



August 13, 2008

CIE TC1-58 'Visual Performance in the Mesopic Range'

Minutes of the Meeting

Date: June 14, 2008

Time: 2:15 – 3:40 p.m.

Place: Scandinavian Colour Institute AB, Igeldammsgatan 30
Kungsholmen, Stockholm, Sweden

Present:	Liisa Halonen	Finland	(chairman)
	Marjukka Eloholma	Finland	(secretary)
	Miyoshi Ayama	Japan	
	Mike Pointer	UK	
	Peter Bodrogi	Hungary	
	János Schanda	Hungary	
	Colette Knight	Netherlands	
	Chang Soon Kim	Republic of Korea	
	Oswaldo da Pos	Italy	
	Emil Radkov	USA	(observer)
	Katalin Toth	Hungary	(observer)
	Peter van der Burgt	Netherlands	(observer)
	Philipp Kittelmann	Germany	(observer)
	Thorstein Seim	Norway	(observer)
	Wendy Davis	USA	(observer)
	Elsie Coetzee	South Africa	(observer)
	Gerhard Rösler	Germany	(observer)
	Changjun Li	UK	(observer)
	Rengin Ünver	Turkey	(observer)

1. Opening of the meeting

Liisa Halonen opened the meeting and welcomed all to the 6th meeting of TC1-58.

2. Noting the TC members and introducing the participants

A list of the current TC members was reviewed.

3. Approval of the Agenda

The Agenda was approved.

4. TC working programme and schedule

Liisa Halonen reminded of the TC terms of reference, these are: *'To define mesopic visual performance and related terms. To investigate performance based photometry in the luminance region below approximately 10 cd/m². To propose a model for the basis of performance based mesopic photometry.'*

Liisa Halonen reviewed the outcomes of the previous TC1-58 meetings. In the 1st meeting (Tokyo June 10, 2004) the new terms of reference were agreed. In the 2nd meeting (León May 17, 2005) the TC working programme (tasks and schedule) was defined. In the 3rd meeting (Ottawa May 18, 2006) the TC work (outcomes of expert surveys, model comparisons) was introduced and decision was made on generation of further data for model comparisons and analysis. In the 4th meeting (Beijing July 9, 2007) analysis of MOVE-, X- and Y-models based on three new independent data-

sets were presented, the contents of the TC report were agreed and the required future actions needed to accomplish the TC work were discussed. After the Beijing meeting the first drafts of the Chapters 3-6 of TC report were sent to members for commenting. In 5th meeting (Eindhoven November 9, 2007) the contents of the Chapters 3 and 4 were agreed and also the criteria to be used in proposing the mesopic model were agreed. After the Eindhoven meeting the second draft of Chapters 5 and 6 were circulated to members for their comments. The aim of the Stockholm meeting is to agree on the contents of the Chapters 5 and 6 and to agree on the schedule for finalizing the TC report.

The chairman presented the TC working programme which is divided into three main tasks according to the terms of reference. The definition of visual performance and related terms has been completed. Also, the generation of new data, analysis of new data and modeling of mesopic data have been completed. The aim is to finalise the TC work (proposal for a model and TC report) within four years and three months from its start, this is by September 2008. The final TC report will be sent to members for commenting by September 15, 2008.

5. TC Report

Marjukka Eloholma reviewed the TC report. The contents (Attachment 1) of the report are organised according to the terms of reference and the contents were agreed in the Beijing meeting.

The 4. draft (including Chapters 3-6) of the report was sent to members on May 19, 2008. In this draft the comments received after the Eindhoven meeting to Chapters 3 and 4 were considered and thus these Chapters are now final (small editorial changes possible to avoid repetition once Chapters 1 and 2 are complete). Comments to Chapters 5 and 6 were received from members by June 9, 2008 and these comments are discussed in this meeting.

Marjukka reviewed the procedure of the TC work which will form the basis of the TC report. The TC has reviewed and tested the existing visual performance based mesopic models, which are linear combinations of the photopic $V(\lambda)$ and the scotopic $V'(\lambda)$. The existing models have been tested with new independent data sources based on the criteria defined in the TC work. The outcome of the testing shall be the proposal of a model for the basis of visual performance based mesopic photometry, which is the final outcome of the TC work. The criteria to be used in testing the models were agreed in the Eindhoven meeting and these are: spread in mesopic contrast for constant visual performance and trend analysis (see Attachment 1).

