E³Light

Annex 45
Energy Efficient Electric Lighting for Buildings

Biannual Newsletter 1/2006

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

Web-site: lightinglab.fi/IEAAnnex45

New Doctors in the Lighting Field

M.Sc. Bruno Coutelier defended his PhD Thesis *Characterization of the Luminous environment with the help of luminance-mappers and virtual reality simulations* at the National Engineering School of State Public Works, Lyon, France, on March 16, 2006.

M.Sc. Jari Hovila defended his PhD Thesis *New Measurements Standards and Methods for Photometry and Radiometry* at Helsinki University of Technology, Finland, on December 9, 2005.

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EPIC 2006 AIVC Palais des Congrès, Lyon, France 20 - 22 November 2006

The 4th European Conference on Energy Performance & Indoor Climate in Buildings

The 27th Conference of the Air Infiltration & Ventilation Centre

Conference of the IEA Programme on Energy Conservation in Buildings & Community systems

http://epic.entpe.org/

Annex 45.will have special Session in the EPIC 2006 AIVC Conference. The Session chair is professor Liisa Halonen from TKK and co-chair is professor Marc Fontoynont from ENTPE.

TRUMPF ´iLED5` Surgical Light.

Luminaires with LEDs

For some applications LEDs are already the best light source. A special example of such a luminaire development is the ´iLED 5` from Trumpf, a German surgery lighting company.

For this company a special Surgery Luminaire was developed in the last two years. This luminaire consists of a lense matrix (180 small lenses) which creates a very homogenous spatial light distribution over the surgery's wound, with minimal shadows and an illuminance of 160 000 lux. The colour temperature is variable from 3000 K up to 6000 K, thus adjustable to different medical situations and to different daytimes. Due to the ´cold` LED-light (no infrared) the surgeries are not exposed to any heat radiation which increases the comfort during operation significantly.

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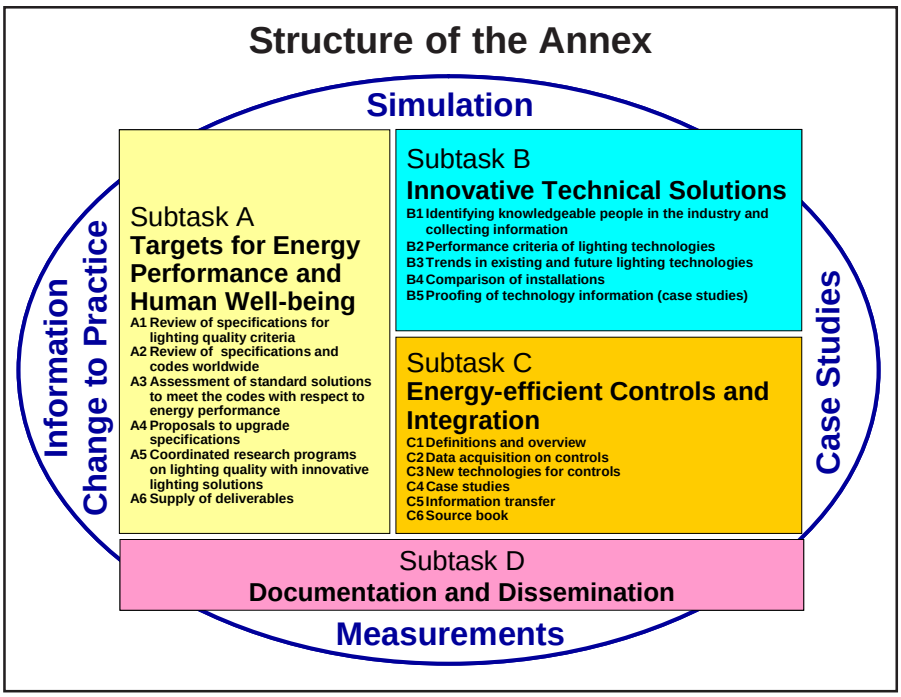
Annex 45
Energy Efficient Electric Lighting for Buildings

Introduction

The Executive Committee of the Energy Conservation in Buildings and Community Systems (ECBCS) program established a new research project (Annex) in June 2004 called Energy Efficient Electric Lighting for Buildings. Professor Liisa Halonen from the Lighting Laboratory of Helsinki University of Technology was elected for the Operating Agent of the Annex 45.

