Public Lighting – How and Why

Peter Raynham
Introduction

• Lighting for drivers
• Lighting for pedestrians

What are the requirements for each type of road user?
Why have we got these requirements?
Reasons for Lighting for Drivers

- Safety
- Comfort
- Traffic density
How Lighting is Specified for Drivers

• Average Road Luminance ($\bar{L}$)
• Overall Uniformity ($U_O$)
• Longitudinal Uniformity ($U_L$)
• Disability Glare - Threshold Increment ($T\%$)
• Surround Ratio ($SR$)
<table>
<thead>
<tr>
<th>Class</th>
<th>Luminance of the road surface of the carriageway for the dry road surface condition</th>
<th>Disability glare</th>
<th>Lighting of surroundings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\bar{L}$ in cd/m² [minimum maintained]</td>
<td>$U_o$ [minimum]</td>
<td>$U_i$ [minimum]</td>
</tr>
<tr>
<td>ME1</td>
<td>2,0</td>
<td>0,4</td>
<td>0,7</td>
</tr>
<tr>
<td>ME2</td>
<td>1,5</td>
<td>0,4</td>
<td>0,7</td>
</tr>
<tr>
<td>ME3a</td>
<td>1,0</td>
<td>0,4</td>
<td>0,7</td>
</tr>
<tr>
<td>ME3b</td>
<td>1,0</td>
<td>0,4</td>
<td>0,6</td>
</tr>
<tr>
<td>ME3c</td>
<td>1,0</td>
<td>0,4</td>
<td>0,5</td>
</tr>
<tr>
<td>ME4a</td>
<td>0,75</td>
<td>0,4</td>
<td>0,6</td>
</tr>
<tr>
<td>ME4b</td>
<td>0,75</td>
<td>0,4</td>
<td>0,5</td>
</tr>
<tr>
<td>ME5</td>
<td>0,5</td>
<td>0,35</td>
<td>0,4</td>
</tr>
<tr>
<td>ME6</td>
<td>0,3</td>
<td>0,35</td>
<td>0,4</td>
</tr>
</tbody>
</table>

1) An increase of 5 percentage points in TI can be permitted where low luminance light sources are used.

2) This criterion may be applied only where there are no traffic areas with their own requirements adjacent to the carriageway

Table 1a from EN 13201-2
Visual Tasks

- Task Size
- Luminance
- Luminous Contrast
Questions about Lighting for Drivers

- Is small target visibility an appropriate criterion?
- What is the impact of colour contrast?
- What is the impact of headlights?
- Is $U_L$ the best measure to control driver comfort?
- What is the impact of mesopic vision?
- What happens when you measure the lighting?
Questions about Lighting for Drivers

- Is small target visibility an appropriate criterion?
- What is the impact of colour contrast?
- What is the impact of headlights?
- Is $U_L$ the best measure to control driver comfort?
- What is the impact of mesopic vision?
- What happens when you measure the lighting?
What is the Effect of Vehicle Lights

- Typical road – 8m wide
  - L: 1 cdm$^{-2}$
  - U$_O$: 0.4
  - U$_L$: 0.7
  - TI: 15%
  - Ignoring glare from headlights
Glare from Headlights

- Cars spaced every 40 m
- H4 Headlights meeting (E/ECE/324/R112)
- Correct aiming
- No allowance for dirt or non étalon lamps

- Note formula for glare calculation is only valid for if angle between glare source is greater than 1.5°
\[ TI\%_0 = 65 \sum_{\theta} \frac{E_{\text{Eye}}}{\theta^2} L_{Av}^{0.8} \]

\[ TI\%_0 = \frac{10 \times 2.66}{1} = 1470 \]
Measurement of Lighting (Luminance)

- Set out in EN 13032-4
- Patch size of road being measured
- Variation in road surface properties
  - Uniformity values low
- Uncertainties
  - Meter
  - Installation
- Difficulties in measuring Ti
- Impact of other factors
Tasks for Pedestrians

- Safe movement
- Orientation
- Visual comfort
- Facial recognition
- A general feeling of safety
Tasks for Pedestrians

- Safe movement
- Orientation
- Visual comfort
- Facial recognition
- A general feeling of safety
Average recognition distance observers
PLT 827, PLT 840, SON

Semi-cylindrical Illuminance [Esc] vs. Recognition distance [m]

- PLT 840 (pink line)
- PLT 827 (blue line)
- SON (orange line)
Results from the facial recognition experiment with 2 subjects
Knight and van Kemenada

<table>
<thead>
<tr>
<th>Source</th>
<th>Illuminance /lux</th>
<th>Distance for gender recognition /m</th>
<th>Distance to guess identity /m</th>
<th>Distance to identify person /m</th>
</tr>
</thead>
<tbody>
<tr>
<td>SON</td>
<td>3.3</td>
<td>13.4</td>
<td>7.6</td>
<td>5.4</td>
</tr>
<tr>
<td>CDO-TT</td>
<td>1.4</td>
<td>13.3</td>
<td>8.5</td>
<td>6.6</td>
</tr>
</tbody>
</table>
Study by Boyce

- Subjects taken to parking lots in the Albany area
- Rated “Safe to Walk”
- Sites visited by night and by day
Lighting for Pedestrians

- Mainly Specified by $S$ classes – $E_h$
- Other classes available but not generally used
  - $E_{scyl}$
  - $E_{ssph}$
Measurement of Lighting (Illuminance)

- Lamp output ± 5%
- Luminaire distribution ± 10%
- Mounting height ± 6%
- Spacing ± 20%
- Luminaire tilt ± 8%
- Luminaire level ± 10%
- Supply voltage ± 2.5%
- Light Meter ± 6%
- Meter placement and level ± 5%

- Overall typical ± 30%

Values from ILE study
Conclusion

• Lighting for drivers
  – Lighting specification well related to key task
  – Is the task the right one?

• Lighting for pedestrians
  – Good basic understanding of visual needs
  – Lighting specification not well related to tasks

• Measurement problems