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# **Energy Efficient Railway Lighting** **according to EN 12464-2**

## **„Lighting of work places – Part 2: Outdoor work places“**

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# The current seven CIE Divisions (2009)

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- Div. I Vision & Colour
- Div. II Physical Measurement of Light and Radiation
- Div. III Interior Environment and Lighting Design
- Div. IV Lighting and Signalling for Transport
- **Div. V Exterior and other Lighting Applications**
- Div. VI Photo-biology and Photo-chemistry
- Div. VIII Image Technology

# CEN TC 169 Light and Lighting (2009)

- WG1 Basic Terms and Criteria (EN 12665)
- **WG2 Lighting of Work Places (EN 12464-1/2, EN 13032-2)**
- WG3 Emergency Lighting (EN 1838, EN 13032-3)
- WG4 Sports Lighting (EN 12193)
- WG5 Road Lighting (EN 13201)
- WG6 Tunnel Lighting (CR 14380)
- WG7 Photometry (EN 13032-1)
- WG8 Photobiology (EN 14255)
- WG9 Energy Performance of Buildings –  
Energy Requirements for Lighting (EN 15193)
- WG10 Performance of Optical Material for Luminaires

# Relevant CIE Publications for EN 12464-2

- CIE 112-1994 Glare Evaluation System for Use within Outdoor Sports and Area Lighting
- CIE 115-1995 Recommendations for the Lighting of Roads for Motor and Pedestrian Traffic
- CIE 129-1998 Guide for Lighting Exterior Work Places
- CIE 140-2000 Road Lighting Calculations
- CIE 150-2003 Guide on the Limitations of the Effects of Obtrusive Light from Outdoor Lighting Installations
- CIE 154-2003 Maintenance of Outdoor Lighting Systems

## Other Relevant Publication for EN 12464-2

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- A.F.E. „Recommandations relatives à l'éclairage des voies publiques“
- CIBSE LG6 „The Outdoor Environment“
- DIN 5035 „Beleuchtung mit künstlichem Licht“
- ICAO „International Standards and Recommended Practices Aerodromes“
- DB 954.9103 „Beleuchtungsanlagen im gleisnahen und/oder sicherheitsrelevanten Bereich“

etc.

# Lighting Design Criteria (EN 12464-2)

- Luminance distribution (description only)
- Illuminance levels (maintained values), uniformities, and diversities (for task areas and surroundings)
- Limitation of glare (for train drivers and passengers)
- Directionality of light (description only)
- Colour appearance and colour rendering
- Avoidance of flicker and stroboscopic effects (description only)
- Limitation of obtrusive light

# Illuminances, EN 12464-2 (I)

- All values of illuminances in this standard are **maintained illuminances** over the task area on the reference surface which may be horizontal, vertical or inclined.
- The **task area** is defined as the partial area in the work place in which the visual task is carried out.
- For places where size and/or location of the task area are **unknown**, the area where the task **may occur** is the task area.



# Illuminances, EN 12464-2 (II)

- The maintained illuminance of the **surrounding area** shall be related to the maintained illuminance of the task area and should provide a well-balanced luminance distribution in the field of view.
- The surrounding area is regarded as a **strip surrounding the task area** in the **field of view**; the width of this strip **should** be at least **2 m**.

# Relationship of maintained illuminances of surrounding areas to task areas

<b>Task illuminance</b>	<b>Illuminance of surrounding areas</b>
$\geq 500 \text{ lx}$	100 lx
300 lx	75 lx
200 lx	50 lx
150 lx	30 lx
$50 \text{ lx} \leq E_m \leq 100 \text{ lx}$	20 lx
<b>&lt; 50 lx</b>	<b>no specification</b>

Surrounding area is a strip surrounding the task area **within the field of view**; this strip **should** have a width of at least **2 m**.

# Uniformity and Diversity (EN 12464-2)

- Illuminance **uniformity**  $U_o$  is defined as the ratio of **minimum to average** illuminance on a surface.
- The uniformity of the task area shall not be less than the values given in table 5 of EN 12464-2, the uniformity of the surroundings shall not be less than 0.10.
- Illuminance **diversity**  $U_d$  is defined as the ratio of **minimum to maximum** illuminance on a surface.
- The diversity is an important quality criterion for **railway lighting**, and shall not be less than the values specified in table 5 of EN 12464-2.

