoming Commonwealth Games.

Later in the afternoon the Delhi State Centre Committee members had a meeting with him to get a clearer idea of the functioning of CIE and to give Mr. van Bommel an idea about the activities of the State Centre.

In the evening at the Meridien Hotel members of the State Centre were fortunate to get a presentation on the important topic of Lighting and Health from Mr. van Bommel who is one of the foremost international experts in this relatively new field. (see page 16) Mr.N.Nagarajan, Chairman Delhi State Cente Welcome the speaker and Mr. O.P. Bhola Treasurer felicitated him. The meeting was followed by dinner.

Prof. van Bommel's programme in Mumbai on March 21, began with a visit to the the Rachana Sansad School of Interior Design and Academy of Architecture. He was warmly welcomed by Prof. Sumant Wandrekar, Founder Chairman and Ar. Pradeep Amberkar, Jt. Secy. Rachna Sansad.

Prof. Van Bommel's lecture, the main ideas of which are contained in his paper on page 26 was followed by a lively interaction with the staff and students who were impressed with his vast knowledge and greatly enjoyed his sense of humour.

Ar. Rohini Mani, Hon. Secretary of the Mumbai State Centre who was instrumental in organizing this programme thanked the speaker as well as the Management, Staff and Students for their help in organizing the programme and their participation.

In the evening ISLE members and guests assembled at the MIG Club for Prof. Van Bommel's presentation on Light and Health. Mr. P.C. Barjatia, Chairman of the Mumbai

Ar Rachana Sansad in Mumbai

Prof Van Bommel with Chief Guest, Mr. Manoj Verma and Mumbai State Centre Committee members

State Centre welcomed the distinguished speaker, the Chief Guest, Mr. Manoj Verma, Vice President Lighting at Crompton Greaves and Mrs. Sudeshna Mukhopadhyay, General Manager, LiDEC and Solid State Lighting at Philips Electronics India who were then felicitated by members of the Committee.

After the presentation (see paper published on page 16) and the subsequent interaction, the Chief Guest, Mr. Manoj Verma summed up the proceedings. Mementos were then presented to the Speaker, the Chief Guest and Ms Sudeshna Mukhopadhyay.

The Vote of Thanks was given by Stan Alvares, Convener of the Publicity Sub-Committee. He thanked all the members present especially those from Pune and Indore who came for the lecture. He also thanked Mrs. Rohini Mani for organizing Prof. van Bommel's lecture at Rachna Sansad.

This was followed by cocktails and dinner.

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EU Light India

The first part of the EU Light India programme organized by ISLE the Karnataka State Centre came to an end with the third training programme in Bangalore in February. This program was drawn up with the assistance of the European Commission under the Asia Invest Scheme. The partners in this program are the associations ASSISTAL and ACAI of Italy and IRSEP of Poland, ISLE from India and EU-INDIA Chambers of Commerce also from India. For this program, there were experts from Italy and Poland through the partner associations.

The participants were drawn from all sectors; Municipalities, who provide the street lights, Tourism organizations, who provide the lighting for Monuments for tourism, Sports lighting providers like SAI, CPWD etc., System operators like electricity boards and ESCOMS, Manufacturers as well as Designers and Consultants. The emphasis was on quality, safety, energy conservation and maintenance from all aspects.

From left: M S N Swamy, Co-ordinator of the Indian Society of Lighting Engineers (ISLE) Karnataka State Centre, W Tomasiak and Maurizio Esitini, delegates from Italy, P B Mahishi, Karnataka Chief Secretary, Atul Bhagwati, President of the Council of EU Chambers of Commerce in India and S L Jadhav, ISLE Chairman, at the programme on 'Street Lighting and External Lighting,' at Bharatiya Vidya Bhavan in Bangalore on Friday.

(From press report in the Deccan Herald)

In the next stage of the program, 22 participants will be visiting Poland and Milan for attending the program of technical visits. They will also be visiting the Euroluce trade fair. The group of participants in this program has participation from all sectors and from all geographical regions of India.

The Bangalore training programmme from February 13 to16 went through very well. The Energy Secretary (who also happens to be Additional Chief Secretary) Mr. Dilip Rau inaugurated the training progam. There were 55 registered participants and a few senior invitees such as MDs of ESCOMS.

The Director General, CPWD and Director General, CPRI were there for the workshop session on 15 Feb afternoon.

The Chief Secretary to the Government of Karnataka, Mr. P.B. Mahishi participated in the Program Evaluation Seminar on Feb 16 and also inaugurated and dedicated the Lighting Knowledge Bank website. All the program partners were impressed with the programs held.

What was surprising was that in Bangalore there were four participants from the Delhi Municipal Corporation, even though the previous programme was held in New Delhi. There were participants from all the southern

Messrs.: Giuseppe Tinti, Wojciech Karwacki, Pradeep Nettur, MSN Swamy, and Dario Agalbato

Mr. J. N. Bhawani Prasad

states. In addition to those from Delhi, there were participants from Nasik and Ahmedabad, as the good word reached them after the Mumbai program.

Prior to Bangalore, the second training programme was held in Delhi from November 27 to 29, 2006 with 52 registered participants and 32 guests. The participants included representatives from Street Lighting and External Lighting providers, such as the municipalities of Delhi and New Delhi, Chandigarh, CPWD, DDA, Ministry of Power, Ministry of Urban Development, Delhi PWD etc., The highlight of the program was the great interest shown by the Bureau of Energy Efficiency (BEE). Dr.Ajay Mathur, DG, BEE was in the inauguration program and Shri Mehar Singh, Director in the Ministry of Urban Development dealing with the Jawaharlal Nehru National Urban Renewal Mission, which has a very huge outlay for development of the urban areas through the municipalities attended the workshop session. Practically all the Equipment manufacturers and system providers such as GE, Bajaj Electricals, Philips Lighting, Crompton Greaves as well as a number of small and medium industries manufacturing, controls, light fittings and special purpose

A session in progress at Delhi

equipment for applications like stage lighting etc. attended the programme There were also External Lighting (other than street lighting) providers, like Indian Railways, CPWD, MES, etc., Consultants engaged in the Lighting Design, Lighting and Electrical systems, Equipment design and System integration.

The sessions were interactive and generated a lot of interest. There were over 85 questions and supplementaries thereof. In the workshop, in the final session, about 10 participants each from a different sector, presented the sectorial highlights and the innovative developments that has been made in their organization. Specific areas where mutually beneficial activities can be developed were discussed.

Delhi will be hosting the Commonwealth Games in 2010 and work on various sports stadia and on lighting the monuments (or upgrading them) has already started. In this context a lot of discussion took place. A request has also come for the arrangement of a dedicated session focussed on Sports lighting and also for a session on Monument Lighting.

The leader of the European Delegation Mr.Maurizio Estini agreed to take up the matter with the European Commission either as an extension of this programme or as a separate programme immediately on conclusion of the present programme.

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ISLE Sponsored Research Project on New Road Lighting Design Approach for Developing Countries.

Interim Report

***Objective of the Project*:**

The objective of the Research proposal has two parts:

Part A - To determine Design Factors taking into account any reduction in Illuminance on the road surface due to:

- High vehicle emission during the peak traffic periods;
- Different environmental conditions;
- Different atmospheric conditions.

The current ISLE sponsored project is for Part-A.

Part B - To determine

- Lighting Parameters like desired Illuminance, Luminance, Uniformity Factors etc. for the mixed vehicular traffic with different speeds of movement and pedestrians on the road;
- Whether both Illuminance and Luminance concepts are suitable for all types of roads.

Part-B will be taken up after completion of the Part-A.

Why this Project?

1. As all research and studies on Roadlighting, like all other application areas, have been done in developed countries, specific conditions prevailing in a developing country like India, were not considered in the existing Codes of Practice and Guides available internationally.
2. It has been observed by the Lighting Practitioners that Illuminances were less during peak traffic hours in Indian cities than designed values. No research has been done on reduction in Illuminance due to high vehicular emission, as developed countries do not experience as much reduction as in countries like India, Thailand etc.
3. Even if the proposed Research concludes that higher lighting levels should be provided during peak traffic hours, with the latest dimming technology these levels could be brought down to normative values thus saving energy consumption.
4. The BIS Code of Practice on Roadlighting is due for revision, now that National Lighting Code is almost finalized. The conclusions of the proposed Research will go into these documents.
5. At the initiative of ISLE, in 1995 CIE recognized the need for a separate Guide on Roadlighting in Developing Countries and formed a Technical Committee with an Indian as the Chairman, who was replaced subsequently by a member from UK in 1999. No worthwhile progress has been made till now in spite of some personal efforts of both the Past Presidents of ISLE, mainly due to the absence of any data from any developing country.

Who will benefit?

(1) All Lighting companies who carry out Roadlighting Design.
(2) All Government and Municipal Bodies, who provide and maintain Roadlighting.
(3) Police Departments.
(4) Insurance Companies.
(5) All Road users.

Progress so far:

The research team realised at the very outset, that to utilise the data obtained from this research project for road lighting design work using photometric data of all lamp and luminaire manufacturers [I-table], it was necessary to develop new design software. So a Visual Basic based road lighting design software "ROADLIGHT_JU" has been developed as a M.E. Illumination Engineering final year student project assignment.

Field measurements were then carried out on a stretch of road at Panchasayar, Garia situated on the South-Eastern fringe of Kolkata with the support of the Deputy Chief Engineer [Lighting], Kolkata Municipal Corporation [KMC].

The predicted values obtained from ROADLIGHT_JU were close to measured values. However, output of ROADLIGHT_JU when compared with CALCULUX and DIALUX showed minor variations.

Next, the 2nd phase of design software ROADLIGHT_JU was taken up as another M.E. Illumination Engineering Project assignment. This will cover luminance computation and glare assessment. As on February 2007, the luminance computation was completed, but verification will be done during field measurement. Data were compared with CALCULUX output and variations were observed. Glare computation started in March, 2007.

Meanwhile, the West Bengal Pollution Control Board was approached to support the project activity by measuring pollution levels on the same roads, where illumination data would be measured.

Dr. Ujjal Mukhopadhyay, Senior Scientist, agreed to support this field research. He proposed that mathematical model should be made from the outcome of the study, which would enable determination of the extent of reduction in illuminance due to the level of pollution. This could be applicable everywhere once the pollution level is known in the concerned area. After discussion with Dr. Mukhopadhyay it was decided that the field measurement would be started at a suitable road stretch in central Kolkata around the Maidan.

Support from authorities like Kolkata Police [KP], PWD, Govt. of West Bengal and KMC are very important for the selection of road and to conduct the field measurement.

A survey to find a suitable stretch of road in Central Kolkata was conducted along with Sri M.Gangopadhyay, Superintendent Engineer, PWD and Sri S.Karmakar, Assistant Engineer in charge of the maintenance of street lighting. Three stretches of roads were found suitable for field measurement keeping in view the lighting equipment used, layout of street furniture and the importance of roads from the angle of traffic density-

a.	Red Road	Stretch opposite Mohammedan Sporting Club
b.	Kidderpore Road	Stretch opposite Fort William
c.	St.Georges Gate	Opposite Princep Ghat Road

To conduct field measurements on city roads, from evening and continuing beyond midnight at certain time intervals, police permission is important as during measurement on a particular stretch traffic should not be allowed to run on it to avoid interference of traffic headlights.

Sri J. Shamim, DC, Traffic, Kolkata Police was approached for permission and he mentioned the following regarding the selection of site-

- Police protection from two sides of the road stretch is a must for the survey team, as measurement will be taken from evening (peak traffic period) and continue beyond midnight (lean traffic period)
- Traffic may be blocked on Red Road after midnight.
- Traffic may be blocked only for one way after midnight on Kidderpore Road.
- It is not possible to block traffic on St.Georges Gate Road at any time even after midnight.

Based on the above input from the DC, Traffic it was decided to conduct field survey on Red Road.

