TÉCNICO LISBOA

DEEC
DEPARTAMENTO DE ENGENHARIA ELETROTÉCNICA E DE COMPUTADORES
TÉCNICO LISBOA

# Redes e Instalações Eléctricas

## Electrical and Servicing Systems

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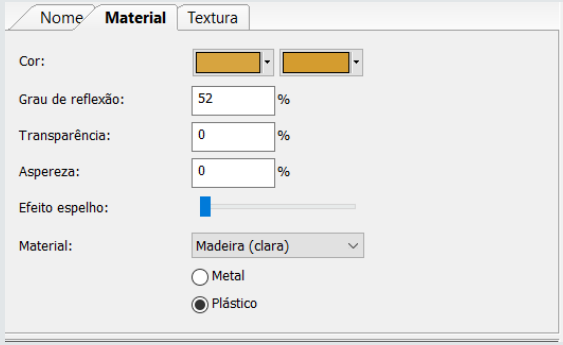
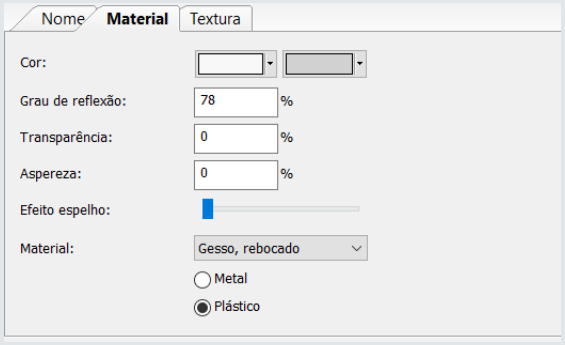
# Coeficientes de reflexão – escritórios e similares

- Deverão considerar os seguintes materiais:

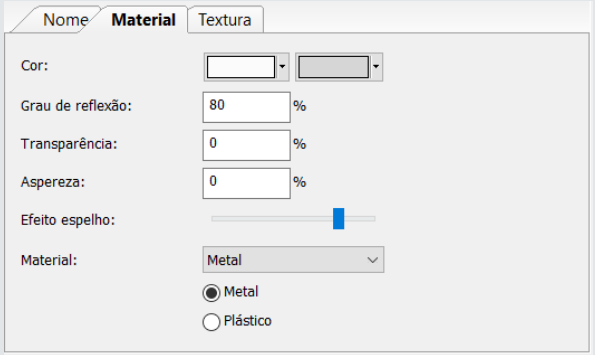
Pavimento:




Paredes:



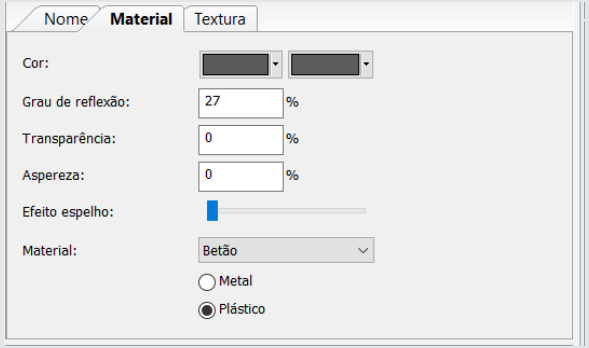

Teto:



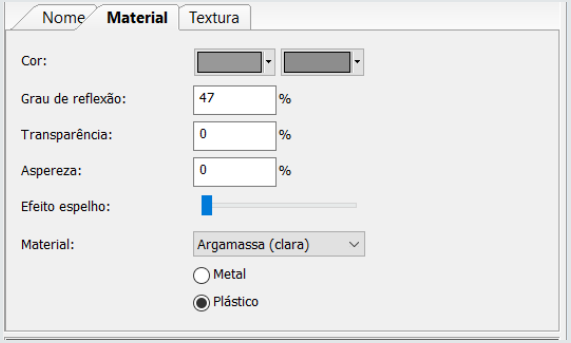
# Coeficientes de reflexão – áreas técnicas e arrumos