The objectives of Annex 45 are to identify and accelerate the use of energy-efficient high-quality lighting technologies and their integration with other building system, to assess and document the technical performance of existing and future lighting technologies, as well as to assess and document barriers preventing the adoption of energy-efficient technologies, and to propose means to resolve these barriers.



Management of the Annex

Operating Agent:	**Finland, Helsinki University of Technology Professor Liisa Halonen**
Subtask A Leader:	**France, École Nationale des Travaux Publics de l'État (ENTPE) Professor Marc Fontoynont**
Subtask B Leader:	**Austria, Bartenbach LichtLabor GmbH General Manager Wilfried Pohl**
Subtask C Leader:	**Germany, Technische Universität Berlin Professor Dr. rer. nat. Heinrich Kaase**
Subtask D Leader:	**Finland, Helsinki University of Technology D.Sc. Eino Tetri**

Objectives

Identify and accelerate the use of energy efficient high-quality lighting technologies and their integration with other building systems

Assess and document the technical performance of existing and future lighting technologies

Assess and document barriers preventing the adoption of energy efficient technologies and propose means to resolve these barriers

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More Comfort, Less Electrical Power for Office Spaces

Marc Fontoynont & Laurent Escaffre

Ingélux consultants and ENTPE have conducted a campaign of testing efficient lighting installations. The result is a proposal of specifications for lighting solutions in offices which are preferred by users, and with lighting power density below 10 W/m².

Laurent Escaffre and Christophe Marty from Ingélux Consultants testing performance of office luminaires.

26 Work Places Tested

Ingélux Consultants and ENTPE tested 26 work places, during 6 months in the area of Lyon, France. Each of work places had a specific lighting scheme.

The goal was to identify directions in preferred lighting schemes requiring less electrical power. Every user of each of the 26 workstations could adjust the power of the lamps in the luminaire.

The preferred lighting schemes were carefully recorded through measurements of illuminance distribution, luminance values in the field of view and electric power required by the lighting installation for the selected lighting scheme.

Results

The result is a proposal of specifications for lighting solutions in offices which are preferred by users, and with lighting power density below 10 W/m².

There was a clear rejection of any directly visible fluorescent tube (T5, T8 or compact fluorescent lamp). We found however that when fluorescent lamps were partly dimmed, the luminance of the lamps was acceptable. It seems that the threshold value is 7 000 cd/m²: fluorescent lamps above head with luminances below 7 000 cd/m² seem to be acceptable.

Preferences

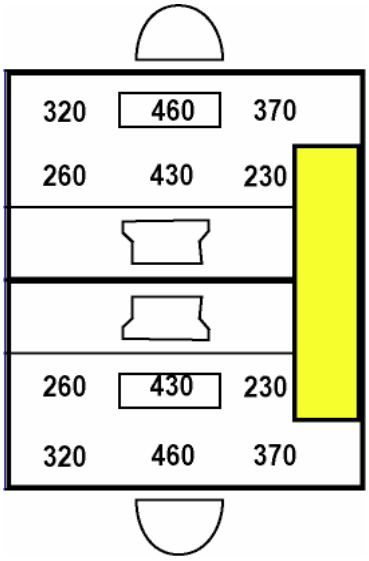
There was a clear preference for powerful task lighting, able to supply up to 500 lx on the desk, 380 to 450 lx average, with a good uniformity (0.6 to 0.8). The uniformity on the desk is the ratio of the minimum illuminance (230 to 350 lx) to the average illuminance (around 400 lx).

There was also a clear preference for systems hiding totally the vision of the fluorescent lamps, and indirect lighting systems.