The first meeting of the Project Administrative Committee [PAC] formed as per the University regulation was held in February 2007. The meeting was attended by:

1. Sri Pranab Kumar Bandyopadhyay, Project Advisor
2. Prof.P.K.Chattopadhyay, Head of Electrical Engineering Department, JU
3. Dr. Biswanath Roy, Principle Investigator, Reader, Electrical Engineering Department, JU
4. Sri P.J. Biswas, Deputy Chief Engineer(Lighting), Kolkata Municipal Corporation
5. Dr. Ujjal Kumar Mukhopadhyay, Senior Scientist, West Bengal Pollution Control Board
6. Sri Manas Ganguly, Superintendent Engineer-EC-I, PWD, Govt. of West Bengal
7. Sri Biswajit Bhattacharya, Lecturer, Electrical Engineering Department, JU
8. Sri Nikhil Mondal, Reader, Electrical Engineering Department, JU
9. Sri Sovan Dalai, Lecturer, Electrical Engineering Department, JU

The meeting, chaired by Sri Pranab Kumar Bandyopadhyay, reviewed the progress and following future plan of action was agreed upon:

1. The use of Free and Open Source Software (FOSS) to write roadlighting design software, which was written in Visual Basic. This was suggested by Dr.Ujjal Kumar Mukhopadhyay and he agreed to provide all support to do it.
2. As blocking the traffic during the peak period would be a problem, speedy measurement process using some automation instead of conventional method is a must. A trolley, holding the luxmeter sensor horizontally, will be made which moves at a constant velocity, say 1m/s, along a straight line parallel to the road axis. Data will be recorded and stored by Data Acquisition System (DAS) after a specified time interval, say, every 2s, then illuminance values can be recorded at each point 2m apart. The recording time interval, specifying the grid length, is restricted by the response time of the Luxmeter sensor. This automated Data Acquisition System will record light levels in a more reliable and precise manner. Necessary technical support to

make this facility will be provided by Dr. U. Mukhopadhyay.

3. At Red Road, the pollution level will be measured extensively along with illuminance measurement on the road surface. Presence of carbon mono-oxide and sulpher di-oxide and oxides of Nitrogen, Ozone and particulates will be monitored from evening to after-midnight. This data will indicate reduction of illuminance level due to mixed effect of vehicular emission and atmospheric haze.
4. Measurements at Red Road will be conducted during March, June, November and January representing four distinct seasonal conditions.
5. Environmental effect on light level will be studied at roads in Salt Lake and Panchyasayar, Garia which are on the eastern periphery of Kolkata and the pollution due to vehicular emission is less there. On these roads only the presence of atmospheric particulate measurement will be done. Thus the study will reveal predominantly the effect of seasonal variations.
6. On the day of field measurement, the data for traffic density at Red Road and estimation of total traffic in the city are to be collected from DC, Traffic, Kolkata Police.
7. The Director, Meteorological Department, Kolkata, will be requested to supply the following data on the day of measurement—
   - Dew point.
   - Mixing height.
   - Humidity—maximum & minimum.
   - Temperature—maximum & minimum.

The progress of work on the above action plan will be reported in the next half-yearly report.

Dr.Biswanath Roy
Principal Investigator
Reader, Illumination Engineering
Electrical Engineering Department
and
Joint-Director, School of Illumination Science,
Engineering & Design, Jadavpur University
[SISED-JU]Kolkata.

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National Lighting Code and Standardization on Illumination Engineering and Luminaires — A Status Report

Illumination Engineering and Luminaires Sectional Committee ET 24 of the Bureau of Indian Standards held its 9th meeting at Kolkata on 14th and 15th February, 2007. This was a very successful meeting with active participation of all Committee members.

The main item on the agenda was approval for finalization of drafts of various chapters of the National Lighting Code (NLC). In the last two meetings excellent contributions from members speeded up the progress and several drafts were finalized.

Contents of the NLC and status of each of the Parts/ Sections are given below:

Part I	**General and Common Aspects, Lighting Vocabulary**	Finalized
Part 2	**Physics of Light**	
Sec 1	General Principles	Finalized
Sec 2	Vision	-do-
Sec 3	Colour	-do-
Part 3	**Electric Light and their Accessories**	
Sec 1	Electric light sources	-do-
Sec 2	Control gear for light sources	-do-
Part 4	**Luminaires**	
Sec 1	Classification and Selection of Luminaires	-do-
Sec 2	Construction and Safety Requirements	-do-
Sec 3	Photometric Data	-do-
Part 5	**Interior Illumination**	
Sec 1	Industrial Lighting	-do-
Sec 2	Office Lighting	-do-
Sec 3	Lighting for Educational Institutions	-do-
Sec 4	Hospital Lighting	-do-
Sec 5	Lighting for other Public Buildings	-do-
Part 6	**Exterior Illumination**	
Sec 1	General features	-do-
Sec 2	Industrial Area Lighting	-do-
Sec 3	Security Lighting	-do-
Sec 4	Decorative Lighting (flood, monument, park and garden)	-do-
Sec 5	Lighting for utility areas (dock and harbour, railway marshalling yard, airport apron and open areas)	-do-
Sec 6	Sports Lighting	-do-
Part 7	**Lighting for Hazardous Areas**	-do-
Part 8	**Road Lighting**	Draft to be modified
Part 9	**Energy Conservation in Lighting**	-do-
Part 10	**Installation aspects for lighting**	
Sec 1	Mechanical	Finalized
Sec 2	Electrical	-do-
Sec 3	Coordination with related disciplines	-do-
Part 11	**Daylighting for buildings**	-do-
Part 12	**Emergency Lighting**	-do-
Part 13	**Field Measurement**	Draft not ready
Part 14	**Lighting Maintenance**	Finalized

It has been decided that the next meeting would be called early to finalize the three drafts as mentioned in the foregoing. Also, it has been decided that final editing for printing would commence from April, 2007 to save time, instead of waiting for the remaining drafts, so that NLC would be published within this year.

Members of Working Group for NLC under the BIS Sectional Committee, ET 24 are :

Mr. P. K. Bandyopadhyay, Chairman
Indian Society of Lighting Engineers

Mr. Debasis Basu
Philips Electronics India Ltd.

Mr. Soumen Bhowmick
Philips Electronics India Ltd

Mr. S Chakraborty
Bajaj Electricals Ltd.

Ms. Sudheshna Mukhopadhyay
Philips Electronics India Ltd

Mr. Ramesh H. Patel
Indian Flameproof Manufacturers Association

Dr. Biswanath Roy
Jadavpur University

Mr. S R Ramavat
Military Engineering Services

Mr. Ashis Sengupta
Central Public Works Department

Mr. S R Subramanian
Central Public Works Department

Mr. P K Mukherjee, Scientist 'F' & Head (Electrotechnical), BIS is the Member Secretary.

Regarding standardization of Luminaires, the most important decision taken was to revise IS 10322 on Luminaires, Part 1 General Requirements and Tests, to be in line with the latest IEC Publication. This standard is extensively used by organized buyers, testing laboratories and BIS Licencees. It has also been decided to gradually revise all other parts of IS 10322 to be in line with IEC 60598 series.

With the publication of the NLC and the new Luminaire standard some of the codes of practice on various lighting applications will either become obsolete or need revision and many of the existing standards on various luminaries will be withdrawn.

Other important decisions were:

a. Five existing standards on Flameproof electric lighting fittings and those for Division 2 areas will be transferred to the Sectional Committee on Electrical Apparatus for Explosive Atmospheres, ET 22 for better synergy.

b. Twelve existing standards on Elevated type and Inset type aerodrome lighting fittings including codes of practice for installation and maintenance are very old. As the technology has undergone considerable changes, BIS will seek the opinions of experts from relevant user organizations for a final decision on the suitability of these standards now.

The ET 24 Sectional Committee feels that with the above new introductions and decisions, on the one hand the standardization of Illumination Engineering and Luminaires will be contemporary and on the other with the possible withdrawals and transfers of about 30 standards, the list of publications will look more compact with a higher degree of usage by all stakeholders.

Pranab K. Bandyopadhyay
Chairman, Illumination Engineering and
Luminaires Sectional Committee, ET 24, BIS

KARNATAKA STATE CENTRE

Celebrating 10 Years of ISLE KSC
February 16, 2007, Bangalore

ISLE Karnataka State Centre celebrated 10 years of activity on February 16.

The Chief Guest for the occasion was Mr. P.B.Mahishi IAS, the Chief Secretary of the Government of Karnataka.

On this occasion all the people involved in the EU Light India project were honoured together with the Executive Committee members.

Mr. Thampi presented a case study on Controls and their effect on energy conservation. This was followed by

Mr. Mahishi, Chief Secretary Karnataka honouring the speakers

Celebrating 10 years of Karnataka State Centre

a talk by Mr. V.K. Gupta on LEDs, the future of lighting and by Mr. Muthur Krishna Murthy of Bharatiya Vidya Bhavan on planets and their effects.

Mr. M.G. Satyendra, the Director of the Educational Programme of the ISLE, KSC recalled the history of the State Centre, starting with the initial efforts of Mr. M.S.N. Swamy as early as 1993 which did not meet with immediate success but nonetheless did not discourage him. Later with encouragement of Mr. Satyendra and support from Mr. Riaz Kagalwala and later Mr. Mohan from ISRO, Mr. Thulasidas from MECON and the DG of CPRI, Mr. M.G.K. Pillai, Mr. Swamy was able to ensure that the Centre came into being in February 1997 with the simultaneous holding of a National Conference on Lighting for the 21st Century. Other major events held since then include the Vision 2004 and Vision 2006 Conferences and Exhibitions. In addition, a large number of technical lectures on the latest developments and training programmes for different sectors have been held periodically. Mr. Satyendra enumerated these. With the move of Mr. Bhavani Prasad, former Director General of CPWD and former Chairman Delhi State Centre to Bangalore and the support of the other Executive Committee Members, KSC has started a Work Shop and Training Programme for Engineers, Future decision makers, Contractors and Non Professionals on the Basic Language of Lighting, Controls, Saving of Energy and Effect on Environment. Mr. M.S.N. Swamy's handbook, "Lighting, What Everyone Should Know" is also being used for this objective.

The ongoing EU Light India programme is the latest in the ambitious projects undertaken by the Centre.

The Cultural Programme following the talks was sponsored by GE Consumer and Industrial. A dance drama was presented by The Venkateshwara Natya Mandira. The programmes were well attended by Members of ISLE as well the Public and appreciated by all, especially the Delegates from Italy and Poland. The programme ended with Dinner.

PUNE LOCAL CENTRE

ISLE Student Chapter at MIT Pune

February 13, 2007, Pune

The Pune Local Centre, in its effort to bring students into the ISLE fold, inaugurated a Student Chapter at College of Engineering at MIT Pune on February 13.

The Chapter was inaugurated by Dr. Avinash Kulkarni, Managing Director of the Litex Group of Industries and Former President ELCOMA. The Chief Guests at the function were Prof. A. K. Pathak and Dr. Mulay of the MIT College of Engineering. Mr. P.C. Barjatia, Chairman of ISLE Mumbai State Centre and Mr. P.C. Jain, Chairman of the Pune Local Centre presided over the function.

38 students submitted membership application forms and fees after the function and 16 other applications were received subsequently.

Exhibition – Wonderful World of Lamps

February 22-26, 2007, Pune

Pune Local Centre organised this unusual exhibition with the help of MCCIA, in particular, Mr. G.A. Sathe, Vice President and Shri Vinayak Inamdar as part of the Pune Expo 2007. The exhibition consisted of the unique collection of 3000 lamps put together by Mr. C.K. Chaudhari over the years.

The display included lamps ranging in size from 0.9 mm to 300 mm in diameter and in power from 0.20 milliamps to 10,000 Watts and tubes ranging from 5 mm to 75 mm in diameter with lengths ranging from 30 mm to 6 feet. The exhibition also had a replica of the Edison lamp.

Prof. Dr. Vishwanath D. Karad, Executive Director of MAAER's MIT was the Chief Guest for the inauguration of

A section of the display

this exhibition on February 22. Mr. P.C. Jain, the Chairman of the ISLE Pune Local Centre gave the welcome address while Mr. P.C. Barjatia, Chairman of the Mumbai State Centre and Convener of the Lamp Exhibition Committee spoke about the exhibition and thanked Mr Sathe and Mr. Inamdar for making it possible.

The exhibition was opened by Mr. A.K.Chaturvedi, Sr.Vice President of Lumax Industries, Pune and sponsored by Star Engineers also from Pune The function was presided over by Dr. Avinash Kulkarni, CMD of Litex Industries, Pune and Ex. President, ELCOMA.

The Souvenir brought out on the occasion jointly by the Pune Electric & Electronic Association and ISLE was released by Dr. Bijoy Kumar Dash, Eminent Scientist and Expert in Lighting Technology from the USA. All dignitaries were felicitated by a memento, and were presented the Directory of the Lighting Industry in India. Dr. A.R. Bhalerao, Principal of Bharti Vidyapeeth Deemed University College of Engineering, and Prof. Mangesh Karad of MIT College of Engineering, both from Pune, were specially felicitated for promoting ISLE Student Chapters in their colleges, for the first time in the country. The Vote of thanks was proposed by the Student Representative Mr. Ishan Jain.