- Incluindo estacionamentos

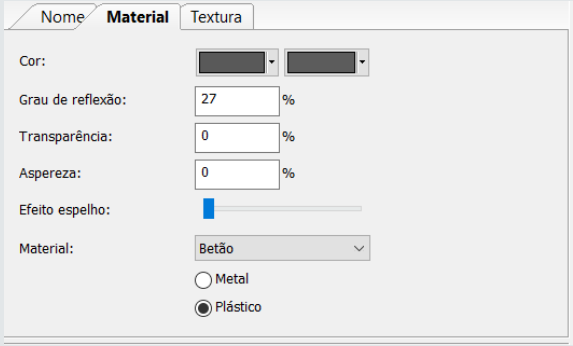
Pavimento:




Paredes:



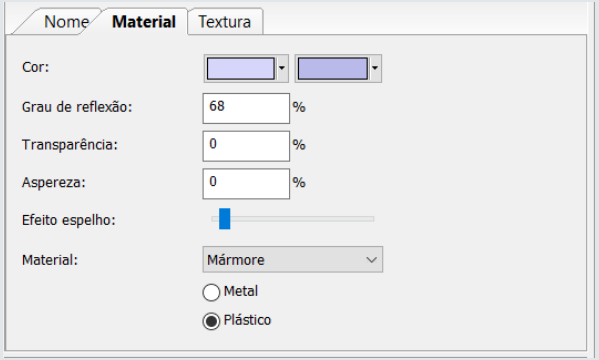

Teto:



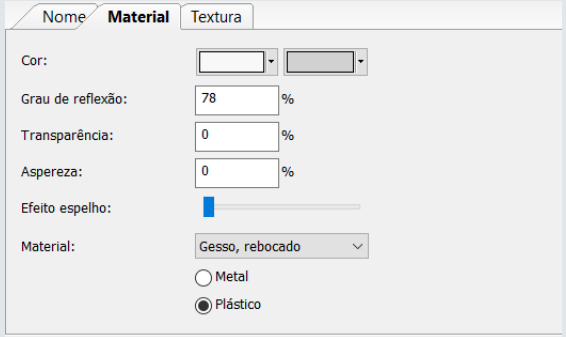
# Coeficientes de reflexão – Escadas e circulações

- Deverão considerar os seguintes materiais:

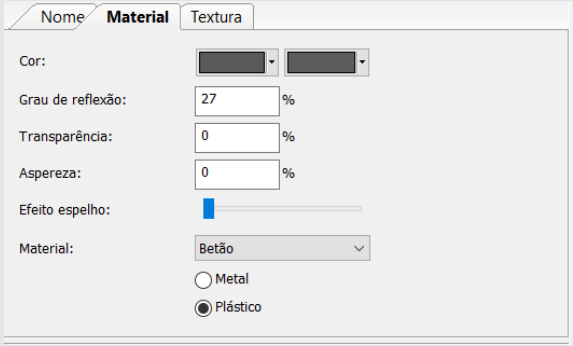
Pavimento:



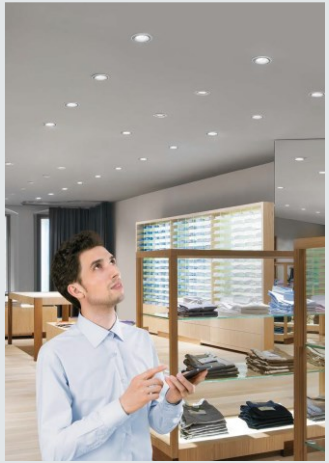

Paredes:




Teto:



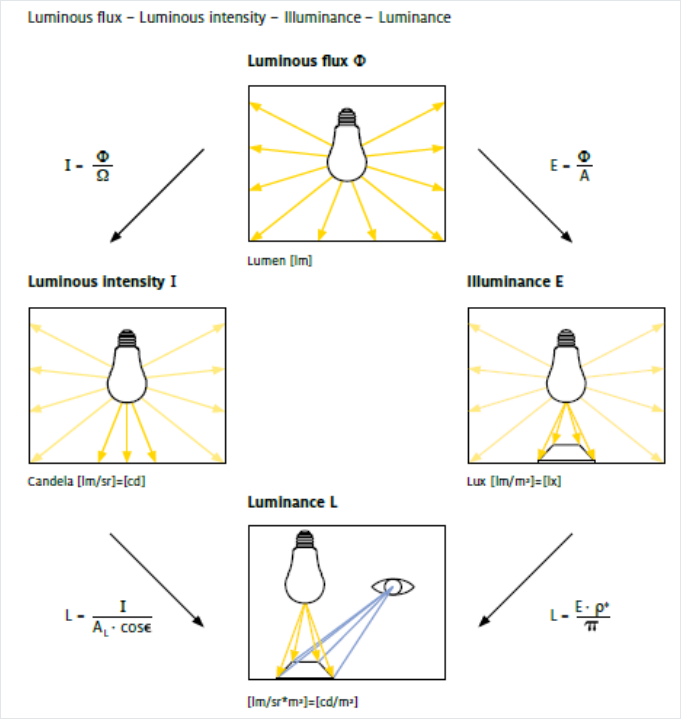
# Leitura recomendada



Chapter 1

**Lighting technology**

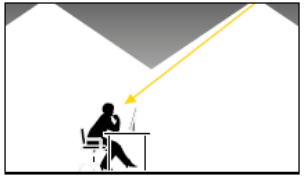

| | | |
|---|---|---|
| **What is light?** | | 6 |
| | What does the human eye see? | 7 |
| | Human Centric Lighting | 8 |
| | Light has a triple effect | 8 |
| **Basic parameters used in lighting** | | 10 |
| | Luminous flux | 11 |
| | Luminous intensity | 11 |
| | Illuminance | 11 |
| | Luminance | 11 |
| **Quality characteristics of lighting** | | |
| | The right light – traditional and new quality criteria | 12 |
| | Illuminance – definition of terminology | 12 |
| | Glare – glare limitation | 14 |
| | The UGR method | 15 |
| | Illuminance levels on ceilings and walls | 17 |
| | Spatial illumination | 17 |
| | Light colour | 18 |
| | Colour rendering | 18 |
| **Measuring illuminance** | | 19 |
| **Outdoor lighting** | | 20 |
| **Types of lighting** | | 22 |
| **Lighting concepts** | | 24 |
| **Energy efficiency in buildings** | | 26 |

# Glare & UGR

Glare – glare limitation

**Direct glare**

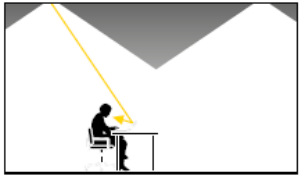


*Cause*
- Luminaires without glare control
- Very bright surfaces

*Effect*
- Loss of concentration
- More frequent mistakes
- Fatigue

*Remedy*
- Luminaires with limited luminance levels
- Blinds on windows

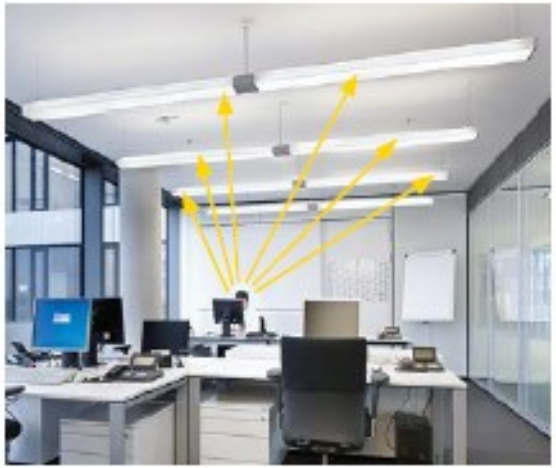
**Reflected glare**



*Cause*
- Reflective surfaces
- Incorrect luminaire arrangement
- Incorrect workstation position

*Effect*
- Loss of concentration
- More frequent mistakes
- Fatigue

*Remedy*
- Matching luminaire to workstation (layout)
- Indirect lighting
- Matt surfaces



$$UGR = 8 \log \left( \underbrace{\frac{0{,}25}{L_b}}_{(1)} \underbrace{\sum \frac{L^2 \Omega}{P^2}}_{(2)} \right)$$

**Type of interior, task or activity**

**Offices**

| | $E_m$ | $UGR_L$ | $U_o$ | $R_a$ |
|---|---|---|---|---|
| Filing, copying, etc. | 300 | 19 | 0.4 | 80 |
| Writing, typing, reading, data processing | 500 | 19 | 0.6 | 80 |
| Technical drawing | 750 | 16 | 0.7 | 80 |
| CAD work stations | 500 | 19 | 0.6 | 80 |
| Conference and meeting rooms | 500 | 19 | 0.6 | 80 |
| Reception desks | 300 | 22 | 0.6 | 80 |
| Archives | 200 | 25 | 0.4 | 80 |