There was a great satisfaction to dimming systems that provide individual controls. Although occupants did not use them often, they offer a guaranty that they could adjust the illuminance level according to their needs and physical state (fatigue, stress, etc.).

Preferences

L_{lamp} < 7000 cd/m²
E_{task} up to 500 lx
E_{ave} 380...450 lx
Fluorescent lamps out of side
Indirect lighting



Illuminance distribution on desk selected by the users for a direct-indirect lighting scheme shared by the occupants (2 x 54 W T5 dimmed at 65 %, power density 6 W/m²)

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Example of a direct-indirect lighting scheme tested.

Luminaires with LEDs

Wilfried Pohl & Eino Tetri

Introduction

Since the introduction of the light emitting diode (LED) in the 1960ies, a lot of technological development brought the initial small indicator LED, powered by a view milliwatt, to a high power device of several watts. Simultaneously, the efficacy (lm/W) and the light flux per LED advanced so that LEDs became a serious competitor to conventional light sources.

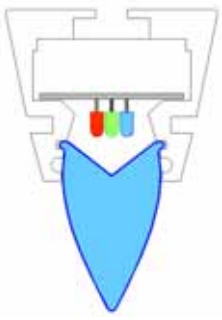
For the general public LEDs are the perfect replacement for conventional light sources with an enormous life time and a very high efficiency. These optimistic performance characteristics are a result from a strict publicity drive at the very first years of LED development. But it was just partially possible to reach these ambitious goals up to now.

Barriers

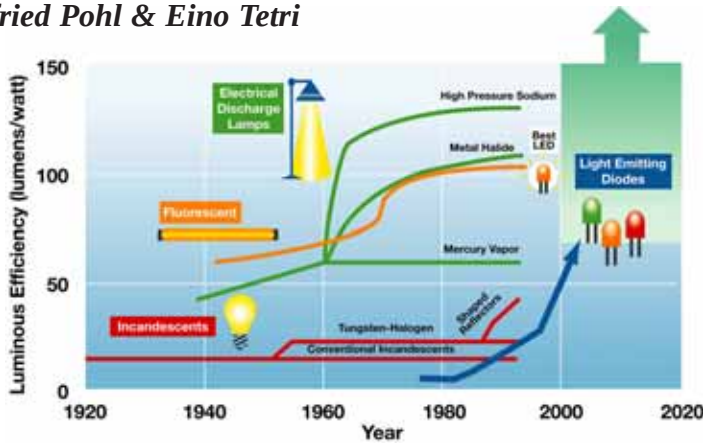
Up to now missing industrial standards (holders, control and ballast, platines, ..), high prizes, high risk (not fully developed state at the moment, LEDs in practise do not fulfil the promises), and short life cycles are strong barriers for lighting industry.

Additionally the uncertainty and risk caused by the absence of common standards in the LED industry is a significant barrier for luminaire manufacturers and end users. So at the moment they serve only for a niche market for special applications.

But following the actual LED performance forecast, this will change rapidly in the next years. White LED lighting will become a potential source of energy savings by replacing incandescent and halogen lamps, metal halide lamps and compact fluorescent lamps.



HESS ´Millennium` Aspheric lens mixing RGB-LEDs for street lighting application.



Evolution of light sources. Picture courtesy of Philips Lumileds.

Future

Seoul Semiconductor (SSC) has a power LED that has luminous flux of 98 lm at 350 mA current and the luminous efficacy is 84 lm/W for pure white LED (LEDs Magazine). With warm white LED the values are 67 lm and 57 lm/W. These luminous efficacies are far beyond of incandescent or halogen lamp.

So in 5 to10 years LEDs will outperform most traditional lamps in their superior lifetime, the possibility of spectral mixing, they are free of IR / UV and very robust. Prices are decreasing rapidly in the near future, the efficiency is further increasing which opens the way for LEDs to be the light source of the future with a broad field of applications.

