1. STREETLIGHTING QUALITY CHARACTERISTICS

To calculate the quality characteristics, the light distribution of the luminair is measured, i.e. the light intensity (cd/klm) is measured for a number of C and gamma angles.

\[ C = 270° \]
\[ C = 180° \]
\[ C = 90° \]
\[ C = 0° \]

Then the illumination of a theoretical street, illuminated by 5 luminaires, is calculated.

For the area, between the second and third pole, the computer calculates, by means of the reflection properties of the road, how the incident flux is reflected in the direction of the driver, 60 m before the second pole in the middle of the driving lane.

CIE specifies different roadsurfaces what reflection properties are concerned:
- \( R1 = \text{DIFFUSE REFLECTION} \)
- \( R2 = \text{DIFFUSE-COMPOUND REFLECTION} \)
- \( R3 = \text{SPECULAR-COMPOUND REFLECTION} \)
- \( R4 = \text{SPECULAR REFLECTION} \)

The result of the calculation is a table with the luminance value of a number of points on the street.

The quality of the streetlighting depends on:
- AVERAGE LUMINANCE
- LUMINANCE UNIFORMITY
- GLARE CONTROL

Values of average luminance and uniformity (ratio between minimum and mean or maximum luminance values) are deducted from luminance table.

Glare is evaluated by Treshold Increment (TI) and glare mark (G), which are calculated by means of empiric formulas.

Depending on the road category CIE recommends following values for the quality characteristics:
2. ILLUMINATION CALCULATION FOR INTERIOR LIGHTING

Number of luminaires to create an average illumination level working plane on floor is:

\[ N = \frac{E \times S}{U \times d \times n \times F} \]

- **E** = average illumination level
- **S** = surface of working plane (on floor) in m²
- **U** = utilisation factor
- **d** = maintenance or deprecation factor
- **n** = number of lamps per luminaire
- **F** = luminous flux per lamp

To obtain an illuminance uniformity (Emin/Eave) of at least 70% on the working plane, the luminaires must be positioned in a regular pattern on the ceiling.

The maximum center to center distance between two luminaires must be equal or less than “e”.

For each luminaire the “e/h” ratio is found in the catalogue.

2.1. Average Illumination Level

Recommended illumination levels for office lighting:

- 1000 to 1600 Lux  Critical drawing tasks
- 400 to  800 Lux    General office work
- 200 to  400 Lux    Stores and stockrooms
- 100 to  200 Lux    Circulation areas

2.2 Working Plane

- Working plane height: - 0.75 m for office
  - 0.85 m for working areas

2.3 Utilisation factors

Depends on luminaire type, luminaire wattage, room dimensions (room index) and reflectance of ceiling, walls and floor. Is found in datasheets as function of:

- Room index:  \[ K = \frac{L \times B}{h \times (L + B)} \]
  - **L** = length
  - **B** = width
  - **h** = distance luminaire - working plane

- Reflectance:

<table>
<thead>
<tr>
<th>Colour</th>
<th>Average Reflectance</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>80 %</td>
</tr>
<tr>
<td>Light grey</td>
<td>50 %</td>
</tr>
<tr>
<td>Grey</td>
<td>30 %</td>
</tr>
<tr>
<td>Dark grey</td>
<td>10 %</td>
</tr>
<tr>
<td>Light blue</td>
<td>45 %</td>
</tr>
<tr>
<td>Light green</td>
<td>50 %</td>
</tr>
<tr>
<td>Dark green</td>
<td>15 %</td>
</tr>
<tr>
<td>Light yellow</td>
<td>65 %</td>
</tr>
<tr>
<td>Brown</td>
<td>25 %</td>
</tr>
<tr>
<td>Pink</td>
<td>50 %</td>
</tr>
<tr>
<td>Dark red</td>
<td>15 %</td>
</tr>
</tbody>
</table>

2.4 Maintenance factor:

Takes into account the depreciation in light output caused by:
- luminous flux reduction of lamps with use (depending on lamp type).
- dirt on lamps and luminair.
- reduction of reflectance values of walls and ceiling.

<table>
<thead>
<tr>
<th>Room type</th>
<th>Maintenance factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td>0.9</td>
</tr>
<tr>
<td>Dirty</td>
<td>0.8</td>
</tr>
</tbody>
</table>
3. GLARE EVALUATION FOR INTERIOR LIGHTING

To prevent glare, the luminance values in the range of the viewing angles (gamma from 45° to 85°) should not exceed specified limits.

These limits are a function of the service illuminance and the quality class of the lighting installation.

**Quality class**
- A = Very high
- B = High
- C = Medium
- D = Low
- E = Very Low

**Recommended quality class**
- A - B: offices, classrooms
- B - C: shops, medium work
- C - D: stairs, rough work
- D - E: circulation areas

\[
\text{h} = \frac{a}{h_a}
\]

**Gamma**

<table>
<thead>
<tr>
<th>Quality class</th>
<th>g</th>
<th>Valid for service illuminance E (lux)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.15</td>
<td>2000 1000 500 300</td>
</tr>
<tr>
<td>B</td>
<td>1.5</td>
<td>2000 1000 500 300</td>
</tr>
<tr>
<td>C</td>
<td>1.85</td>
<td>2000 1000 500 300</td>
</tr>
<tr>
<td>D</td>
<td>2.2</td>
<td>2000 1000 500 300</td>
</tr>
<tr>
<td>E</td>
<td>2.55</td>
<td>2000 1000 500 300</td>
</tr>
</tbody>
</table>

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