**UGR limits ($UGR_L$) that must not be exceeded:**

- **≤ 16** Technical drawing
- **≤ 19** Reading, writing, training, meetings, computer-based work
- **≤ 22** Craft and light industries
- **≤ 25** Heavy industry
- **≤ 28** Railway platforms, foyers

# Glare & UGR

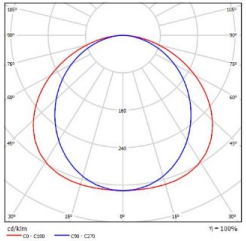
**PHILIPS RC126B W62L62 1 xLED34S/830 NOC / Folha de dados de luminária**



Classificação de luminárias conforme CIE: 100
Código de Fluxo (CIE): 46 78 95 100 100

CoreLine Panel Generation 4 - For when light really matters CoreLine Panel Generation 4 delivers on the CoreLine promise of innovative, easy-to-use and high-quality luminaires, ready to directly replace functional luminaires in general lighting applications. CoreLine Panel innovative MultiColour/Lumen offers two colours of white and four lumenpackages, all in one luminaire. And thanks to a new connector, installation is quick and easy.

Emissão luminosa 1:




Emissão luminosa 1:

**Avaliação de ofuscamento seg. UGR**

| ρ Tecto | 70 | 70 | 50 | 50 | 30 | 70 | 70 | 50 | 50 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| ρ Paredes | 50 | 30 | 50 | 30 | 30 | 50 | 30 | 50 | 30 | 30 |
| ρ Solo | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Tamanho da sala X Y | Direcção transversal do olhar em relação ao eixo da lâmpada | | | | | Direcção longitudinal do olhar em relação ao eixo da lâmpada | | | | |
| 2H 2H | 17.6 | 18.9 | 17.9 | 19.2 | 19.4 | 16.0 | 17.3 | 16.3 | 17.5 | 17.8 |
| 3H | 19.2 | 20.5 | 19.6 | 20.7 | 21.0 | 17.4 | 18.6 | 17.7 | 18.9 | 19.2 |
| 4H | 19.9 | 21.0 | 20.2 | 21.3 | 21.6 | 18.0 | 19.1 | 18.3 | 19.4 | 19.7 |
| 6H | 20.4 | 21.5 | 20.7 | 21.8 | 22.1 | 18.4 | 19.5 | 18.7 | 19.8 | 20.1 |
| 8H | 20.6 | 21.6 | 20.9 | 21.9 | 22.2 | 18.5 | 19.5 | 18.9 | 19.9 | 20.2 |
| 12H | 20.7 | 21.6 | 21.0 | 22.0 | 22.3 | 18.6 | 19.6 | 19.0 | 19.9 | 20.3 |
| 4H 2H | 18.1 | 19.2 | 18.4 | 19.5 | 19.8 | 16.9 | 18.0 | 17.2 | 18.3 | 18.6 |
| 3H | 19.9 | 20.9 | 20.3 | 21.3 | 21.6 | 18.4 | 19.4 | 18.8 | 19.7 | 20.1 |
| 4H | 20.8 | 21.6 | 21.2 | 22.0 | 22.3 | 19.1 | 20.0 | 19.5 | 20.3 | 20.7 |
| 6H | 21.4 | 22.1 | 21.8 | 22.5 | 22.9 | 19.6 | 20.4 | 20.1 | 20.8 | 21.2 |
| 8H | 21.6 | 22.3 | 22.1 | 22.7 | 23.1 | 19.8 | 20.5 | 20.3 | 20.9 | 21.3 |
| 12H | 21.8 | 22.4 | 22.2 | 22.8 | 23.3 | 20.0 | 20.6 | 20.4 | 21.0 | 21.4 |
| 8H 4H | 21.0 | 21.7 | 21.4 | 22.1 | 22.5 | 19.5 | 20.2 | 20.0 | 20.6 | 21.0 |
| 6H | 21.7 | 22.3 | 22.2 | 22.7 | 23.2 | 20.2 | 20.8 | 20.7 | 21.2 | 21.7 |
| 8H | 22.1 | 22.6 | 22.5 | 23.0 | 23.5 | 20.5 | 21.0 | 20.9 | 21.4 | 21.9 |
| 12H | 22.3 | 22.7 | 22.8 | 23.2 | 23.7 | 20.6 | 21.1 | 21.1 | 21.5 | 22.0 |
| 12H 4H | 21.0 | 21.6 | 21.4 | 22.0 | 22.5 | 19.6 | 20.2 | 20.0 | 20.6 | 21.1 |
| 6H | 21.8 | 22.3 | 22.3 | 22.7 | 23.2 | 20.3 | 20.8 | 20.8 | 21.2 | 21.7 |
| 8H | 22.1 | 22.6 | 22.6 | 23.0 | 23.5 | 20.6 | 21.0 | 21.1 | 21.5 | 22.0 |