Costs in EUR/(klm*1000 h)

Lamp type	EUR */Mlmh*
Incandescent, halogen	10
Fluorescent	1
Metal halide	5
LEDs	20

General Lighting

In general lighting the traditional light sources like halogen lamps or fluorescent lamps are the first choice for the customer because of the low prices and the high lumen output. In comparison to these conventional light sources, LEDs are at the moment relatively expensive and offer a relatively low light output. On the basis of the luminaire cost the gap between conventional light sources and LEDs is decreasing but at the moment is still too large for economical lighting.

Luminaires

Pictures show examples of special applications in which LED luminaires are already the best choice.

For the future we have to take care that LED-luminaires do not produce electronical waste (trend to throw away elements and luminaires, no replacements, due to the high life time!). We have to establish industrial standards for LEDs, holders, controls etc. to encourage sustainable LED luminaire design.

LEDs combined with halogen lamp for adjustable ambient lighting.

Conference room with LEDs.

Authors: General Manager Wilfried Pohl, Bartenbach LichtLabor GmbH, Aldrans/Innsbruck, Austria. D.Sc. Eino Tetri, Lighting Laboratory, Helsinki University of Technology, Finland

Classification Scheme of Lighting Control Systems

Arnaud Deneyer

The BBRI (Belgian Building Research Institute) and the UCL (Université Catholique de Louvain) are currently working together on a research project entitled MACONSOL (Control of the Lighting Energy Consumption through the use of Daylight) funded by the Walloon Region.

The project focuses on the prediction of lighting energy consumption linked to daylight availability and on the user behaviour in offices.

A characterisation scheme of the control systems linked to the IEA 45 activities is currently proposed. This scheme will help the user to identify the functionalities of the lighting control systems and its techniques.

Classification scheme

The scheme considers 2 different aspects:

– The control of the luminaire response: The light flux of the luminaries can be controlled in function of the daylight availability, the occupancy can be detected by a sensor,…
– The nature of the luminaire response: The response of the luminaire can be a dimming or a switching On/Off function that can be local or not.

The way the information transfer is achieved may also be considered under technical aspect:

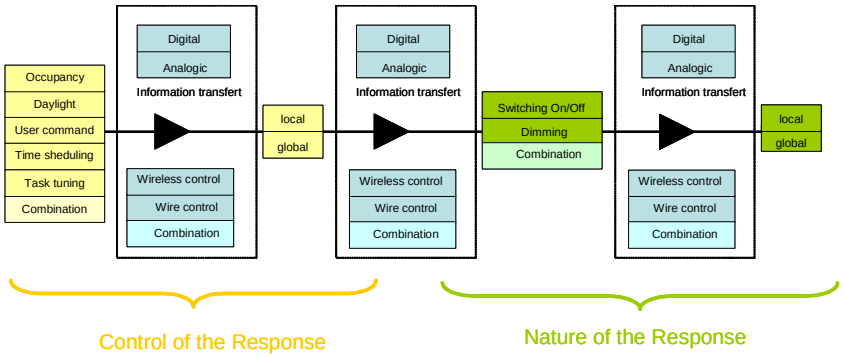
– The control of the luminaire can be analogical (1-10 V ballast supply) or digital (i.e. DALI protocol).
– The control can be wireless or not.

E.g., a lighting installation made of individual luminaries equipped with local daylight sensors can then be characterized according to this scheme.

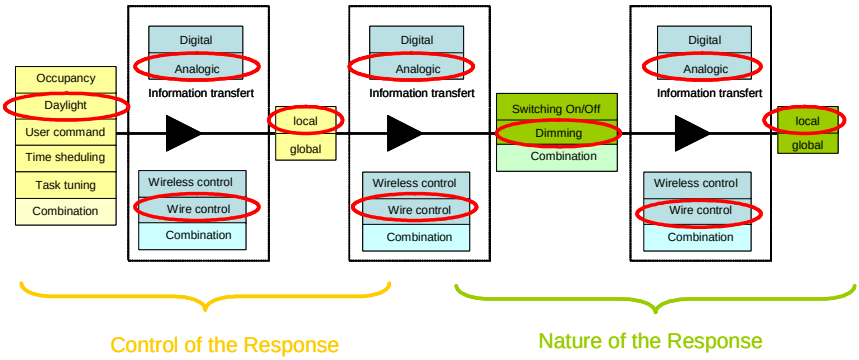
Energy Consumption

General energy consumptions of control systems are also measured in this project. It can be noticed that the energy consumption of the control system may be not negligible.