The Exhibition was visited by more than 10,000 visitors. With this event, ISLE made its presence felt in Pune amongst manufacturers, professionals and consultants. A few companies have already agreed to support ISLE by becoming Institutional Members, whereas a number of individuals have already applied for membership in different grades.

The display by ELCOMA on Energy Efficient Lighting was appreciated by a number of visitors and there were detailed enquiries about the feasibility of replacing conventional lamps with CFLs.

CIE ACTIVITY

26th Session of the CIE
July 4-11, 2007, Beijing

The CIE Session in Beijing is just around the corner. Even though the last date for concessional registration is over, you can still take advantage of the special rate for Developing Countries.

For information on the programme you can look at the CIE website, www.cie.co.at or www.cie2007.org.cn

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New Supportive Members

We are happy to announce the following 3 new Supportive Members of CIE

AB Fagerhult
Colours
Ink Mann

The last two are non lighting companies from India from the Micro Inks and Huber Group.

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Creating a CIE Book: CIE Colorimetry
Understanding the CIE System – CIE Colorimetry 1931 – 2006

Colorimetry played an important role in CIE activity ever since it was first discussed in 1927 in Bellagio, Italy. It is perhaps worth mentioning that in those days CIE was able to come up with a metrological recommendation within four years of preparation. CIE passed its first and fundamental recommendations on colorimetry in 1931, and these are still in use all over the world.

During the years CIE published many technical reports and recently also standards on colorimetry, but no CIE endorsed publication summed up all the work done in this - or any other - field of light and lighting. Naturally experts, who are active also in the CIE, published several books on colour; the most notable was probably “Color Science: Concepts and Methods, Quantitative Data and Formulae” by G. Wyszecki and W. S. Stiles. This book became the unofficial “bible of colorimetry”. The second edition of this book was published in 1982, and as time passed it became clear that an updating of its content would be necessary. Unfortunately both authors passed away untimely, thus an updating by the original authors became impossible. CIE Division 1 would have been prepared to look into this problem, but the approach of the CIE towards the publisher and the heirs of the authors turned out to be unsuccessful.

CIE Board of Administration then thought to just publish a compendium of CIE Technical Reports related to colour as one volume, making CIE knowledge accessible also to those who do not have access to the single publications. Also this approach turned out not to be feasible; the age, structure, typeset, etc. of the different publications were so different that it would have been impossible to bring them to a common format, or at least the work necessary to do so would have been too expensive.

In 2005 we realized that the next year will be the 75th anniversary of the first CIE recommendations on colorimetry, thus it would be appropriate to commemorate this not only with a symposium but to publish a CIE Colorimetry book. 2005 was the year when colorimetrists gathered first in Granada at an AIC congress and subsequently CIE Division 1 and the Board of Administration met in Leon at a Midterm Meeting. Thus it was relatively easy to discuss the question with a number of experts active in colorimetry, and a content list of a book, as well as a list of devoted possible authors could be established quickly. The CIE Board of Administration was of the opinion that real impact also outside of CIE circles could be obtained only if a globally active publisher would be involved in publishing the book. As the Wyszecki – Stiles book was a Wiley publication, and Wiley publishes also a periodical in colour (Color Research and Application) it seemed reasonable to approach Wiley with the idea of the book. Ellen Carter, editor of CR&A was helpful to the designated editor of the book to establish the contact with Wiley Interscience, and after some correspondence an agreement could be reached.

According to this Wiley was willing to publish the book, but it wanted to be in contact with responsible persons as editor and authors, not a society. CIE agreed to this under the condition that it could publish a pre-print volume for the participants of the CIE Colour Symposium 2006, as Wiley could not guarantee the appearance of the book for May 2006.

During the autumn and winter of 2005 and early spring 2006 a handful of CIE experts have shown that they are capable to do the impossible, the manuscript was ready in April 2006, and the CIE Central Bureau printed enough copies to be available in Ottawa at the CIE Symposium.

The book summarized CIE colorimetry in 14 chapters. The first one was a facsimile reproduction of the 1931 resolutions on colorimetry, the second one a facsimile reproduction of professor Wright's historic overview of the 1931 congress he presented at the Golden Jubilee meeting of the CIE Colorimetric System. To produce these was easy, only some scanning work, producing headers and footers were necessary.

The next six chapters summarize CIE knowledge on colorimetry, starting with a more descriptive text of CIE Publication 15, where a number of explanatory figures are included; followed by an introduction to colour difference evaluation. The next two chapters deal with colorimetric practices, how to perform spectral and tristimulus measurements, where the pitfalls of such measurements are, what precautions are necessary to achieve meaningful results. These chapters contain already information that cannot be found anywhere else.

Two further chapters deal with applications of colorimetry in colour management and colour rendering calculation.

The further chapters deal with subjects that have not been described yet in CIE publications, but are dealt with in different CIE Technical Committees. Among others these chapters deal with open questions of colorimetry, the problem of better colour matching functions, colour difference calculation based on colour appearance models, and spatial and temporal descriptions.

The main part of the book closes with an outlook into the future by Professor Hunt.

Three appendices provide fundamental information, uncertainty calculation in colorimetry and some information on CIE colorimetry used in the paper and the textile industry.

The text, conceived in late summer 2005, could not have been absolutely error free and peer reviewed by May 2006. This was the task of some further CIE experts and the authors during the summer of 2006, but the complete peer reviewed and error corrected manuscript was handed over to the publisher in a page edited form in early autumn 2006, with the hope that if not for the Jubilee meeting, but within the Jubilee Year the official book would be published by Wiley.

The big surprise came only afterwards, when it turned out that the publishing activity of a professional publisher takes much-much longer than the work done by the CIE Central Bureau. The complete book is about 450 pages long. The proof-reading and correcting of this number of pages would be done in the Central Bureau within one or two months. But Wiley has informed the editor of the book this February that it will not be able to publish it for the Beijing Session, only some preprint volumes will be made available for the meeting.

Why did I bring all this to the attention of the entire CIE community? CIE incurs frequent reproaches that it is too slow. If some CIE members see a task that is worth completing, they can act swiftly and produce very valuable results. It is the task of the Divisions and their leaders to motivate the experts to complete the reports in a short time. Probably we will have to introduce new ways of collaboration to be able to achieve this. But on the other side with a strong and well equipped Central Bureau we can also get the final production of our publications, whether technical reports or even books, ready in a reasonable time. Naturally there is one further link missing: CIE knowledge has to be brought to the general public, and this has to be the task of our National Committees. Without their help and contacts to their national societies and journals the CIE know-how cannot be brought to the attention of the many experts who do not collaborate in one of the Divisions or technical committees. Marketing - not just of our publications but of the entire CIE knowledge - is possible only with the contribution of the National Committees. From the production of the book on colorimetry we have learned a lesson and should be even more effective in the future in producing and disseminating CIE know-how among the many engineers and scientists working in light and lighting.

János Schanda

(Reproduced from CIE News)

CIE PUBLICATIONS

Measurement of LEDs
CIE 127:2007

This report is an update of the previously published CIE Technical Report CIE 127-1997.

There are significant differences between LEDs and other light sources which made it necessary for the CIE to introduce new quantities for their characterization with precisely defined measurement conditions. New quantities introduced here are “Averaged LED Intensity” and “Partial LED Flux”.

The report describes in detail the measurement conditions for ALI (Averaged LED Intensity), Total and Partial LED Flux and Spectral Power Distribution. It is shown that measurements by substitution method using LED standards can be simpler; however it is important to compare similar coloured LEDs or use colour correction on the measurement results. The standard LEDs need to be calibrated by National Metrology Laboratories or a laboratory traceable to National Metrology Laboratories.

The report is written in English, with a short summary in French and German. It consists of 38 pages with 15 figures, and is readily available via the website of the Central Bureau of the CIE (www.cie.co.at).

The price of this publication is EUR 48,— (Members of the national CIE organisations get 50% discount).

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Colour Rendering of White LED Light Sources
CIE 177:2007

This Technical Report reviews the applicability of the CIE colour rendering index to white LED light sources based on the results of visual experiments. The currently recommended colour rendering index (CRI) calculation method was officially introduced in 1974, and is described in the current publication CIE 13.3- 1995. Visual experience has shown that the current CRI based ranking of a set of light sources containing white LED light sources contradicts the visual ranking.

In this Technical Report, three recent visual experiments (including simulations) on colour rendering including white LED light sources are described that confirm this contradiction. It was concluded from these visual colour rendering results that the current CRI method did not describe well those situations where white LED light sources were involved i.e. if white LED light sources were visually ranked together with other light sources. Low correlation was found between the visual colour differences and the computed colour differences if the current CRI method was applied to calculate those colour differences. The conclusion of the Technical Committee is that the CIE CRI is generally not applicable to predict the colour rendering rank order of a set of light sources when white LED light sources are involved in this set.

The Committee recommends the development of a new colour rendering index (or a *set* of new colour rendering indices) by a Division 1 Technical Committee. This index (or these indices) shall not replace the current CIE colour rendering index immediately. The usage of the new index or indices should provide information supplementary to the current CIE CRI, and replacement of CRI will be considered after successful integration of the new index. The new supplementary colour rendering index (or set of supplementary colour rendering indices) should be applicable to all types of light sources and not only to white LED light sources. Possibilities for an improved description of colour rendering are summarized in the Appendix of this Technical Report.

The report consists of 14 pages with 1 figure. The price of this publication is EUR 38,— (Members of the national CIE organisations get 50% discount).

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Proceedings of the 2nd CIE Expert Symposium Lighting And Health
7-8 September 2006, Ottawa, Ontario, Canada
CIE x031:2006

The first CIE Expert Symposium in this Series, entitled “Light and Health” was held in Vienna, Austria, 29 September- 1 October 2004, and its emphasis was centred on the results of unfolding research on the effects of light upon the neuro-endocrine system, most notably the identification of a novel photoreceptor in the human retina and its role in regulating circadian rhythms, and ultraviolet radiation effects upon the skin and eyes. The discussions during that symposium led to the conclusion, that a follow-up symposium should be organized with the emphasis upon practical implications for lighting from new research findings.

This second symposium on Lighting and Health was thus organized in conjuction with Division 3. It was held in Ottawa, 7-8 September 2006, and provided updates on scientific progress, with a stronger emphasis on how we might apply this new information in lighting recommendations and lighting design. The sessions were organized in two parts 1) fundamentals where the biological basics were presented, and 2) application papers detailing the practical implications and practices that might result. About one-third of the time was devoted to discussion of the possible consequences for different lighting scenarios, lamp and luminaire specifications.

The symposium had four presented paper sessions and a poster session. The session on Fundamentals reviewed photoreception, the neural pathways that regulated circadian rhythms and experiments to phase shift the circadian cycle. The related application papers discussed measurement issues and the different effects of application with different light sources.

The session Effects upon Healthy People concentrated on fatigue, stress and reduced alertness after long periods spent indoors under artificial lighting. Extra stress, sleep disorders and cancer risk of shift workers, further jet-lag of travellers were debated and lighting conditions were presented to reduce these negative effects. Medical and Clinical Lighting Therapy focused on well adapted lighting conditions especially for the elderly to treat sleeping disorders by supplying carefully prescribed light exposures. Lighting therapy devices and new concepts of luminaires were demonstrated.

Finally, a panel-led discussion, Applications in Lighting, centred on discussions on applying the circadian and health research findings for applied lighting. The discussions were triggered by a featured speaker in each session. Implications for day and night lighting and future road maps for CIE Divisions 3 and 6 were discussed. The Poster Session covered very diverse topics from gerontopsychiatric care of aged people that showed improvement for higher lighting to effective UV radiance and irradiance measurements, and the interrelation between in vivo and in vitro action spectrum for vitamin D production.

More than 160 people from 21 countries attended the symposium showing an increase of around 60% compared to the first symposium in Vienna, indicating an increasing interest in Lighting and Health.

The papers included in this volume are edited by the authors; they are published in full under the responsibility of the authors themselves. The editing group restricted its contribution to matters of typography and layout.

The Proceedings contains the full text of all the presented 24 papers and 29 posters.

The publication consists of 239 pages with 164 figures and 13 tables.

A CD-ROM with all papers in a searchable form is included. CIE x031:2006 is readily available via the website of the Central Bureau of the CIE (www.cie.co.at).

The price of this publication is EUR 128,— (Members of the CIE National Committees get 50% discount).

Continued on page 31

TECHNICAL PAPER

Lighting for work: Visual and Biological Effects

Prof. Ir. W.J.M. van Bommel and Ir. G.J. van den Beld

Summary

With the detection in 2002 of a novel photoreceptor cell in the eye, the biological effects that light has on human beings can be better understood. The spectral sensitivity of the novel cell type has in the meantime been studied and shows that bluish light has biologically a larger activating effect than does reddish light.