Variação da posição do observador para as distâncias de luminária S

| | | |
|---|---|---|
| S = 1.0H | +0.1 / -0.1 | +0.1 / -0.1 |
| S = 1.5H | +0.2 / -0.3 | +0.3 / -0.4 |
| S = 2.0H | +0.4 / -0.6 | +0.4 / -0.8 |
| Tabel padrão | BK06 | BK06 |
| Adicional de correcção | 4.9 | 3.3 |

Índices de ofuscamento corrigidos com referência a 3400lm Corrente luminosa total

# Glare & UGR

**Sala 1 / Resultados Luminotécnicos**

Fluxo luminoso total: 20400 lm
Potência total: 216.0 W
Zona marginal: 0.000 m

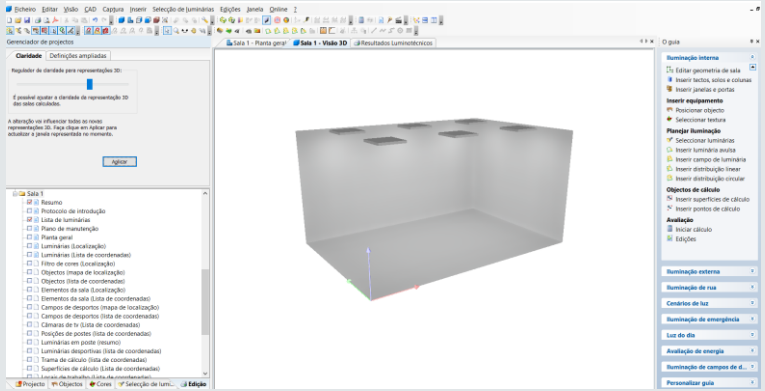
| Superfície | Iluminâncias médias [lx] directo | indirecto | total | Grau de reflexão [%] | Luminância média [cd/m²] |
|---|---|---|---|---|---|
| Plano de uso | 394 | 252 | 646 | / | / |
| Solo | 292 | 244 | 536 | 78 | 133 |
| Tecto | 0.54 | 305 | 306 | 80 | 78 |
| Parede 1 | 216 | 289 | 505 | 50 | 80 |
| Parede 2 | 182 | 285 | 468 | 50 | 74 |
| Parede 3 | 216 | 289 | 505 | 50 | 80 |
| Parede 4 | 182 | 288 | 470 | 50 | 75 |

Uniformidades no plano de uso
$E_{min}$ / $E_m$: 0.657 (1:2)
$E_{min}$ / $E_{max}$: 0.545 (1:2)

| UGR | Longitudinal- | Transversal | em relação ao eixo da luminária |
|---|---|---|---|
| Parede esquerda | 19 | 17 | |
| Parede inferior | 18 | 17 | |

(CIE, SHR = 0.25.)

Potência específica: 11.11 W/m² = 1.72 W/m²/100 lx (Superfície básica: 19.44 m²)