# Illuminance Grid Size (EN 12464-2)

**Maximum grid size** (A.Stockmar):

$$p = 0.2 \cdot 5 \log d$$

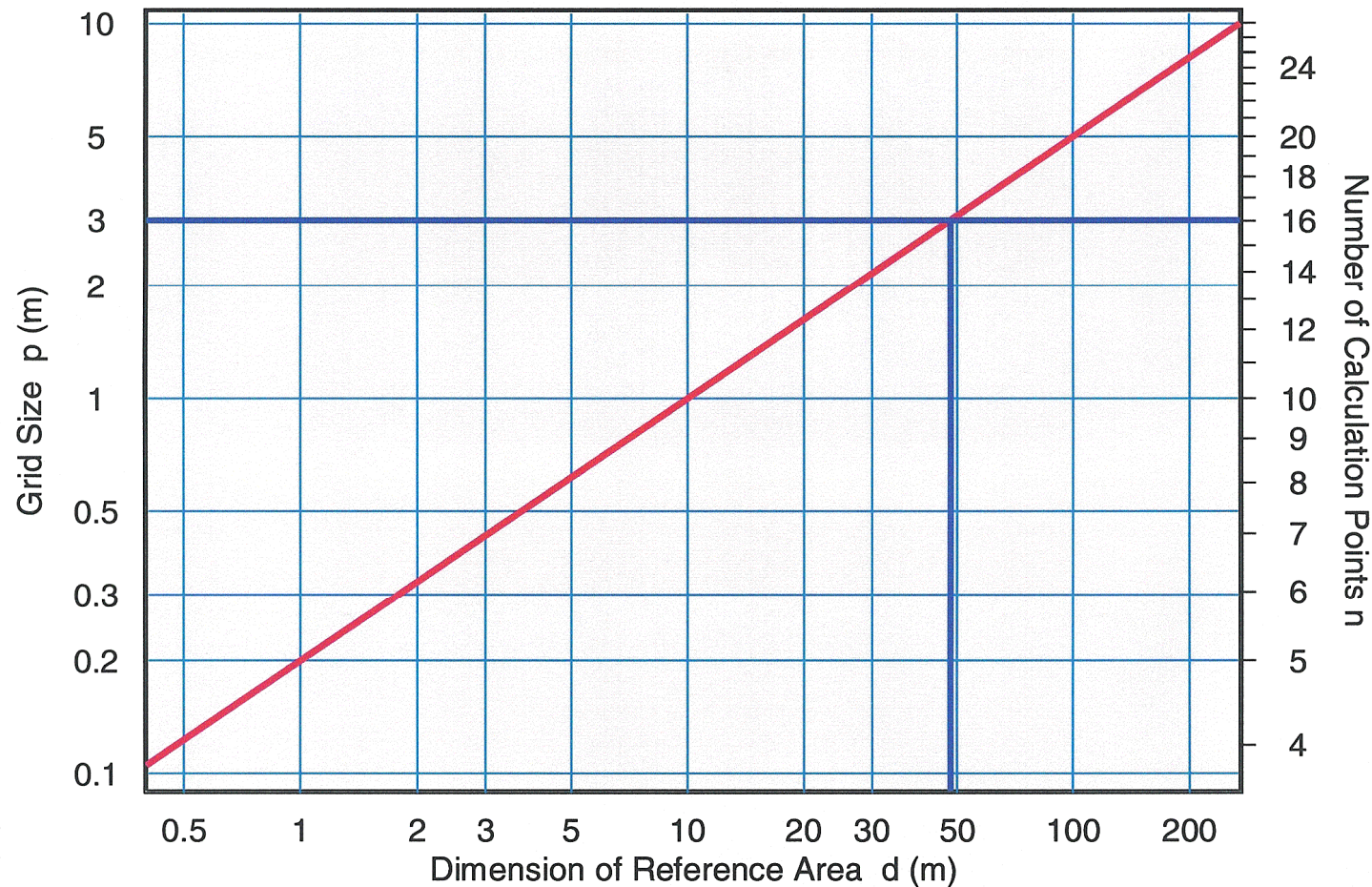
p ... grid cell size (m),  $p_{\max} = 10$  m

d ... longer dimension of area (m) if the ratio  
of the longer to the shorter side is less  
than 2,

otherwise

d ... shorter dimension of area (m)