A large number of research projects that compare the effects on health, well-being and alertness as a result of people working under different lighting conditions have been carried out. The results, as summarised in this article, show that good lighting indeed has important beneficial effects, not only visually but also biologically. From the research on the biological effects of lighting, it is evident that the rules governing the design of good and healthy lighting installations are, to a certain degree, different from the conventionally held rules. We demonstrate that it can be beneficial to be able to adapt both the level and the colour of the lighting. Not only the light on the visual task, but also that entering the eye determines the overall quality of lighting.

In a working environment, not only are the advantages in terms of health and well-being important for the workers themselves, they also lead to better work performance, fewer errors, better safety, and lower absenteeism. An example from an industrial environment demonstrates that by changing the lighting from 300 to 500 lux may easily increase the overall productivity by 8 per cent.

Introduction

The visual effects of lighting have been studied for more than 500 years. Leonardo da Vinci (1452-1519) described ideas about “street lighting”. Christiaan Huygens (1629–1695) formulated the wave theory of light, while Sir Isaac Newton (1642-1727) developed the corpuscular theory of light. Johann Wolfgang Goethe (1749-1832) analysed the colour effects and aspects of lighting. With the introduction of gaslight and electric light in the early-to-mid 1800s, the study of visual lighting effects was directed more and more towards practical lighting application research. As regards the mechanism of visual effects, as early as 1722 the Dutchman Antony van Leeuwenhoek noted the presence of “rod and cone cells” in the retina. Their existence was confirmed as “the light sensitive photoreceptors” in 1834 by the German Gottfried Treviranus. This discovery opened the way to the understanding of many of the visual lighting effects already described and to a more concrete investigation into the

visual effects of lighting, the goal being to design more effective lighting installations.

For more than 150 years, scientists considered rods and cones to be the only photoreceptor cells in the eye. Seen in this historic context, it is sensational that in 2002 David Berson et al. [1] of the Brown University (USA) detected a novel, third type of photoreceptor in the retina of mammals. This novel photoreceptor is a “missing link” in describing the mechanism of biological effects as controlled by light and darkness. That lighting has important biological effects has been the subject of extensive studies in the biological and medical scientific world during the past twenty-five years. From this, we have learned that the effects of good lighting extend much further than visual effects only: the biological effects mean that good lighting has a positive influence on health, well-being, alertness, and even on sleep quality [2], [3], [4], [5]. At the same time, it means that the lighting parameters with which good lighting can be described need to be revised.

This article first describes the mechanism of both visual and biological effects based on the three photoreceptors in the eye. Subsequent sections deal with lighting and visual effects, and lighting and biological effects. The first of these sections concludes with a summary of the “vision-related” lighting quality aspects, while the second concludes with a discussion of “health-related” lighting quality aspects.

Three Types of Photoreceptor Cells in the Eye

The photoreceptor cells in the retina of the eye, the cones and rods, regulate the visual effects. When light reaches these cells, a complex chemical reaction occurs. The chemical that is formed (activated rhodopsin) creates electrical impulses in the nerve that connects the photoreceptor cells with the back of the brain (visual cortex). In the visual cortex of the brain the electrical impulses are interpreted as “vision”.

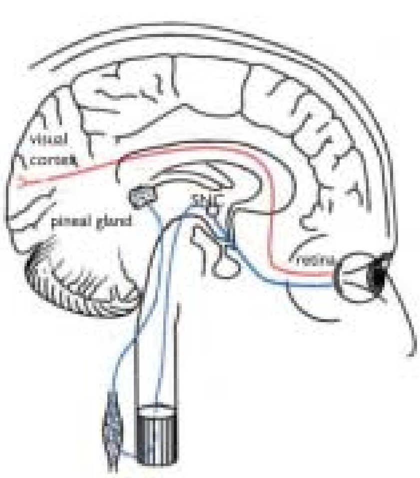

Fig.1 Visual and biological pathways in the brain:nerve connections between the retina of the eye, with its cones and rods, and the visual cortex on the one hand (in red) and between the retina, with the novel photoreceptor cell,and the suprachiasmatic nucleus (SNC) and the pineal gland (in blue).

Figure 1 shows the nerve connection between cones and rods in the eye and the visual cortex of the brain.

The rods operate in extremely low-level light situations (scotopic vision) and do not permit colour vision.

The cone system is responsible for sharpness and detail and colour vision. For all indoor lighting situations, the cones are to a very large extent decisive.

The sensitivity of the cone and rod systems varies with varying wavelength of light, and thus with varying colour of light. This is illustrated in Figure 2, where the spectral eye sensitivity curves Vλ for the cone system and V’λ for the rod system are given. The Vλ curve for the cone system is the basis for all lighting units such as lumen, lux and candela. It is called the photopic system. As can be seen from the Vλ curve, the eye is not very sensitive to extreme blue and extreme red light, and has its maximum sensitivity for green-yellow light.

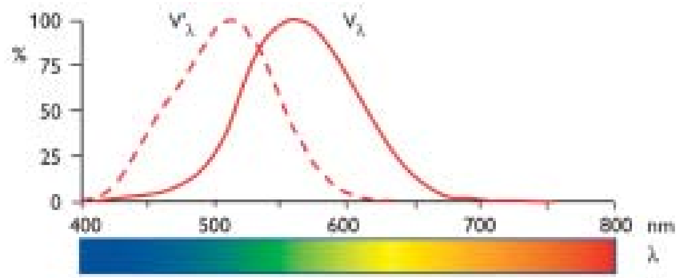

Fig.2 Spectral eye sensitivity curves,Vλ for the cone system (photopic vision: solid line) and V'λ for the rod system (dotted line).

It should be noted that different light colours can be obtained by different mixtures of wavelengths.

White light consists of such a mixture. It is evident that the (visual) efficacy of a light source is very much determined by the spectral eye sensitivity and the wavelengths that are incorporated in its light.

The novel photoreceptor cell type in the retina of the eye detected by David Berson et al. [1] in 2002 regulates the biological effects[1]. When light reaches these cells, a complex chemical reaction occurs (here involving the photo pigment melanopsin [6]), again producing electrical impulses. These cells have their “own” nerve connections to, amongst others, locations in the brain called the suprachiasmatic nucleus (SNC), which is the biological clock of the brain, and the pineal gland. Figure 1 shows the nerve connection between the novel photoreceptor cells in the eye and these locations in the brain.

[1] *Probably, the rods and cones do play a certain role in this respect as well.*


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The sensitivity of this novel photoreceptor cell also varies for different wavelengths of light, and thus for different colours of light. On the basis of the biological factor “melatonin suppression”, Brainard [7] was already able to determine the spectral “biological action” curve[2].

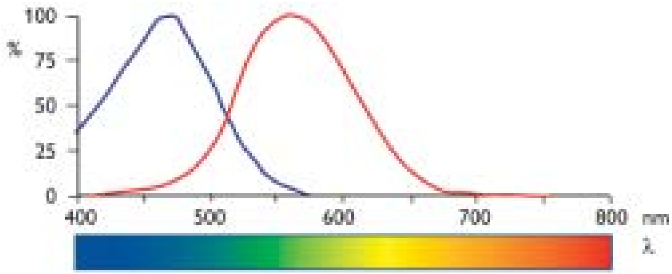

Fig.3 Spectral biological action curve (based on melatonin suppression), in blue, (source: Brainard [7]), and the visual eye sensitivity curve, in red.

This curve is given in Figure 3, together with the visual eye sensitivity curve of cones.

By comparing the two curves it is immediately evident that the biological sensitivity for different wavelengths of light is quite different from the visual sensitivity. Where the maximum visual sensitivity lies in the yellow-green wavelength region, the maximum biological sensitivity lies in the blue region of the spectrum. These phenomena have an important meaning for the specification of healthy lighting.

Lighting and Visual Effects

Visual performance

Lighting for work covers a wide range of different working interiors and tasks: from offices and small workshops to huge factory halls, and from reading, writing and PC working tasks to fine precision work or heavy industrial tasks.

The lighting quality should always be high enough to guarantee sufficient visual performance for the tasks concerned. However, a person’s actual visual performance depends upon not only the quality of the lighting but also upon his or her own “seeing abilities”. In this respect, age is an important criterion, since lighting requirements increase with age. Figure 4 gives the relative amount of light required for reading a wellprinted book, as a function of age. This research was carried out with test persons wearing, if required, the correct reading glasses. It is evident from this curve that the age effect is extremely severe. One of the many reasons for this age effect is the deterioration of the transmittance of the eyes’ lenses: the lenses gradually turn yellowish (see Figure 5). This deterioration means that the ageing lens has a lower transmittance.

[2]*As will be discussed further on in this article, one of the biological effects of light is the suppression of the hormone melatonin. Probably many other biological factors regulated by lighting will have an action spectrum similar to that determined on the basis of melationin suppression.*

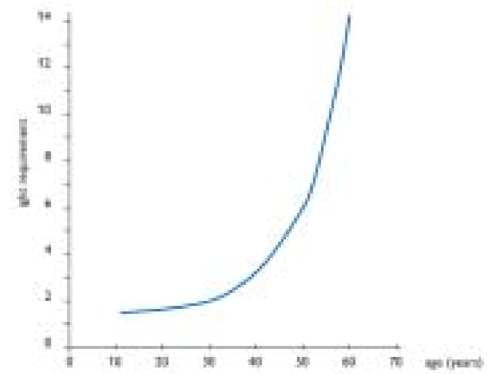

Fig.4 Relation between age and relative amount of light required for reading good print (source:Fortuin [8]).

It also means that less and less bluish light is transmitted. The ageing eye sees a less-blue world.

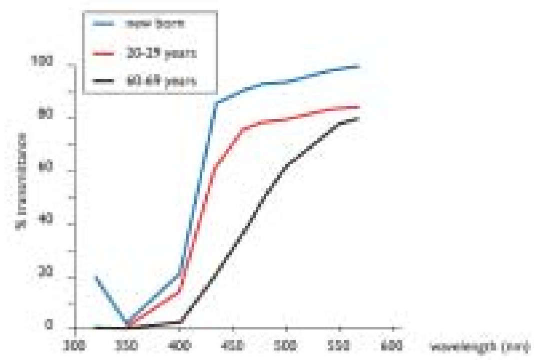

Fig.5 Lens transmittance for various age categories.Values are expressed as a percentage of the 560 nm point for the new born (source:adapted from Brainard et al. [9]).

Figure 6 serves as an illustration of the many research results pertaining to the influence of lighting quality on visual performance. It gives the relative visual performance as a function of lighting level for different visual task difficulties: one for a moderately difficult task (e.g. office work or general machine work in an industrial environment) and another for a difficult task (e.g. colour inspection work or fine assembly work).

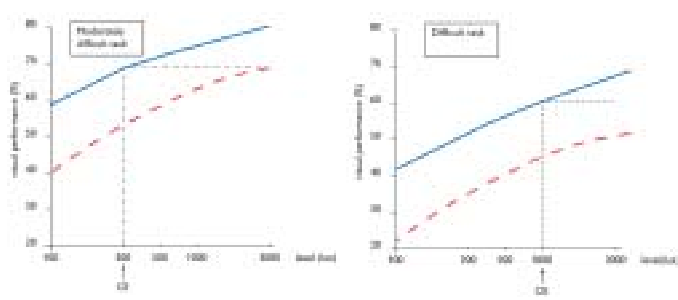

Fig.6 Relation between relative visual performance (in %) and lighting level (in lux). Continuous blue line:young persons;broken red line: older persons (source: CIE [11]). EN:lighting levels specified in the European Norm.

All tasks show a clear increase in visual performance with increased lighting quality – in this example the lighting level. In the graph, the required lighting levels (EN) for industrial environments, as in many cases specified in the European Norm for the lighting of work places [10], are indicated.

The graph shows that the requirements laid down in the European Norm are, in fact, well-suited to the younger persons. However, the visual performance of the older workers is considerably lower. Luckily, compensation with a higher lighting level is completely possible for the moderately difficult task. In practice, this calls for adaptable lighting on top of the lighting required by the "EN Standard" for those moments that daylight is not sufficient to give the higher lighting levels needed for the older workers.

Of course, an improvement in visual performance yields, in its turn, an improvement in sustained work performance, reflected in a higher output and in a lower number of errors. The extent to which good quality lighting enhances work performance depends on the visual component of the task. A task with an important visual component will benefit more from good seeing conditions than a task with a less important visual component.