# UGR tables

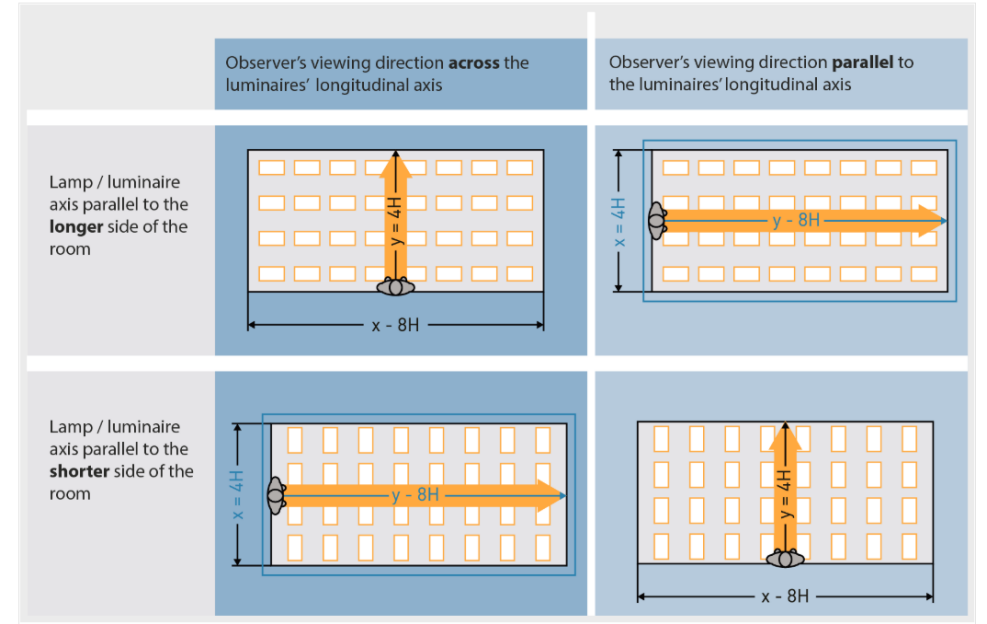
**Avaliação de ofuscamento seg. UGR**

| ρ Tecto | | 70 | 70 | 50 | 50 | 30 | 70 | 70 | 50 | 50 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ρ Paredes | | 50 | 30 | 50 | 30 | 30 | 50 | 30 | 50 | 30 | 30 |
| ρ Solo | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Tamanho da sala X | Y | Direcção transversal do olhar em relação ao eixo da lâmpada | | | | | Direcção longitudinal do olhar em relação ao eixo da lâmpada | | | | |
| 2H | 2H | 15.0 | 15.9 | 15.3 | 16.1 | 16.3 | 15.1 | 15.9 | 15.3 | 16.1 | 16.3 |
| | 3H | 14.9 | 15.7 | 15.2 | 15.9 | 16.2 | 15.0 | 15.8 | 15.3 | 16.0 | 16.2 |
| | 4H | 14.9 | 15.6 | 15.2 | 15.9 | 16.1 | 14.9 | 15.7 | 15.3 | 15.9 | 16.2 |
| | 6H | 14.8 | 15.5 | 15.2 | 15.8 | 16.1 | 14.9 | 15.6 | 15.2 | 15.8 | 16.1 |
| | 8H | 14.8 | 15.4 | 15.2 | 15.7 | 16.0 | 14.9 | 15.5 | 15.2 | 15.8 | 16.1 |
| | 12H | 14.8 | 15.4 | 15.1 | 15.7 | 16.0 | 14.8 | 15.4 | 15.2 | 15.7 | 16.1 |
| 4H | 2H | 14.9 | 15.6 | 15.2 | 15.8 | 16.1 | 14.9 | 15.6 | 15.2 | 15.9 | 16.2 |
| | 3H | 14.8 | 15.4 | 15.2 | 15.7 | 16.0 | 14.9 | 15.5 | 15.2 | 15.8 | 16.1 |
| | 4H | 14.8 | 15.3 | 15.2 | 15.6 | 16.0 | 14.8 | 15.3 | 15.2 | 15.7 | 16.0 |
| | 6H | 14.7 | 15.2 | 15.2 | 15.6 | 15.9 | 14.8 | 15.2 | 15.2 | 15.6 | 16.0 |
| | 8H | 14.7 | 15.1 | 15.1 | 15.5 | 15.9 | 14.8 | 15.2 | 15.2 | 15.6 | 16.0 |
| | 12H | 14.7 | 15.0 | 15.1 | 15.4 | 15.9 | 14.7 | 15.1 | 15.2 | 15.5 | 15.9 |
| 8H | 4H | 14.7 | 15.1 | 15.1 | 15.5 | 15.9 | 14.7 | 15.1 | 15.2 | 15.5 | 15.9 |
| | 6H | 14.7 | 15.0 | 15.1 | 15.4 | 15.8 | 14.7 | 15.0 | 15.2 | 15.4 | 15.9 |
| | 8H | 14.6 | 14.9 | 15.1 | 15.4 | 15.8 | 14.7 | 15.0 | 15.2 | 15.4 | 15.9 |
| | 12H | 14.6 | 14.8 | 15.1 | 15.3 | 15.8 | 14.7 | 14.9 | 15.1 | 15.3 | 15.8 |
| 12H | 4H | 14.7 | 15.0 | 15.1 | 15.4 | 15.8 | 14.7 | 15.1 | 15.1 | 15.5 | 15.9 |
| | 6H | 14.6 | 14.9 | 15.1 | 15.3 | 15.8 | 14.7 | 14.9 | 15.1 | 15.4 | 15.9 |
| | 8H | 14.6 | 14.8 | 15.1 | 15.3 | 15.8 | 14.7 | 14.9 | 15.1 | 15.3 | 15.8 |