Comments to the 4. draft of the report were received from four members. The comments were reviewed and discussed in detail. All the comments were presented on the screen to the participants of the meeting. Minor comments were received from Peter Bodrogi (HU) and Collette Knight (NL) and the needed actions to consider the comments were agreed. More comprehensive comments were received from Mark Rea (US), John Bullough (US) and Teresa Goodman (UK), and are presented in the following in combined and compressed form. The comments were discussed in the meeting with agreements on possible required actions:

- **Comment:** *The goal of the committee is not clear. A major problem is a lack of clarity between what constitutes a model of visual performance and what is needed for a system for making photometric measurements. No system of photometry can provide a full description of visual task performance.*

Response/Action: The goal is stated in the terms of reference, this is to propose a model for the basis of performance based mesopic photometry. It will be clarified in Chapter 1 (Introduction) that the task of the committee has been to propose a *model of mesopic spectral sensitivity* for the basis of mesopic photometry. The spectral sensitivity functions in turn are derived based on criteria of visual task performance (not brightness matching), i.e. on recognition task, reaction time task etc. As in the mesopic region several spectral sensitivity functions are needed, the model incorporates these functions. The model of mesopic spectral sensitivity is distinct from a model of visual performance. The term *visual performance based mesopic photometry* will be clarified in the Introduction.

In addition, it says in Chapter 3.2.1:

'While it is not necessary or possible to have a single system which can completely predict visual performance for all tasks and lighting conditions, the recommended visual performance based mesopic model must have its roots on visual task performance data

and be sufficiently accurate to be used in defining mesopic luminances based on the spectral characteristics of the lamp and the photopic luminance level.'

- **Comment:** *The unified system of photometry, erroneously labeled the "X-model" in this report, makes no claims with regard to predicting visual performance. Neither the unified system of photometry nor the MOVE algorithms can completely rectify the luminous stimulus, even if only visual performance is considered.*

Response/Action: Chapter 4.1: 'The foundations for any system of photometry must lie in empirical visual performance data using human subjects. Photometry has always had its roots in human visual psychophysics.....It is worth noting that no single system can ever hope to provide a complete prediction of visual performance for all tasks and lighting conditions....Instead of trying to describe the detailed performance of the eye under a given set of conditions, the emphasis has been on developing a system which can be readily implemented in practice, but which may not provide a precise description of visual performance.'

The analysis and testing of the models (Chapter 6) in the report are made to see how well the models predict the luminous stimulus (mesopic luminance) in various task and lighting conditions. This is consistent with the TC working programme, which was agreed in the 2nd TC meeting.

- **Comment:** *It is not clear how the MOVE consortium can on one hand be so specific about there being three different levels of visual processing (which of course there are) and then attempt to "model" visual performance with a set of algorithms that do not reflect these three levels.*

Response/Action: Chapter: 3.2.1: 'It is widely acknowledged that there is no single task or target that could characterise the difficulty of the visual task of night-time driving. One approach, yet simplified, is the visual performance-based approach adopted by the MOVE consortium.'

To be added in MOVE-model description Chapter 4.3:

'A distinction was made between a model applicable in practice and a model of the eye response in the mesopic region. In order to be implemented alongside the current photopic photometry, the mesopic spectral sensitivity functions should tend to the photopic $V(\lambda)$ at the upper end, and to the scotopic $V'(\lambda)$ at the lower end of the mesopic region. Still, the model should predict visual task performance reasonably well. It was foreseen in the MOVE work that the spectral response for each visual sub-task might require a distinct description of mesopic spectral sensitivity. In modelling the MOVE data each type of the three visual sub-task measurements was modelled separately, with each background light level taken in turn. It was, however, found that an acceptably good fit to all the data sets was obtained with a single model.'

- **Comment:** *If the goal of the committee is to develop a system of photometry which, by definition will also be "simplified," then that should be clearly stated. If photometry is the goal, then a determination of which approach, the unified system of photometry or the MOVE algorithms, should be adopted would not be based upon curve fitting psychophysical data, but rather the discussion should center on the basic principles of photometry such as additivity, in particular, but also practicality, economics, and the ability to measure and calculate photometric quantities. Indeed, if the goal of the committee is to develop a system of photometry, then the exercise of curve fitting psychophysical data is entirely superfluous.*

Response/Action: The terms of reference define the goal of the committee, this is to investigate performance based photometry. This investigation includes testing the existing models with new data sets. The criteria to be used in testing the models were agreed in the Eindhoven meeting and these are: spread in mesopic contrast for constant visual performance and trend analysis. The outcome of the testing shall be the proposal of a model for the basis of visual performance based mesopic photometry, which is the final outcome of the TC work.