Visual Environment

Besides its effect on visual performance, lighting can also have a powerful influence on atmosphere and the visual impression of the workplace. Properly designed, the overall working environment can have a stimulating effect on the people working within it [12]. Today, a lot of emphasis is placed on the layout and interior design of the workplace. Good lighting can strengthen the interior design, but poorly-designed lighting can diminish or even "destroy" the effect of the interior design.

One aspect that is important in this respect is a controlled brightness of the surfaces that form the physical limits of the space, such as walls, floor and ceiling. The brightness of these surfaces determine to a large extent how the total space is experienced. Another factor is a proper limitation of glare and undesirable light reflections. Glare is the sensation produced by brightness levels within the visual field that are considerably greater than the brightness to which the eyes are adapted. Owing to limitations in the adaptation properties of the eye, abrupt changes in brightness may lead to reduced visual performance and to visual stress and discomfort.

The colour properties of the light should also receive considerable attention. The lighting should permit the "real" colours to be seen. Proper colour rendering of the human skin is especially important, since lighting that makes the skin look pale and unhealthy often leads to complaints. Also, the colour appearance of the light itself plays a role in providing the space with an atmosphere. It may even have an emotional influence.

For example, a somewhat bluish-white light gives a cool impression that is often experienced as businesslike, while reddish-white light gives a warm impression that may be experienced as cosy and relaxing.

Finally, daylight contribution to the interior is another very important factor determining the quality of the working environment. Fortunately, in many cases daylight penetrates the building for at least several hours each day, considerably increasing the overall lighting levels. But daylight not only facilitates the visual performance of the visual task by contributing to the lighting on that task; because of its dynamic, varying character in both intensity and colour, it also contributes greatly, if properly controlled (e.g. by proper window and sun-shielding design), to a good working environment. The dynamic changes in daylight have a positive influence on mood and stimulation. An extensive study under office conditions has shown that people prefer artificial lighting in addition to the normal daylighting present in an office environment: average 800 lux on top of the prevailing daylight contribution [13].

Vision-related quality aspects of lighting installations

Most national and international recommendations and standards specify lighting quality figures for the majority of the visual quality aspects mentioned above, and for a wide variety of interiors and activities. Table 1 lists the visual quality aspects together with the most important parameter for each aspect as used in the European Norm for the lighting of workplaces.

It should be noted that the colour appearance of the light itself is not specified in the European Norm. The reason for this is that so far the colour appearance is seen as a matter of psychology and aesthetics and is considered to be natural.

Visual quality aspect	Quality parameter
Lighting level	Average illuminance level, E_{av}
Spatial distribution	Uniformity: E_{min} / E_{av} Glare restriction: UGR
Colour rendering	R_a

Table 1 Visual quality aspects of lighting installations with their quality parameters as specified in the European Norm for the lighting of workplaces [10].

As an illustration of what quality is required in different situations, Tables 2 and 3 give the required values specified in the European Norm for an office and for an industrial environment (the chemical, plastics and rubber industries)[3]. These requirements are values that meet the needs of visual performance and visual comfort for workplaces for the majority of the workforce. However, as discussed above, the age effect is so important that

[3] *The values specified for the average illuminance are "maintained illuminances": viz. values below which the average illuminance on the specified surface is never allowed to fall. The value specified for uniformity on the task is always the same:* $E_{min} / E_{av} \geq 0.7$.

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	R_a	Remarks
3	Offices				
3.1	Filing, copying etc.	300	19	80	
3.2	Writing, typing, reading, data processing	500	19	80	DSE-work: see clause 4.11.
3.3	Technical drawing	750	16	80	
3.4	CAD workstations	500	19	80	DSE-work: see clause 4.11.
3.5	Conference and meeting rooms	500	19	80	Lighting should be controllable.
3.6	Reception desk	300	22	80	
3.7	Archives	200	25	80	

Table 2 Lighting requirements for offices (source: EN 12 464 [10]).

Ref. no.	Type of interior, task or activity	$\bar{E}_m$	UGR_L	R_a	Remarks
2.5	Chemical, plastics and rubber industry				
2.5.1	Remotely-operated processing installations	50	-	20	Safety colours shall be recognisable
2.5.2	Processing installations with limited manual intervention	150	28	40	
2.5.3	Constantly-manned workplaces in processing installations	300	25	80	
2.5.4	Precision measuring rooms, laboratories	500	19	80	
2.5.5	Pharmaceutical production	500	22	80	
2.5.6	Tyre production	500	22	80	
2.5.7	Colour inspection	1000	16	90	$T_{CP} \geq 4000$ K.
2.5.8	Cutting, finishing, inspection	750	19	80	

Table 3 Lighting requirements for the chemical, plastics and rubber industries (source: EN 12 464 [10]).

adaptable lighting on top of the "EN Standard lighting" is needed for those moments when daylight is not sufficient to give the higher lighting levels that are required for the ageing eye.

Lighting and Biological Effects

The beneficial effect of (day)light has been well known since ancient times, an example being heliotherapy, or the treatment of disease by exposure of the body to the sun's rays. Light therapy for dealing with health problems was popular until the 1930s, after which time the introduction of penicillin led to pharmaceuticals taking the leading role. Over the last 20 to 30 years, however, the appreciation of light as an important contributor to health and well-being has been revived, thanks to various findings in biological and medical research.

We normally think of the eye as an organ for vision, but due to the discovery of additional nerve connections from recently-detected novel photoreceptor cells in the eye to the brain, it is now understood how light also mediates and controls a large number of biochemical processes in the human body.

The most important findings are related to the control of the biological clock and to the regulation of some important hormones through regular light-dark rhythms. This in turn means that lighting has a large influence on health, well-being and alertness.

Light and body rhythms

Light sends signals via the novel photoreceptor cells and a separate nerve system to our biological clock, which in turn regulates the circadian (daily) and circannual (seasonal) rhythms of a large variety of bodily processes. Figure 7 illustrates some typical rhythms in human beings. The figure shows only a few examples: body temperature, alertness, and the hormones cortisol and melatonin. The hormones cortisol ("stress hormone") and melatonin ("sleep hormone") play an important role in governing

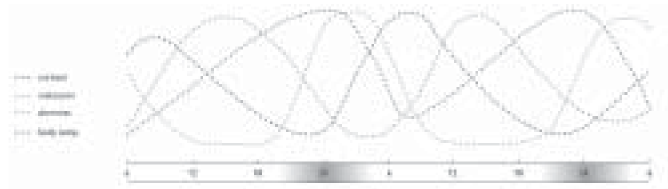

Fig.7 Double plot (2 x 24 hours.) of typical daily rhythms of body temperature, melatonin,cortisol and alertness in humans for a natural 24-hour light/dark cycle.

alertness and sleep. Cortisol, amongst others, increases blood sugar to give the body energy and enhances the immune system. However, when cortisol levels are too high over an extended period, the system becomes exhausted and inefficient. Cortisol levels increase in the morning and prepare the body for the coming day's activity. They remain at a sufficiently high level over the course of the bright day, falling finally to a minimum at midnight. The level of the sleep hormone melatonin drops in the morning, reducing sleepiness. It normally rises again when it becomes dark, permitting healthy sleep (also because cortisol is then at its minimum level). For good health, it is of importance that these rhythms are not disrupted too much. In case of a disruption of the rhythm, bright light in the morning helps restoring the normal rhythm.

In a natural setting, light, especially morning light, synchronises the internal body clock to the earth's 24-hour light-dark rotational cycle. Without the regular 24-hour light-dark cycle, the internal clock would be free-running with, for humans, an average period of about 24 hours and 15 to 30 minutes. This would, as a consequence, produce ever-greater day-to-day deviations in our body temperature, cortisol and melatonin levels from those set by the environmental clock time [14].

This deharmonisation in the absence of the "normal" light-dark rhythm would result in an incorrect rhythm of alertness and sleepiness, ultimately leading to alertness during the dark hours and sleepiness during the bright hours. In fact, the same symptoms, and for the same reasons are associated with jet lag after travelling over several time zones [15]. Rotating shift workers also experience the same symptoms for a couple of days after each shift change, again for the same reason [16].

Lighting, alertness, mood, and stress

A wealth of research projects that compare the effects of health, well-being and alertness as a result of people working under different lighting conditions have already been carried out. In this article we will discuss only a limited but typical number of these.

Küller and Wetterberg [17] studied the brain-wave pattern (EEG) of people in a laboratory made to look like an office environment, once with a relatively high lighting level (1700 lux) and once with a relatively low lighting level (450 lux). The composition of the EEGs exhibit a pronounced difference: the higher lighting level results in fewer delta waves (the delta activity of an EEG being an indicator of sleepiness), meaning that bright light has an alerting influence on the central nervous system (see Figure 8).

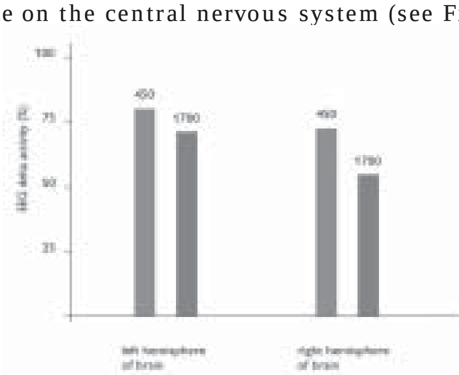

Fig.8 Delta activity in the EEG of office workers under lighting levels of 450 lux and 1700 lux (source: Küller and Wetterberg [17]).

Many investigations into the effects of light on alertness and mood have been carried out under night-shift conditions, because here the effects to be expected would be strongest. Figure 9 shows the effect of two lighting regimes on arousal as a function of time at work for shift-workers [15]. A decline in arousal over the night occurs for both regimes, but the high-light regime always results in a significantly increased arousal level and thus better alertness and mood.

Other studies show that the use of higher lighting levels to cope with fatigue results in the subjects indeed staying alert longer [19], [20], [21].

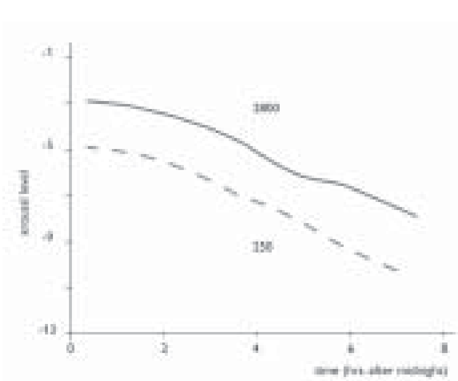

Fig.9 Alertness and mood expressed as arousal level for lighting levels of 250 lux and 2800 lux, as a function of working hours after midnight (source:Boyce et al. [18]).

Studies of stress levels and complaints in people working indoors have been made by comparing a group of people working solely under artificial light with a group working under a combination of artificial light and daylight [22]. As can be seen from Figure 10, in January, when daylight penetration is not sufficient to make a substantial contribution to the lighting level, there is hardly any difference between the two groups. But in May, when daylight really contributes, the group benefiting from daylight has a considerably lower stress complaint level. Another study shows that bright artificial light in interiors in winter has a positive effect on mood and vitality [23].

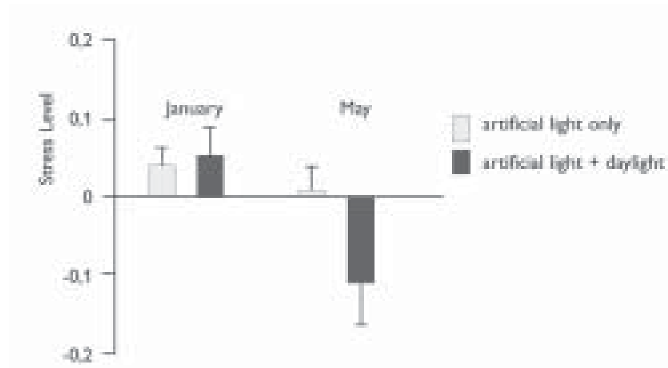

Fig.10 Stress complaint levels (with statistical spread) in a group of workers working either under artificial light only or under a combination of artificial and daylight (source:Kerkhof [23]).