As example, measurements on a 58 W luminaire equipped with occupancy and daylight sensor with DALI compatible ballast and DALI controller may be resumed as follows:



Proposal of characterisation scheme.



Example of the use of the characterisation scheme.

Total power of the luminaire:
– 100 % of the light flux: 57.2 W
– 3 % of the light flux: 11.8 W
– 0 % of the light flux: 2.8 W

The 2.8 W for 0 % light flux is the parasitic consumption of the luminaire.

This value is not negligible at all and has a significant impact on the annual energy consumption of the luminaire.

The energy savings due to the use of the daylight and the occupancy sensors can be considered to be 30 % of total energy use, which represents on a yearly basis about 38.6 kWh (2250 h x 57.2 W x 0.30). The parasitic energy consumption of the luminaire is evaluated to be 18.2 kWh ([8760 h - 2250 h] x 2.8 W).

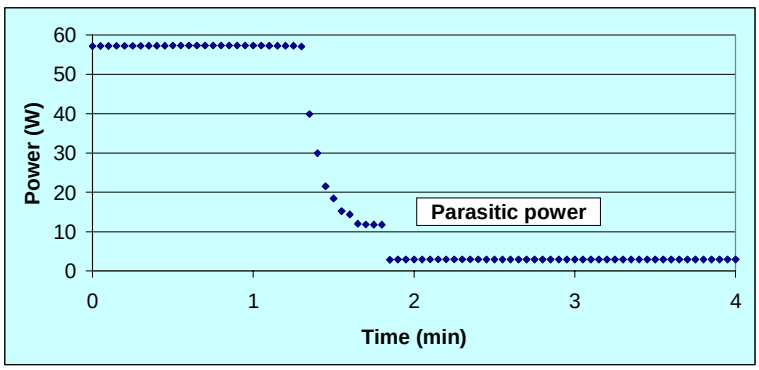
This shows that the parasitic energy consumption of this control systems is about 47 % of the energy savings due to the control system.

Therefore, the real global energy savings are about 20.3 kWh instead of 38.6 kWh, representing only about 16 % of the total energy consumption of this luminaire.

This proves that it is very important to choose for energy efficient control systems in order to avoid a significant decrease of the energy savings.

Author Project Leader Arnaud Deneyer, Belgian Building Research Institute, Brussels, Belgium.

Power measurements on luminaires



New Doctors in the Lighting Field

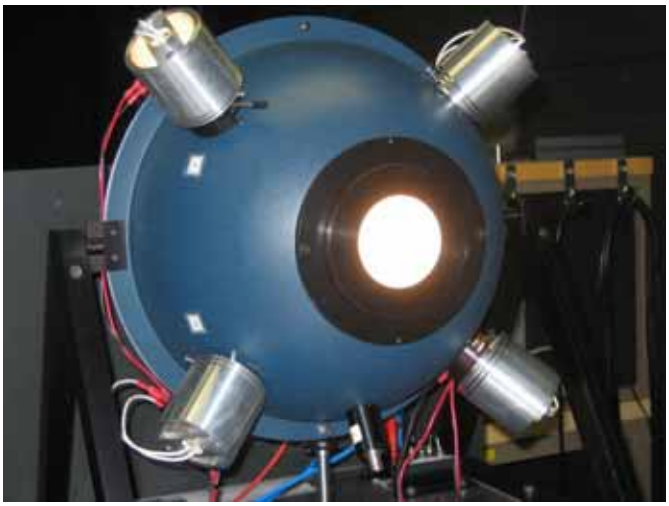
Characterization of the Luminous Environment with the help of Luminance-Mappers and Virtual Reality Simulations

Bruno Coutelier

The purpose of the study was to bring to the fore some descriptors of the visual comfort conditions, based on luminance ratio, luminance distribution in the field of vision and their variation. Many description scales were considered (linked with luminosity, space, uniformity, comfort impression) for different scenes linked to various types of premises (office, classes, museum, etc.).