- **Comment:** *There are major concerns about Section 5, in particular the way in which the 'match' between the predicted task performance and the measured task performance seems to be intended to be used as a basis for justifying the choice of one system or another. This should not be the aim. Rather, it should be clearly acknowledged that the system to be proposed by TC1-58 is a compromise between practical utility and an ability to provide a measure of light output that is meaningfully-related to task performance, with the over-riding requirement that it is consistent with the present photopic and scotopic systems. With this in mind, the recommended system should be justified primarily in terms of utility, with the correlation with task performance as a secondary aspect. Issues of additivity, practicality, tradition, economics, and measurement precision are equally or more important to consider and discuss in moving forward toward the adoption of a comprehensive system of photometry.*

Response/Action: Chapters 5 and 6 remained as they are, but in Chapters 1 and 2 to be acknowledged that practical utility of the model is also an important issue. The TC terms of reference and Working Programme define the task of the TC and this includes the following: collecting and analysing mesopic data, generating new data and investigating the data and finally, based on this, proposing a model. The criteria to be used in testing the models has been agreed in the TC work, and it has also been agreed that the final proposal of a model will be based on these two criteria and the models ability to describe various visual and lighting conditions. It is out of the scope of CIE Div 1 committee to use economics, tradition etc. as the criteria for justifying its proposal for a model. Furthermore, there are no defined criteria for using e.g. 'economics' as the criteria for proposing a model within CIE Div 1.

- **Comment:** *The comparisons between the systems should not be described as 'testing' the systems, and if the comparisons are to be of any value then they also need to be considered in the context of the uncertainty in the psychophysical data.*

Response/Action: uncertainty of the data will be given (when possible), or the consequences of uncertainty will be discussed in Chapter 5.

- **Comment:** *It will be clearer if Chapter 4 (Mesopic models) comes before Chapter 3 (Mesopic visual performance and mesopic conditions).*

Response/Action: The Contents of the Report, as agreed in the Beijing meeting, follows the terms of reference and the TC working programme. It is also relevant to introduce the mesopic visual performance and mesopic conditions before introducing the models. Order of Chapters not changed.

- **Comment:** *We find the whole presentation in this section ironic. The curves clearly show that a ("simplified") rectifying photometric system can never be expected to explain all of the variance in the visual performance data. Different contrasts will, as shown, have different functional relationships with performance.*

Response/Action: It is evident that different contrasts lead to different performance responses. The curves do, however, indicate that all the mesopic models yield to better predictions than the photopic system. Chapter 6.3.3 remained as it is.

- **Comment:** *Chapter 6.4 should be omitted, for the following reasons: there exists no X-model but unified system of photometry, the principles of photometry are often ignored in preference to fitting visual performance data, it is not clear whether independent data was used to validate the models, Table 8 is problematic in including data confounded by colour and other factors.*

Response/Action: Chapter 4 not omitted, but it will be made more clear that there is no X-model, but a unified system of photometry. The testing of the models is justified by the terms of reference and Working Programme of the TC. Chapter 5.2 explains that all the data sets are independent from the data sets used to develop the models. Table 8 summarises the results of the testing and is important in that sense.

- **Minor comments:**

- o page 6/47, last sentence first paragraph: will be clarified.



- citations to Johnson (1937) and Rea et al (2004) (page 4/47, 1st paragraph), McGowan and Rea (1994) (page 6/47 2nd paragraph), He et al (1997) (page 4/47 2nd paragraph), Rea et al (2004) (page 11/47, last paragraph), Rea and Bullough (2007) (page 13/47, 2nd paragraph), Bierman et al (1998) (page 14/47, first paragraph), Rea et al (2004) (page 15/47, first paragraph) will be added
- accuracy of luminance meters to be added (page 7/47, last paragraph)
- page 14/47, text following Table 1: will be corrected
- Figure 16 of Chapter 6.3.2: to be clarified that the points represent visual performance data points (similarly to Figures 14 and 15 of Ch. 6.3.1)

It was agreed that the TC report will be modified according to the above agreed actions. With these modifications the Chapters 5 and 6 are in the final form. The final draft report with all Chapters including a proposal for a model will be sent to members by September 15, 2008.

6. Future actions

In the discussions it was pointed out, that there is an ongoing CIE TC4-48 studying the effects of white light under mesopic conditions for urban environments. Collette Knight will inform TC4-48 of the progress of TC1-58. This is to consider how the proposed model can be integrated in TC4-48 work and its practical guidelines. There are further investigations on the mesopic topic going on (e.g. in LRC, USA), but it was considered that these can be integrated in TC4-48 work dealing with practical issues and that now it is time to finalise the TC1-58 work

There will be no more meetings of the TC1-58. The report will be completed through communication by e-mail. The aim is to finalise the report soon after comments have been received to the final draft, so that the report can be rendered to Div 1 for further processing to become a Technical Report.

7. Closure of the meeting

Liisa Halonen closed the meeting at 3:40 p.m. and thanked everyone for participation.

Attachment 1. TC report contents and work procedure