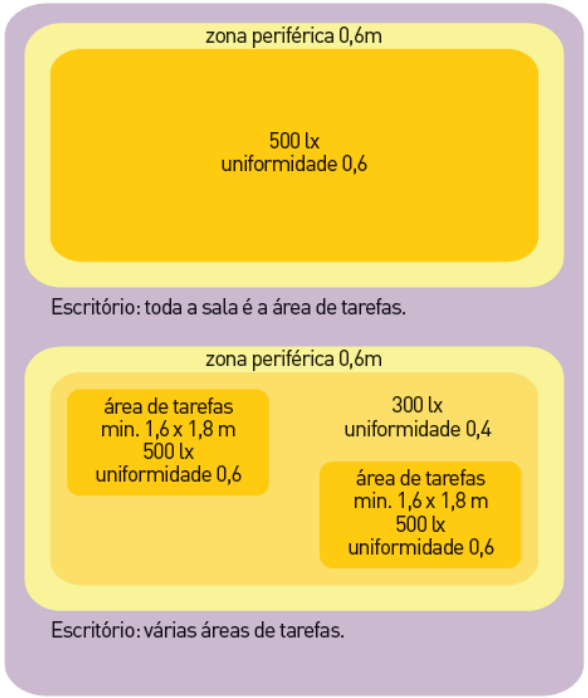
1. Determining the luminaire height above the observer's eye for sitting H = h – p – 1,2 m and for standing persons H = h – p – 1,7 m. Example: Room height h = 3,0 m, ceiling-mounted luminaires (p = 0 m), for sitting persons H = 1,8 m.

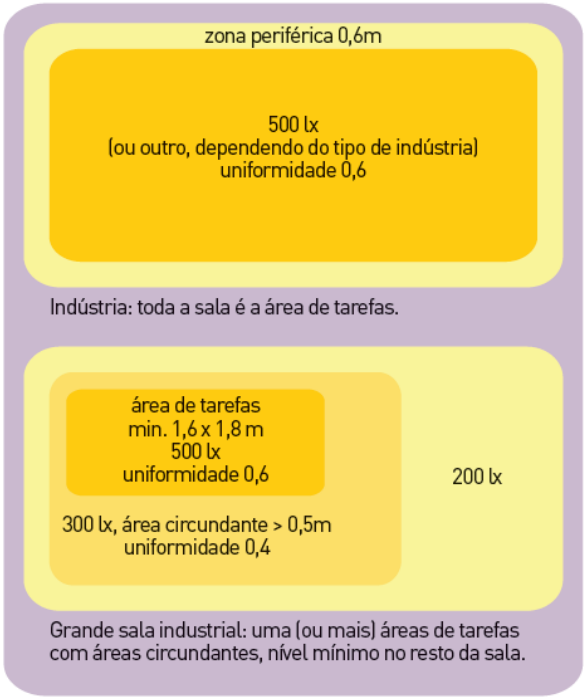
2. The multiple of the luminaire height above the observer's eye is determined L = 14 m /1,8 m = 7,8 H and B = 7,5 m /1,8 m = 4,2 H using the room dimensions (example: room length L = 14,0 m, room width B = 7,5 m).

