UGR-Calculation

Calculation with formula $UGR = 8 * \lg(0.25 \sum_{i=1}^{n} \frac{L_i^2 \Omega_i}{L_b P_i^2})$ according to CIE 117-1995.

- L_i : luminance of the luminous parts of each luminaire in the direction of the observer's eye
- Ω_i : solid angle of the luminous parts at the observer's eye; L_b : $L_b = \frac{E_{indirect}}{\pi}$
- P_i : Guth position index of the luminaire
- 10 <= value of UGR <=30

1. Standard Tables

To calculate the background luminance the Formula $L_B=L_0 \times L_R$ from page 12 chapter A2.3 of the CIE 117 is taken. L_0 is given through the definition of 1000 lumens per Luminaire (A2.2, page 12). If the spacing to height ration (SHR) is 0.25 and H is 2m, there are 4000 lumens per square meter. The result for L_0 will than be:

$$L_0 = 4000 \frac{lm}{m^2} * \frac{1cd * m^{-2}}{10 * \pi * lm * m^{-2}} = 127 \frac{cd}{m^2}$$

If SHR is 1.0 (used in the UK) the luminous flux per squre meter is than reduced from 4000lm/m² to 250lm/m². Using SHR 1 reduces the L_0 from 127cd/m² to 7.95cd/m².

L_R is calculated according to the formula A.4 of CIE 117:
L_R = 6 x UF(total) – 5 x UF(direct)

UF is defined in CIE 52 82, page 56

The Luminaire luminance L_i is calculated by:

- using the light intensity into the direction to the observer, in the middle of the left wall and the lower wall in 1.2m above ground
- using linear interpolation between given values of the LDC divided by the projected luminous surface taking into account also the side surfaces of the fixture, if they are light emitting
- The Luminaire luminance is calculated in the following way:
  If the Luminaire shape code 3D is box than:
  $$A_{Proj} = l * w * \cos\gamma + w * h * |\sin C| * |\sin\gamma| + h * l * |\cos C * \sin\gamma|$$

If the Luminaire shape code is sphere:

$$A_{\Pr oj} = \mathrm{p} * \left(\frac{D}{2}\right)^2$$

If the lumiare shape code is cylinder:

$$A_{\Pr oj} = \mathrm{p} * \left(\frac{D}{2}\right)^2 * \cos \mathrm{g} + D * h * \sin \mathrm{g}$$

Where:

l is the length of the light emitting surface
w is the width of the light emitting surface
h is the height of the light emitting surface
D is the diameter of the light emitting surface
C is the angle of the C plane
γ is the γ angle

The luminance is the light intensity in the direction divided by the projected surface in the direction.

$$L(C,\mathrm{g}) = \frac{I(C,\mathrm{g})}{A_{\Pr oj}(C,\mathrm{g})}$$

The solid angle is calculated by:

- dividing the projected luminous surface by the distance squared
- the distance is defined as the distance from the observers eye to the middle point of the LEO
- DIALux defines the area as planar not as a part of a sphere

The position index according Guth is calculated by:

- Linear interpolation between the values of the table in CIE 117
- In the range of H/R 1.7 to 1.8 and T/R 0.0 to 0.8 a value is given, that excludes the fixture from the UGR calculation (no definition in the table)

The maintenance factor is not taken into account.

2. UGR Observer and UGR grids

The UGR values of the UGR objects are calculated according to the UGR formula. For the background luminance the "real" background luminance at the observers' eye is taken from the result of the Radiosity calculation. Material, furniture, shadows,… are taken into account for this calculation

Single observer in a general room

- the line of sight is parallel to the plane z=0.
- Furniture is possible

- Room does not have to be convex. Any room shape is possible
- Different types of luminaries are possible
- Only these luminaires are considered, which are visible at the observer

Grid of observers in a general room

There is a grid of observers all viewing into the same direction. This surface is treated similar to a calculation surface. The line of sight is parallel to the plane z=0.