Luminous environments were showed to people owing to a simulator of virtual reality which use a passive stereoscopy technology. Two groups of 30 persons judged the scenes and their judgments were confronted by the photometric data descended from luminance maps produced by a digital imaging camera based on numerical pictures. Luminance map of the area was produced with a Nikon Coolpix 990 camera with a fish eye lens. It was possible to calculate all explanatory leaflets linked to luminance from these maps.

For offices, the best descriptor is the luminance ratio, the preferred ratio between the work plan and the walls is 3, the preferred ratio between the work plan and the rest of the room is 1.8. For shops, average luminance ratios were more relevant. For restaurants people prefer to have more light on the table than on the rest of the room.



New Measurements Standards and Methods for Photometry and Radiometry

Jari Hovila

The Doctoral Thesis of Jari Hovila, "New Measurement Standards and Methods for Photometry and Radiometry", was examined and approved on December 9, 2005 at the Helsinki University of Technology (TKK). The research work was carried out in the Metrology Research Institute, which is the national standards laboratory for optical quantities in Finland.

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More Comfort, Less Electrical Power for Office Spaces

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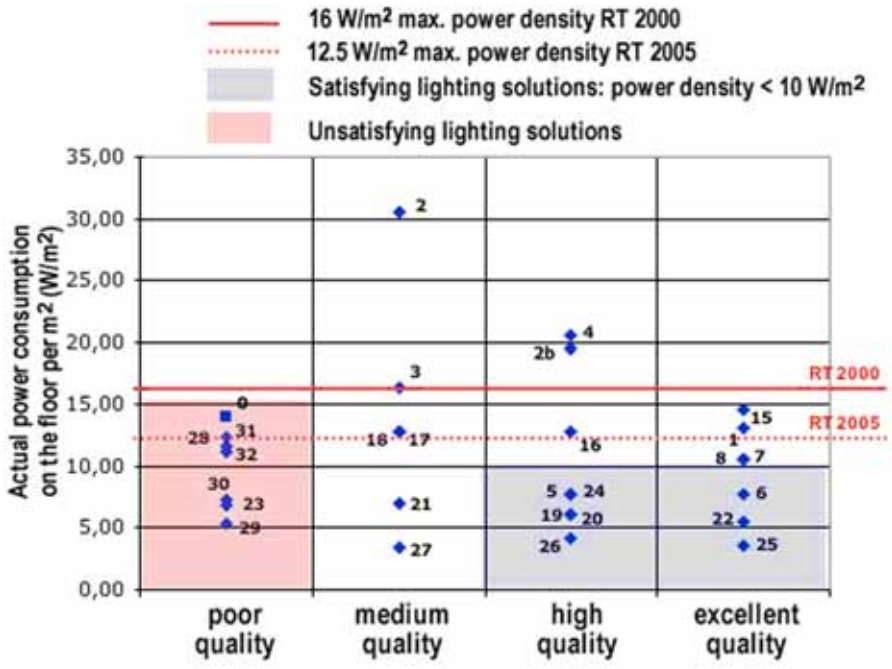

Perceived visual quality as a function of the electric power density for lighting for 26 lighting schemes.

Energy Efficiency

We observed a large variation in energetic efficiency of lighting solutions. The lowest were obtained with suspended direct-indirect luminaries shared by two occupants (6 W/m^2). Very low power densities were found for task/ambient solutions (below 8 W/m^2).

Conclusions

As a conclusion, it appears that the optical performance of a significant fraction of the supply in office luminaries needs to be improved. Individual task lamps could be designed with a power of 25 to 40 W, able to provide excellent illuminance distribution on the work plane. In these conditions, power densities of about 6 W/m^2 are achievable, with very high visual performances.