3. The luminaires are mounted parallel to the longer room side (see sketch 1). UGR values can be gathered from the luminaire-specific UGR table for the applicable reflectance values of ceiling, walls and floor (in the example 0,7, 0,5, 0,2) according to the following reading rule 1 (see also table) with interim values to be interpolated as necessary:

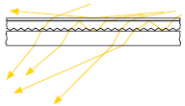
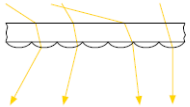
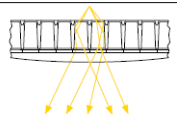
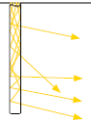
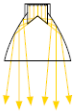


# Zonas de cálculo

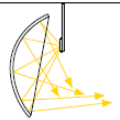
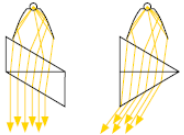
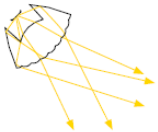
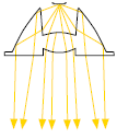


# Tipos de aparelhos

| Technology | Illustration of the principle | Functional principle | Application in products | Application hints/benefits |
|---|---|---|---|---|
| Micro-pyramidal optic |  | The light is coupled into the MPO panel from above. The light beams are precisely directed, resulting in a glare-reduced distribution of light that is thus suitable for use in offices. This optic is also used in a miniaturised form as MPO film. | LIGHT FIELDS, AERO, MELLOW LIGHT V | The luminance of the LEDs is reduced over the entire light-emitting surface, allowing a flexible arrangement of the luminaires at the workplace. |
| Micro-lens optic |  | The film uses the lens effect to paral-lelize the light and thus produce a linear light distribution. | MELLOW LIGHT V | A certain percentage of the light is radiated more horizontally from the light-emitting surface. This increases the vertical luminous intensity compared to louvre luminaires and thus improves the face and object recognition as well as wall illumination. |
| Virtual light source technology |  | The evenly backlit cluster of lenses directs the light so that little flat light can escape from the luminaire. This results in a pleasant brightness with a high light output. | MELLOW LIGHT evolution / infinity | The principle of backlighting and the transformation of the selective light sources on virtual, full-surface light emission creates a uniform appearance. The brightness levels are pleasant and correspond to the typical character of "mellow light". |
| Edge-Lit technology |  | An optimised microstructure has been embossed on a transparent -plastic panel to create an asymmetric light distribution. At the same time, the luminaire's light-emitting surface ap-pears to be homogeneously lit. | CAELA wall-mounted luminaire | The asymmetric beam creates optimum lighting conditions in corridors through sufficient vertical luminous intensities with a -simultaneous reduction of the brightnesses in the field of view. This facilitates orienta-tion and increases safety. |
| Mixing-chamber lens system |  | The LEDs' spectral components are united in the mixing chamber to pro-duce white light, focussed by the lens and directed to the high-precision reflector. | IYON | The division into mixing chamber and optic results in high modularity when using various reflectors, and hence a variety of beam patterns – from narrow-beam to wide-angle. |

# Tipos de aparelhos

| Technology | Illustration of the principle | Functional principle | Application in products | Application hints/benefits |
|---|---|---|---|---|
| Free-form reflector liteCarve® |  | The free-form reflector offers very precise and balanced, rectangular light distribution right up to the edge areas. Used in front of an LED point light source, the reflector directs the light completely indirectly and specifically to the vertical surfaces. | INTRO liteCarve® – also for 3-phase tracks | A single liteCarve® luminaire creates a homogeneously lit area for which up to three spotlights previously had to be used. This simplifies planning because rectangular light distributions can be easily placed next to each other without overlaps. |
| Double lens system |  | The light cone can be quickly and easily adjusted for spot-on accent lighting via the wedge-shaped lenses set into the tube. The light cone can be rotated around 360° by rotating the tube. | PANOS infinity Adjustable | The wide ranging PANOS product group allows different beam characteristics to be achieved leading to a homogeneous visual ceiling appearance. The look of the ceiling remains soothing and unobtrusive. |
| TIR optic with free-form lens |  | The combination of TIR optic (Total Internal Reflection) and a free-form lens array directs the relatively wide light beam of the LED in parallel. | SUPERSYSTEM II Wallwasher Mini | The beam characteristic of the wallwasher creates uniform wall illumination and is ideal for use in rooms up to 3 metres in height. |
| TIR optic with snoot |  | The wide light beam from the LED is directed in parallel with the help of the TIR optic (Total Internal Reflection). The desired light distributions can be achieved by using various snoots (e.g. films). | SUPERSYSTEM II LED spotlight | The special technology permits beam angles from Superspot (8°) to Wideflood (57°) for LED spotlights. |