Some, but few people experience headaches because of the light ripple caused by the 50 Hz power supply of fluorescent lamps operated on magnetic ballasts. Fluorescent lamps running on modern, high-frequency electronic ballasts operate at around 30 kHz and thus do not exhibit this flicker or ripple phenomenon. In a comparison, it has been found that the occurrence of headache is, indeed, significantly lower when electronic ballasts are used [24]. Küller and Laike [25] measured the EEG of persons working in an office environment under respectively magnetic (50 Hz) and high-frequency fluorescent lighting. At the same time, they also measured the speed and errors made in a proof-reading task. Figure 11 shows that the reciprocal value of the alpha activity of the EEG, and therefore the brain arousal

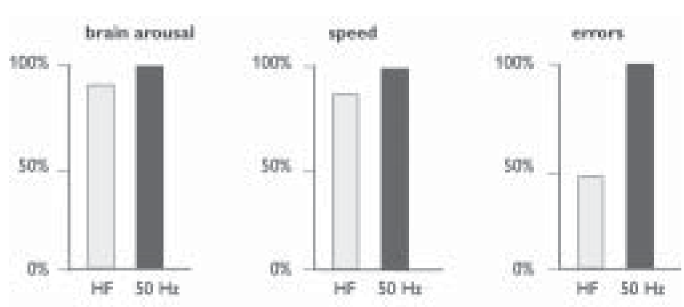

Fig.11 Brain arousal measured as the reciprocal value of the alpha activity of EEGs in persons in offices under 50 Hz and under high-frequency HF (30 kHz) fluorescent lighting. The working speed and errors of a proof-reading task are also given (graph adapted from: Küller and Laike [25]). Subject group:high flicker sensitivity.

("stress"), is higher with the 50 Hz operated lighting. The working speed is slightly higher, but the errors are dramatically higher (more than double). The combined effect means that it is wise, from both the well-being and productivity points of view, to use high-frequency fluorescent lighting instead of magnetic 50 Hz lighting to limit brain arousal or stress.

Health-related quality aspects of lighting installations

The visual-quality aspects of lighting installations as listed in an earlier section, i.e. lighting level, spatial distribution of light and colour rendering, have to be refined and extended if we want to arrive at truly "good and healthy" lighting installations.

The biological effect of light is not steered directly by the illuminance on the working plane, but by light entering the eye. Studies are under way to see how this difference between "visual lighting level on the task" and "biological lighting levels" can be accounted for [26][4].

As has been illustrated, especially because of the effects due to ageing eyes, the lighting level has to be adaptable. Daylight by its nature is dynamic in its intensity. There are indications that a variable lighting condition has a positive effect on the activation state of people in an office environment [28]. Where the benefits of the dynamics of daylight intensity are not sufficiently available, dynamic artificial light can be advantageous.

Two complete new aspects relate to the timing and duration of the lighting. Visually, of course, light is only needed when and for as long as one "views". Biologically, however, the time when the light (or darkness) is received and its duration plays an essential role, as is evident from the rhythm graph of Figure 7.

Fig.12 Ambient colour early in the morning and early in the evening in Paris.

We have always realised that the colour of light itself has an emotional meaning, and is therefore important for the atmosphere of a space. But we now also understand that the spectrum and thus the colour of light has an important biological meaning. As was shown in the section on the novel photoreceptor cell, bluish, cool light has biologically a larger effect than warmer coloured reddish light (Figure 3). The daylight situations of the photographs shown in Figure 12 produce not only a different emotional feeling but also have a different biological effect.

The bluish morning light has biologically an activating (alerting) effect, while the red sky in the early evening has a relaxing effect. In a working environment, both activating and relaxing moments are required. The colour and lighting level of the artificial lighting together may help to create these moments.

Studies on the preferred colour of light in an office environment have shown that there is no trend in preference between individuals in this respect: everyone has their own personal preference (Figure 13).

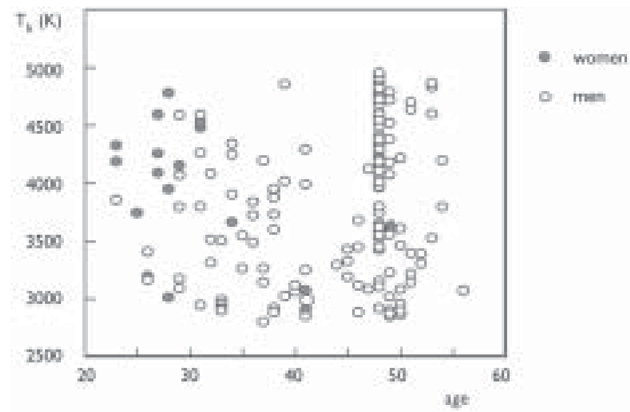

Fig.13 Colour preference of artificial light in an office with (daylight) windows,expressed as correlated colour temperature of the light Tk for different ages and for men and women (source:Tenner [29]).

Table 4 summarises the vision- (from Table 1) and health-related lighting quality aspects that together determine "good and healthy" lighting.

Lighting quality aspects	
Vision related	**Health related**
(adaptable) lighting level on the task	(adaptable) lighting level in the eye
spatial distribution	spatial distribution
colour rendering	(adaptable) colour appearance
	timing
	duration

Table 4 Vision- and health-related quality aspects of lighting installations

Conclusion

Thanks to the recent discovery of a novel photoreceptor in the eye, we are now much better able to understand why the benefits of good lighting at work, taking into account both the visual effects and the biological effects (viz. health, well-being and alertness), are so important. Apart from the health and wellbeing advantages for the workers themselves, good lighting also leads to better work performance (speed), fewer errors and rejects, better safety, fewer accidents, and lower absenteeism. The overall effect of all this is better productivity.

For an industrial environment (moderately difficult visual task), we investigated the possible resulting total productivity increase as a result of improved lighting level [30]. Table 5 provides a summary of the results.

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[4]Very recent research indicates that light on the upper and lower part of the retina has different importance as far as the resulting biological effect is concerned [27].This suggests that also the spatial distribution of light is important from a "health" point of view.

Improvement of lighting level	Productivity increase
From 300 to 500 lux	8 %
From 300 to 2000 lux	20 %

Table 5 Increase in productivity in the metalworking industry with a moderately difficult visual task as the combined effect of increased work performance, errors/ rejects reduction and accident reduction (source: van Bommel et al. [30]).

To confirm the results, we are carrying out real-life productivity investigations in a number of industrial environments where the lighting has recently been renovated. Realising the importance of the biological component in the productivity increase, we believe that similar figures can also be obtained in an office environment.

By putting our advice for flexible and adaptable lighting levels and colours into practice, such productivity advantages will become even more impressive.

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City Beautification And Emotion

Prof. Ir. Wout van Bommel

Abstract

True city beautification with lighting is not an isolated affair. Residential area lighting, road lighting and the aesthetically pleasing lighting of buildings, monuments and structures should be integrated in one overall master plan for an area or city. The final result should have a positive effect on the image created of the area. Image here is important for both visitors (outwards orientation of image) and residents (inwards orientation of image). The effect lighting has on both visitors and residents has much to do with emotion. The paper shows that the creation of the right emotion is directly connected with the appropriate use of dark and light, with the appropriate use of natural white light on the one hand and coloured light on the other hand and with carefully applying dynamic lighting. Guidance is given on how all this can be done while minimizing light pollution.

Introduction

At the start of the 20th century, outdoor lighting was geared towards the purely functional aspect of visibility for motorists. In the fifties of the same century, de Boer was one of the first researchers to add visual comfort to the pure visibility aspect of road lighting [1]. This comfort aspect was felt to be important in view of the fact that high-speed road users were already making use of relatively comfortable motorways for rather long drives: again, traffic safety was the underlying criterion.

However, this attention to visual comfort automatically made new road lighting installations more pleasing. So, up until the late seventies of the last century, road lighting, including that within the urban environment, was seen mostly in the context of motorised traffic. One of the first systematic studies into the needs of residents and pedestrians in residential streets, with the emphasis on personal or social security, was carried out by Caminada and van Bommel and published in 1980 [2, 3]. They concluded that in order to provide good security, the lighting in a street should permit of mutual recognition of pedestrians at a 'safe' distance, viz. before coming almost face to face.

It was only slowly that the architectural aspect of outdoor lighting started to receive some attention in addition to the functional aspects of traffic safety and social security. Today we are seeing a clear shift of focus towards our general "well-being" or "quality of life". Seen in this context, it is not surprising that we are now seeing so much interest in lighting as a means to enhance the visual outdoor environment. During the hours of darkness, the visual environment can be "recreated" with lighting. And while this lighting can simply be designed to almost reproduce the daytime situation, it is often more interesting and challenging to create an entirely "new" night-time scene.

Lighting can be used as a means to "beautify" the urban night-time environment, and with right we can therefore use the term "city beautification".

True city beautification is not an isolated affair. Residential area lighting, road lighting and the aesthetically pleasing lighting of buildings, monuments and structures should be integrated in one overall master plan for an area or city. The final result should have a positive effect on the image created of the area. Here image has both an outward and an inward aspect. The outward aspect of image is related to the creation of a pleasing effect on visitors to the area. That is to say the lighting helps to promote the area, and so attract visitors, so it has a commercial value. The inward aspect of image is related to the way the lighting affects the residents themselves. It serves to give the area an identity all of its own, which can create a feeling of pride in the residents. The effect lighting has on both visitors and residents has much to do with emotion. This means that good city beautification can only be designed if the emotional effects of lighting are properly understood.

Fig.1 Same church with different lighting, resulting in two completely different emotional feelings.

Lighting and Emotion

The presence or absence of daylight, viz. light or darkness, has an important impact on our emotions, which may vary from pleasant to cheerless, even to fear. The "quality" of the daylight also has a strong influence. We usually "feel" better under a sunny sky with strong shadows than under a cloudy, diffuse sky. The emotional impact seems to be an immediate one: we "feel" our mood changing when the sun comes out, and children immediately become fearful when they step into the dark. Artificial light can have similar emotional effects, and this holds true both for indoor and outdoor (night-time) situations. Since contrasts can often be made larger in outdoor environments because the dark sky usually forms the background, we can more easily create strong emotional effects with outdoor lighting than with indoor lighting. Figure 1 illustrates what outdoor lighting can do with our emotions. It shows two photographs of the same church lit in completely different ways.

The point here is not that the situation depicted in one of the photographs is any better than that in the other, but rather the fact that we tend to experience two completely different feelings. The church on the left we see as being "pleasantly lighted", whereas that on the right is much more likely to be described as being "scary".

In these photographs the different effects are obtained by greatly different light-dark contrasts. Another technique that can be used to "play" with our emotions is the use of certain "shades' of white light. From interior lighting we know that lamps with low colour temperatures (warmwhite light) result in a different subjective appraisal than that produced by lamps with high colour temperatures (cool-white light). In road and street lighting, the use of yellow-white (sodium) light has a different emotional meaning to that associated with the use of "whiter" light. The use of saturated coloured light in the outdoor environment has a different emotional effect again. What we especially like about daylight is its dynamic character, viz. the quantity and composition of the light (direction, shadows, colour, clearness and diffuseness) change continuously, especially on sunny days. Dynamic artificial lighting is another technique that we can use to create strong feelings about the night-time environment.

Light and dark

"Light and dark" has two elements in it: the general lightness or darkness and the contrasts between light and dark parts. For example, the church shown on the left in Figure 1 is far lighter than that on the right. This in itself has an emotional effect. But the real dramatic effect of the situation on the right has much more to do with the fact that we have here very large contrasts between the light and the dark parts.

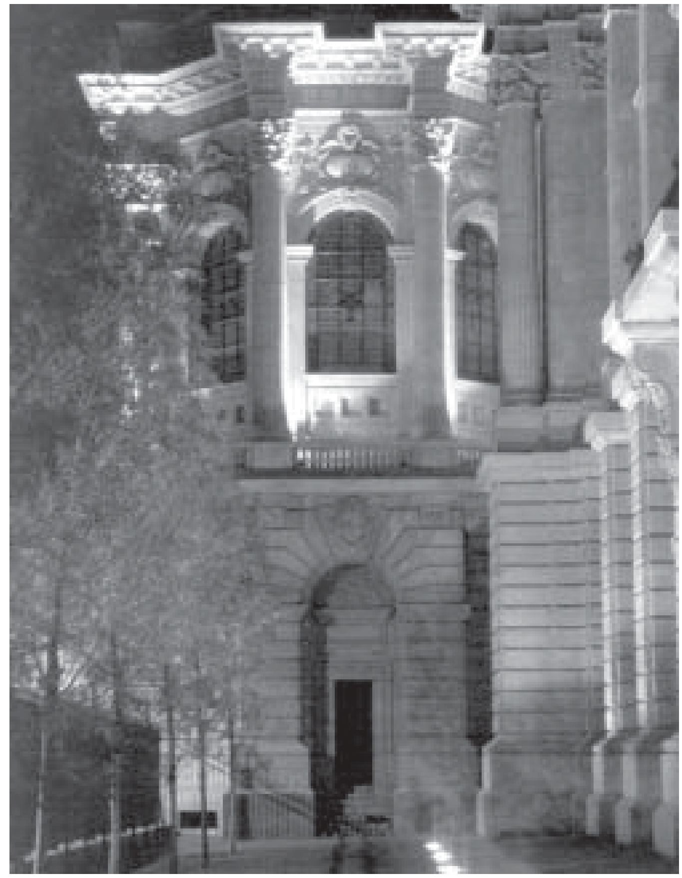

Fig.2 Subtle use of shadows and soft light, alternated with somewhat darker parts, invites further exploration.