Authors: Marc Fontoynont Building Sciences Laboratory ENTPE-CNRS, Lyon, France.

Laurent Escaffre, Ingelux Consultants, Lyon, France.

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The largest part in the thesis is dedicated to the construction of detector-based national measurement standards for luminance, spectral radiance and luminous flux. Luminous flux, in particular, is a very important quantity for the lighting industry. The achieved precision of the luminous flux measurements is very good: the expanded uncertainty of the luminous flux of the primary standard lamps is only 0.47 %, which is one of the lowest reported values in the world. The validity of the uncertainty is verified by bilateral international intercomparisons.

Second topic in the thesis is to evaluate two calibration methods for a photometer measuring LED-based light sources. The photometer in this case is used for online production testing of buoy lanterns used as maritime signal lights. Due to narrow emission spectra of the LEDs and collimated radiation patterns of the lanterns, the photometer calibration is not a trivial task. A recommendation for preferred calibration method is given, taking into account not only the calibration procedure itself, but also long-term maintenance of the measurement system and possible introduction of completely new LED colors in the future.

The final part is related to calibrations of commercial luxmeters. These meters are often equipped with dome-shaped diffusers to improve their cosine responses. However, the improved angular responsivity comes with a price: the distance reference plane is somewhere inside the diffuser. If the meter is calibrated for illuminance responsivity relatively close to a light source and the distance is measured from the outermost surface of the diffuser, as is a common practice, a systematic error of several per cent can be obtained in the calibration. A simple method to determine the magnitude of the distance reference plane shift and means to significantly reduce the error are introduced.

The electronic version of the thesis can be found from http://lib.tkk.fi/Diss/2005/isbn951227955X/

Third Expert Meeting 6 – 7 April 2006, Aldrans, Austria

The third Expert Meeting of Annex 45 was on 6 – 7 April 2006 in Aldrans, Austria. The meeting was hosted by General Manager Wilfried Pohl, Bartenbach LichtLabor. There were 19 participants from 12 countries. During the meeting a detailed action plan was created in group discussions. Next Expert meeting will be on 5 – 6 September 2006, Canada.

National Interest Groups

Finland

Helvar

http://www.helvar.com/

Helvar manufactures ballasts and lighting control electronics for the luminaire industry and other customers specialising in lighting. The product range includes magnetic ballasts, controllable and non-controllable electronic ballasts, and a wide variety of lighting control systems.

Idman Oy

http://www.idman.fi/

Idman Oy develops, manufactures and markets luminaires and lighting systems for private and public use and is the market leader in special purpose luminaires in Finland. Idman is part of the international Philips consortium and is Philips Lighting's centre for lighting expertise in the Nordic countries.

Senate Properties

http://www.senaatti.com/

Senate Properties is a goverment-owned enterprise responsible for managing, developing and letting the property assets of Finnish state.

China

Shanghai Hongyuan Lighting & Electric Equipment Co

www.LVD.cc

www.shhongyuan.com

Contact person:Amy Wang

Shanghai Hongyuan Lighting & Electric Equipment Co, Ltd. owns electromagnetic induction lamp R&D center with Fudan University, forms the largest manufacture base for induction lamps in China, produce industrial and commercial light fixtures to accomade induction lamp with CE, UL approval.

Poland

ENTE Sp.z o.o. (Ltd.)

http://www.ente.com.pl

ENTE Sp. z o.o. manufactures IT and electronic components and systems for different systems of economy, among others offers equipment for intelligent control and visualization and broadband platform for the long range networks.

WASKO S.A. (joint stock comp.)

http://www.wasko.com.pl

WASKO S.A. implements IT solutions to companies and institutions, builds data communication networks and base stations for telephony, offers comprehensive ICT services for emergency communication centers.

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Annex 45 Expert meetings

4th Expert meeting
5-6 September 2006
Canada

5th Expert meeting
19-20 April 2007
Belgium

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