Of course, we should realise that while large contrasts produce strong emotional effects, they can also mask very charming details. It is therefore of the utmost importance that the designer and his client get together at the outset of an illumination project to carefully decide exactly what effects are really wanted. For good recognition, the direction of light incidence on interesting details should be such that the soft shadows created emphasise the three-dimensional character of these, which in their turn will help to create additional emotional effects. Too often we see that buildings and monuments are simply "flooded" with bright light, without producing any shadows or contrasts.

In fact, the church shown on the left in Figure 1 is an example of this. The building depicted in Figure 2, on the other hand, has carefully designed shadows, and lighter and somewhat darker parts create an agreeable and interesting picture that invites the observer to explore further. These photographs also illustrate that a high brightness alone is certainly no guarantee of an acceptable end result – on the contrary, it actually increases the chances of light pollution (see section on Light Pollution).

Whiter light

At the World Exhibition in Paris in 1881, the new incandescent lamp was introduced to a wide public. Slowly, incandescent lamps took over from gas lighting.

Both types of lighting combine a very good colour rendering with a white colour appearance.

Until 1932, no new electric light sources were introduced, which meant that the world became accustomed to a white night-time outdoor environment. In that same year, the first gas discharge lamp was used in an installation. This, the low-pressure sodium lamp, became a very economical (today more than 175 system lm/W - see Figure 3) and technically good solution for use in road lighting. In 1932 a second gas discharge lamp, the high-pressure mercury lamp, was introduced. Whereas the low-pressure sodium lamp “coloured” the outdoor environment in shades of yellow, colour rendition being non-existent, the much less efficient high-pressure mercury lamp (maximum 60 system lm/W - see Figure 3) offered the possibility to have the outdoor environment lit with white light. These lamps, in spite of their poor colour rendering (Ra of 40) were therefore widely used in built-up areas. Nonetheless, more economical light was called for in road lighting, particularly in built-up areas. The answer was the high pressure sodium lamp, introduced in the late nineteen sixties. This lamp combines moderate colour rendering (Ra in the 20-ties) with yellow-white light with a very good efficacy (between 100 lm/W and more than 120 system lm/W – see Figure 3) and a long, reliable lifetime.

After the energy crisis in the early nineteen seventies, this yellow-white lamp became the standard in road lighting in built-up areas. As a consequence, it now “colours” our night-time outdoor environment yellow-white. Only small, minor roads where low lighting levels are accepted are sometimes lit with white compact fluorescent lamps developed after the energy crisis (system lm/W around 75 – see Figure 3). The white colour of these outdoor environments is much appreciated, probably because it evokes a positive emotion. What was needed however, was an efficient, reliable source of white light capable of lighting whole built-up areas in this natural white light.

So far, the metal halide lamp, an efficient version of the mercury discharge lamp with metal halide additives, resulting in white light of good colour rendering, has not yet provided the answer. This is because compared with sodium lamps, the lifetime of metal halide lamps was not good enough to replace the former in road lighting. The same metal halide lamp does, however, produce good results in sports stadiums and other floodlighting installations, where the hours of use per year are much less than in road lighting.

Luckily, however, in the year 2005, a special revolutionary version of a metal halide lamp is being introduced that will enable the world to turn its yellow-white outdoor environment back into natural white! This lamp, the Cosmopolis, draws on high-pressure sodium techniques and has a specific dose of certain metal halides. It combines high efficacy (at its introduction, more than 100 system lm/W – see Figure 3) with a long, reliable life approaching that of high-pressure sodium lamps (90 per cent survival rate at 12,000 – 16,000 hours). The 140 W version has an even higher efficacy than that of the 150 W high-pressure sodium lamp! Further efficiency

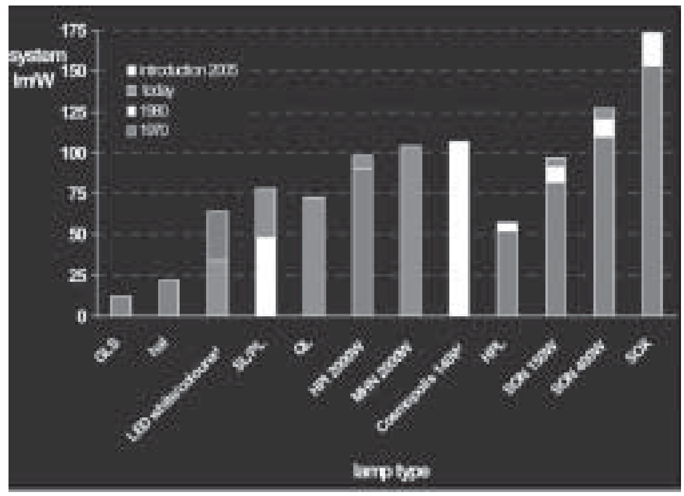

Fig. 3 Luminous efficacy of lamps employed in outdoor lighting (efficacies based on wattages typical for outdoor lighting applications)

GLS = incandescent lamp

hal = halogen lamp (for flood lighting)

LED = light-emitting diode (solid-state light)

SL/PL = compact fluorescent lamp

QL = long-life induction lamp

HPI = metal halide lamp (for flood and sports lighting)

MHD = single bulb metal halide lamp (for flood and sports lighting)

Cosmopolis = new type of metal halide lamp (introduction 2005)

HPL = high-pressure mercury lamp

SON = high-pressure sodium lamp

SOX = low-pressure sodium lamp

improvements are obtained because of the compactness of the lamp, resulting in a better optical performance in luminaires. It can be expected that this new lamp type will indeed dramatically change the appearance of our nighttime outdoor environment [4]

Coloured light

It is interesting to note that the use of coloured light for the floodlighting of buildings and monuments seems to be dependent upon past experience and cultural background. In Asia, coloured light has always been an instrument used to give extra emphasis to the floodlit object, with rather saturated colours often being employed. In America and Europe, the use of coloured light is more recent, and especially in Europe, somewhat softer colours are often used.

It should be noted here that different colours sometimes have different emotional responses in different parts of the world. Coloured light can have a strong impact on the object itself, but also on the whole of the night-time environment. Careful discussions with the owner of the object being lighted on exactly what effects are wanted and what the possible consequences may be for the neighbourhood are very important in order to avoid disappointments or problems with other users of the neighbourhood. Until recently, colour filters attached to conventional light sources were mostly employed to produce coloured light. But coloured metal halide lamps that emit coloured light have now become available. These give saturated colours more efficiently because no filtering is required.

Light emitting diodes (LEDs) or solid-state lights have already been in use for some years for coloured ornamental, festive or advertising lighting. Here the goal is that the eyes of the observer look straight into the light source (in a way, a kind of "signalling" lighting), which means that relatively low-power LEDs can do the job. High-power LEDs have now been developed with such high lumen packages and efficacies (see Figure 3) that they can be employed for real floodlighting of objects. They are available in many different colours, and in white as well, and have long lifetimes and can be easily regulated in light output between 100 and 0 per cent. LED luminaires for floodlighting purposes consist of an array of many individual LEDs that all have there own tiny reflector.

Fig. 4 Near-parallel beam of LED-line

With these small optical units, narrow light beams can be obtained that were once impossible. Figure 4 shows a typical LED-line luminaire with a near-parallel beam. Thanks to this narrow beam, floodlighting installations can now be produced where the luminaires themselves are positioned very close to or against the object being lighted. This offers a unique possibility to create special effects because the grazing light incidence enhances any unevenness of the construction material, and thus the character of it. Installation of the installation is usually easier and more economical, and it can be more easily maintained.

Furthermore, the risk of producing disturbing light pollution is minimised. Figure 5 shows an example of an installation where LED-lines are placed against the lighted chimney itself.

Dynamic Light

One of the many qualities that are so much appreciated with daylight is that it varies so much. It is, in a word, dynamic. It is therefore not surprising that dynamic lighting is also being employed in city beautification. For festive and advertisement lighting, successions of rapid changes in colour and brightness are used, the aim being to attract the attention of passers-by.

LEDs are very suitable as sources of dynamic light: they are easy to regulate, and allow mixing of different colours to create a wide variety of effects using a relatively simple technology. The extremes here are the LED video screens that can have enough brightness to be used even during the bright hours of daytime. A far more subtle use of dynamics in lighting is the slow and gradual change of brightness and or colour. This often "invites" the observer to explore the object and its changing visual impression further.

We are seeing more and more examples of where these kinds of dynamic light changes are also used as a means to communicate. The communication message can employ a change of brightness and or colour pattern to indicate the time, the temperature, the weather forecast, and even whether or not a facility is open. And it is not beyond the bounds of possibility that residents, working together, could influence the lighting of the object(s) concerned via their neighbourhood internet.

Lighting and The Restriction of Light Pollution

City beautification can give rise to obtrusive light, which is defined as light where it is not wanted and not needed. Obtrusive light is spill light, and as such it has direct negative consequences for the efficiency of the installation. More importantly, it can evoke strong negative emotions and have adverse effects on traffic safety. And the "disappearance" of the night sky because of sky glow interferes with both amateur and professional astronomical observations. All this is often referred to as "light pollution".

Fortunately, these negative side-effects of city beautification lighting installations can be avoided, or at least minimised, by a combination of technical and organisational methods. To this end, in 2003 the CIE produced a "Guide on the limitation of the effects of obtrusive light from outdoor lighting installations" [5]. If the recommendations set out in this Guide are applied correctly, it is possible to not only minimise the amount

Fig.5 Example of an installation where LED-lines are placed against the lighted area itself.

of "spilled" light, but also to actually increase the efficiency of the installation concerned. The Guide gives restrictive values for different photometric parameters resulting from the installation, the most important of which are: vertical illuminances on neighbouring properties, maximum luminous intensities for luminaires in directions where views of bright surfaces of luminaires are likely to be troublesome to residents, and upward light ratios to limit sky glow. All limits are dependent upon two different aspects:

- The level of brightness already existing in the area (in the CIE Guide called "lighting environment")
- The time (in the evening or night) that the lighting is to operate.

Zone	Surrounding	Lighting Environment	Examples
E1	Natural	Intrinsically dark	National parks or protected sites
E2	Rural	Low district brightness	Industrial or residential rural areas
E3	Suburban	Medium district brightness	Industrial or residential suburbs
E4	Urban	High district brightness	Town centres and commercial areas

Table 1 Environmental lighting zones

If the brightness of the environment is low, the risk of producing disturbing obtrusive light is high, and consequently the illuminance and intensity limits are stricter. In brighter surroundings, the risks are lower, because the contrasts between any possible obtrusive lighting and the bright surroundings are smaller, so the limits are therefore also less strict. Four different categories or zones of lighting environments are defined as E1 to E4 and given in Table 1. Stricter limits are given for the lower E zones.

In order to achieve a proper balance between the interests of the "users" of the lighting on the one hand and those of the residents on the other, two sets of limiting values (see above) are given for each situation: one with higher (viz. less strict) values for use before a "curfew" hour and the other with lower (stricter) values for use after that curfew hour. The relevant authorities should set the exact time of the curfew hour.

Conclusion

The effect that city beautification lighting has on both visitors and residents has much to do with emotion. The lighting should, and can, be aimed at giving rise to positive emotions. For this a deep understanding of the underlying causes, some of which are dealt with in this paper, is essential. The negative emotional effect of obtrusive light should, and can, be avoided by following the guidelines set out in a recent CIE Publication on obtrusive light [4]. New developments in this respect should be followed, because new research on this subject is being carried out that will probably lead to further and refined rules [5]. A wealth of new products, such as LEDs and new, innovative metal halide lamps, together with more compact luminaires, offer totally new possibilities for city beautification, thus helping to make our night-time environment one that fits in with our endeavours to achieve a better quality of life.

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[3] Caminada, JF; van Bommel, WJM; "New lighting criteria for residential areas", Journal of IES (1984).

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[5] CIE Technical Report 150:2003; "Guide on the limitation of the effects of obtrusive light from outdoor lighting installations", (2003).

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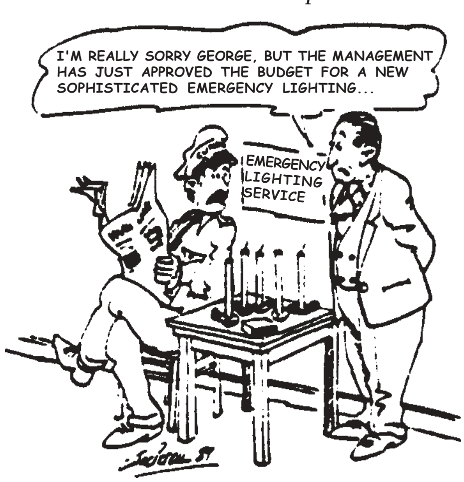
Continued from page 16

CIE Standard CIE S 020/E:2007 Emergency Lighting

This standard specifies the luminous requirements for emergency lighting systems installed in premises or locations where such systems are required. It is principally applicable to locations where the public or workers have access. The primary objective of emergency lighting is the provision of visual conditions that can alleviate panic and facilitate safer evacuation of buildings' occupants during the failure of normal power supply/lighting, in clear (non-smoke) and smoke filled conditions. The emergency lighting scheme design should be based on worst conditions (e.g. minimum light output, maximum glare limits) of the luminaires during operating life. The requirements given in this standard are a minimum for design purposes and are calculated for the full rated duration period and end of design life of the equipment. A special chapter for smoke is included. Safety signs may also fulfil further functions within maintained operation.

This standard has been approved by CIE National Committees. Price of this standard: EUR 28,- (Members of national CIE organisations get 50% discount).

(***Note:*** *Mr. P.K. Bandyopadhyay, Past President of ISLE and former Editor Division 5 CIE was a member of TC5-19, the Technical Commitee that developed this standard.)*



From PKB's old papers, source not known.

CIE Draft Standard DS 018.2/E:2007 Standard File Format for Luminaire Photometric Data

A photometric laboratory may use any format for the storage of photometric data of a luminaire or for the calculation of lighting performance data such as illuminance, luminance, hemispherical illuminance, or glare indices that is most suitable to their purposes, but the interchange of these data among laboratories, countries or design programs require a standard format defined by an international organization. This draft standard meets this requirement and presents a photometric data file format for data transfer between computers and between a computer and a storage medium. The primary purpose is to ensure compatibility between photometric data files and computer programs for lighting applications.

It also ensures that the choice of luminaire is unambiguous and that the relationship between the coordinate system of the photometric data and the geometry of the building or area where the luminaires are to be installed is clearly defined.

In the Appendix five examples are shown each for a different application: roadway lighting, floodlighting, automotive headlight, interior lighting in an industrial area and an optical system.

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 National Committees, it will be published as a CIE Standard and later on eventually as a joint standard with ISO. Price of this draft standard: EUR 20,- (Members of national CIE organisations get 50% discount).

FORTHCOMING EVENTS

Impact of Information Technology in Metrology PTB-BIPM Workshop

5-7 June 2007, Berlin, Germany

The meeting takes place in conjunction with two one day satellite workshops:

- Trends in Uncertainty Evaluation and Interlaboratory Comparison Analysis (4 June 2007)
- Quality and Security of Metrological Software and Data (8 June 2007)

The aims of the workshop are to:

- provide an overview of IT support for metrology,
- identify needs, opportunities and benefits of IT for metrology,
- facilitate the cross-fertilization of different approaches,
- identify cross-sectional mathematical and IT tasks for metrology.

Sessions of the workshop will include:

- Internet-enabled metrology
- E-trace
- Intelligent systems
- Databases in metrology
- Upcoming information and communication technologies for metrology
- Safety and security of measurement systems
- Mathematical modelling and simulation

- Data analysis including uncertainty evaluation
- Software tools and packages
- Software validation
- Quality management and standards.

The workshop programme includes invited presentations and refereed contributed papers. Additionally a poster exhibition will take place.

For further information, please contact:

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BIPM
Pavillon de Breteuil
F-92312 Sèvres, Cedex ,France
e-mail: rkohler@bipm.org
www.ptb-bipm-workshop.de

Lighting 2007

10-12 June 2007, Varna, Bulgaria

Topics of the conference:

- Energy efficiency in lighting
- Lighting pollution and ecology
- Indoor lighting
- Outdoor lighting
- Ergonomics and physiology of vision
- Photometry and colorimetry
- Daylighting
- Architectural, decorative and advertising lighting
- Generals aspects of lighting, terminology and standardization

The working languages of the conference are Bulgarian and English. A simultaneous translation will be available.

An exhibition of lighting products will be held during the conference.

For further information, please contact:

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ISAL 2007 International Symposium on Automotive Lighting

25-26 September 2007, Darmstadt, Germany

The first Symposium on automobile lighting at Darmstadt University of Technology was realized in 1995. ISAL 2007 is the continuation of the successful ISAL Symposium in 2005.

More than 450 experts from around the world - representing car manufacturers, suppliers, international government agencies, universities and testing organisations - attended the previous ISAL Symposium. They met with specialists and discussed innovations and improvements in automotive lighting topics.

Since ISAL 2005 the progress in automotive lighting was very intense and fast. Meanwhile we can see more LED applications on the road, e.g. the LED rear light systems in upper class cars. Also the application of LED headlamps is shortly before market launch.

The ISAL 2007 Symposium covers various topics including:

- Visual performance of drivers
- Automotive lighting
- Driver assistance systems
- Car interior lighting
- Regulations / directives / standards
- Photometric and radiometric measurement
- Styling trends, influence of technology on styling
- Simulation
- Road equipment and street lighting
- Active and passive safety
- Lighting and environment
- Optical design and simulation of automotive lighting systems
- New solutions of automotive lighting systems
  Deadline for early registration: 1 August 2007

For further information, please contact:

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R&D UPDATE

Daysimeter and Human Circadian System

The human circadian rhythm regulates biological functions like sleep, hormone secretion, body temperature, activity levels, etc. It responds to light and is synchronized to daylight. It has been found that the response of circadian rhythm to light differs from that of human vision. Levels of light that are comfortable for human vision do not stimulate the circadian system. The spectral sensitivities for the two systems differ from one another, and the duration of exposure to light to produce a response in the circadian system is different from that required for vision.

All these facts point to the inadequacy of measuring light in terms of lux using the photopic spectral sensitivity of the human eye while correlating the response of the circadian system to light levels and quality of light. Such a correlation is useful in light therapy of circadian rhythm disorders like jet lag, seasonal affective depression, night shift effects and sleep difficulties in the elderly. It is thus necessary to gain an understanding of the effects on human circadian system of intensities of light weighted in terms of the spectral sensitivity of the human circadian system.

This requirement was addressed by the Lighting Research Center of Rensselaer Polytechnic Institute by developing a Daysimeter which measures the intensity of light in terms of an empirically determined spectral sensitivity of the human circadian system along with the photopic intensities. While the photopic and scotopic spectral sensitivities peak at wavelengths of 550 nm and 500 nm, the spectral sensitivity of human circadian system peaks around 460 nm.

The instrument is in the form of a headset with measurements made at the forehead level above the eyebrow. It has two channels, one for photopic and one for circadian sensitivity. It is small and has low weight for wearing on the head. The spectral match to circadian sensitivity is achieved using a Himamatsu gallium phosphate detector with a GG19 filter. It will measure exposure of the eye to circadian light as well as conventional light to understand the response of human circadian system to light. Full details of the device and recording of data are available in the LRC report.

The results of studies made with daysimeter are expected to help in lighting designs that will help people maintain regular circadian functions, and in light therapy for circadian rhythm related disorders. The group at LRC working in this field has plans to form a forum of scientists, physicians and scholars who are interested in a work environment of light where circadian rhythm and photobiology are important factors for better health and productivity, and in clinical applications for phototherapy of circadian rhythm related disorders. It is expected that the efforts of such a forum using the daysimeter will help people to find light sources and lighting techniques both for maintaining regular circadian functions and phototherapy of circadian rhythm related disorders.

V.D.P. Sastri

WEBWATCH

'Light Pollution' Publication Gets Update

The 23-page publication, "Light Pollution," was recently updated as part of the National Lighting Product Information Program (NLPIP).

The Lighting Research Center originally produced this publication in 2003, focusing on light pollution—which is a byproduct of outdoor lighting.

Light pollution can be reduced by lighting only what is actually needed, when it is needed, and to the appropriate level.

This publication discusses the three elements of light pollution:

- Sky glow
- Light trespass
- Glare

It also gives examples and recommendations for minimizing or eliminating the undesirable effects of each element when designing and using outdoor lighting.

This publication is available online at this link :

http://www.lrc.rpi.edu/nlpip/publicationdetails.asp?ID=884&type=2

Oak Ridge Lab Helps Develop Next-Gen LEDs

Nanotechnology may unlock the secret for creating highly efficient next-generation LED lighting systems, and exploring its potential is the aim of several projects centered at Oak Ridge National Laboratory.

Researchers at ORNL's Center for Nanophase Materials Sciences and the University of Tennessee are working to develop technology that will improve a new generation of LED devices composed of thin films of polymers or organic molecules.

These organic LEDs are designed to be formed into thin, flexible sheets that hold promise for a new generation of lighting fixtures and flexible electronics displays.

Currently applications of organic LEDs, or OLEDs, are limited to small-screen devices such as cell phones, personal digital assistants and digital cameras. Scientists hope that large displays and lighting fixtures can be developed using low-cost manufacturing processes.

At ORNL, researchers are developing electrodes composed of carbon nanotubes and magnetic nanowires to enhance the light emission from polymer-based OLEDs.

In early tests, carbon nanotubes improved the electroluminescence efficiency of polymer OLEDs by a factor of four and reduced the energy required to operate them.

Second, magnetic nanowires and dots have been shown to help control the spin of electrons injected into the OLEDs to further improve the efficiency and reliability of the devices.

A third aspect of the research focuses on creation and chemical processing of the nanotubes themselves. Researchers at ORNL use a technique called laser vaporization that produces purer nanotubes with fewer defects than other fabrication techniques.

With assistance of a $600,000 grant from the Department of Energy's Office of Energy Efficiency and Renewable Energy, the ORNL/UT team hopes to merge the science and new materials research into a new technology for practical OLED devices that consumes less than half the power of today's technology and opens the door for their practical use in household lighting.

"Over the next year we hope to learn why nanomaterials enhance these devices. I think someday we will see OLEDs everywhere, from more durable touch-screen displays to electronic newspapers that we can roll up and carry easily to even larger wall displays for home entertainment or lighting," said David Geohegan, an ORNL researcher who is leading the OLED effort.

Electronic International Electrotechnical Vocabulary (IEV)databaseonline, free of charge

The International Electrotechnical Commission (IEC) has launched the content of its electronic International Electrotechnical Vocabulary (IEV) database online, free of charge, on an independent website.

Known as Electropedia, this website, www.electropedia.org, makes it significantly easier to find an internationally-agreed electrical, electronic or related technology term, together with its definition in English and French or search for an equivalent term in Spanish or German (when and where these exist). Terms in other languages (Arabic, Chinese, Italian, Japanese, Dutch, Polish, Portuguese, Russian and Swedish) will be added at a later date.

Put live on 2 April 2007, this website is quick and easy to use because it contains an entirely searchable database of terminology. Looking for a reference word this way is a lot faster than thumbing through printed pages or scrolling through PDF files. In addition, the database will carry on being updated as technical language evolves. So new words will be added to existing parts and further sections will be added as technology broadens out into new areas.

In the past, those who needed standardized terminology bought an entire chapter of the International Electrotechnical Vocabulary on a given subject such as electromagnetism, power capacitors or space radiocommunications. Now, the entire set of 20 000 entries, divided into 77 main subject areas, is about to become fully available at no cost and serve as a free online resource on an easily accessible website for anyone who needs it.

Because the IEC itself was created partly in response to a need for terminology that was standardized, the IEV database lies at the very heart of what the Commission does and has been doing for more than 100 years. Indeed, the first technical committee created by the IEC in 1910, was and remains, TC 1 (Terminology).

Links:

www.electropedia.org
http://www.iec.ch/online_news/etech/

Photosensor Tutorial Available Online

Want to learn more about photosensors?

The Lighting Research Center presents a comprehensive online photosensor tutorial for lighting professionals, including specifiers, contractors, lighting designers and manufacturers.

In fact, anyone interested in reducing the energy they use for lighting could benefit from the Photosensor Tutorial.

The information is organized in levels of increasing detail to make it accessible to everyone.

There is no charge for this tutorial, which can be found here: http://www.lrc.rpi.edu/education/outreachEducation/photosensorTutorial.asp