# Illuminance Grid Size (EN 12464-2)



Illuminance grid size as function of area dimension,  
example:  $d = 48 \text{ m}$ ,  $p = 3 \text{ m}$ ,  $n = 16$

# Maintained Illuminance - Maintenance Factor, EN 12464-2 (I)

- The **maintained illuminance** is defined as the value below which the illuminance on a specified surface is not allowed to fall
- The lighting scheme should be designed with a **maintenance factor** calculated for the selected lighting equipment, space environment and specified maintenance schedule
- The maintenance factor depends on the **maintenance characteristics** of the lamp and control gear, the luminaire, the environment and the maintenance programme

# Maintained Illuminance - Maintenance Factor, EN 12464-2 (II)

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According to CIE Publication 154-2003  
„The Maintenance of Outdoor Lighting Systems“

The **maintenance factor** is defined as the ratio of the luminance / illuminance produced by the lighting system after a certain period to the luminance / illuminance produced by the same system when new.

# Determination of Maintenance Factor (I)

$$\mathbf{MF} = \mathbf{LLMF} \cdot \mathbf{LSF} \cdot \mathbf{LMF} ( \cdot \mathbf{SMF} )$$

**MF** ..... **Maintenance Factor**

**LLMF** .... **Lamp Lumen Maintenance Factor**

**LSF** ..... **Lamp Survival Factor**

**LMF** ..... **Luminaire Maintenance Factor**

**SMF** ..... **Surface Maintenance Factor**



# Determination of Maintenance Factor (II)

## Influencing factors (positive)

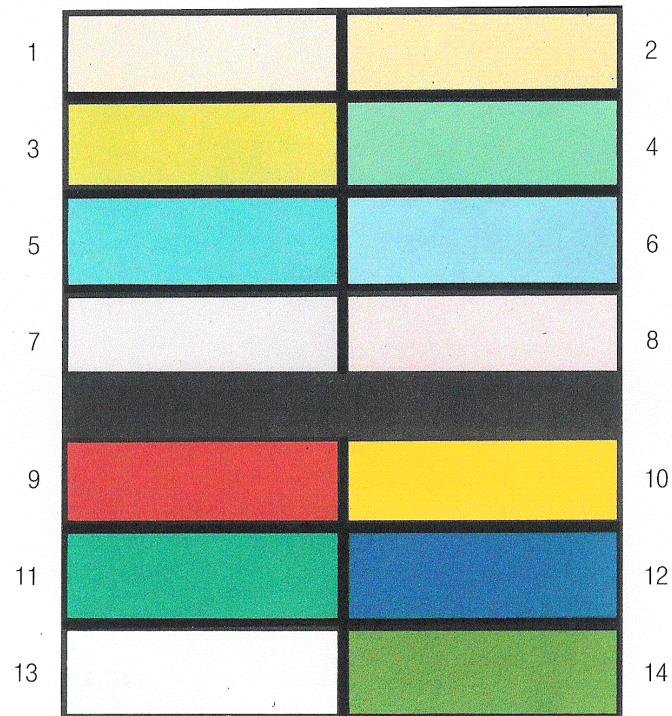
- Application of lamps with modest luminous flux depreciation (dependent on hours of operation)
- Application of luminaires with modest tendency to accumulate dirt
- (Application of electronic control gear)
- (Few annual lamp operating hours)
- Few switching cycles
- Short cleaning and/or maintenance periods, spot and group replacement of lamps
- Clean environment (airborne dirt)
- Modest tendency to accumulate dirt and/or modest degradation of reflecting surfaces

# Colour Appearance and Colour Rendering, EN 12464-2 (I)

<b>Colour appearance</b>	<b>Correlated colour temperature <math>T_{cp}</math></b>
Warm	below 3300 K
Intermediate	3300 K to 5300 K
Cool	above 5300 K

Minimum values of the **general colour rendering index** for distinct areas, tasks or activities are given in the schedule of lighting requirements (e.g.  $R_a \geq 20$ , also  $\geq 40$  or  $\geq 60$ )

# Colour Appearance and Colour Rendering, EN 12464-2 (II)



**CIE test colours for the evaluation of the  
general colour rendering index  $R_a$  (1-8) and the  
special colour rendering indices (8-14)**

# CIE Glare Rating Method (I)

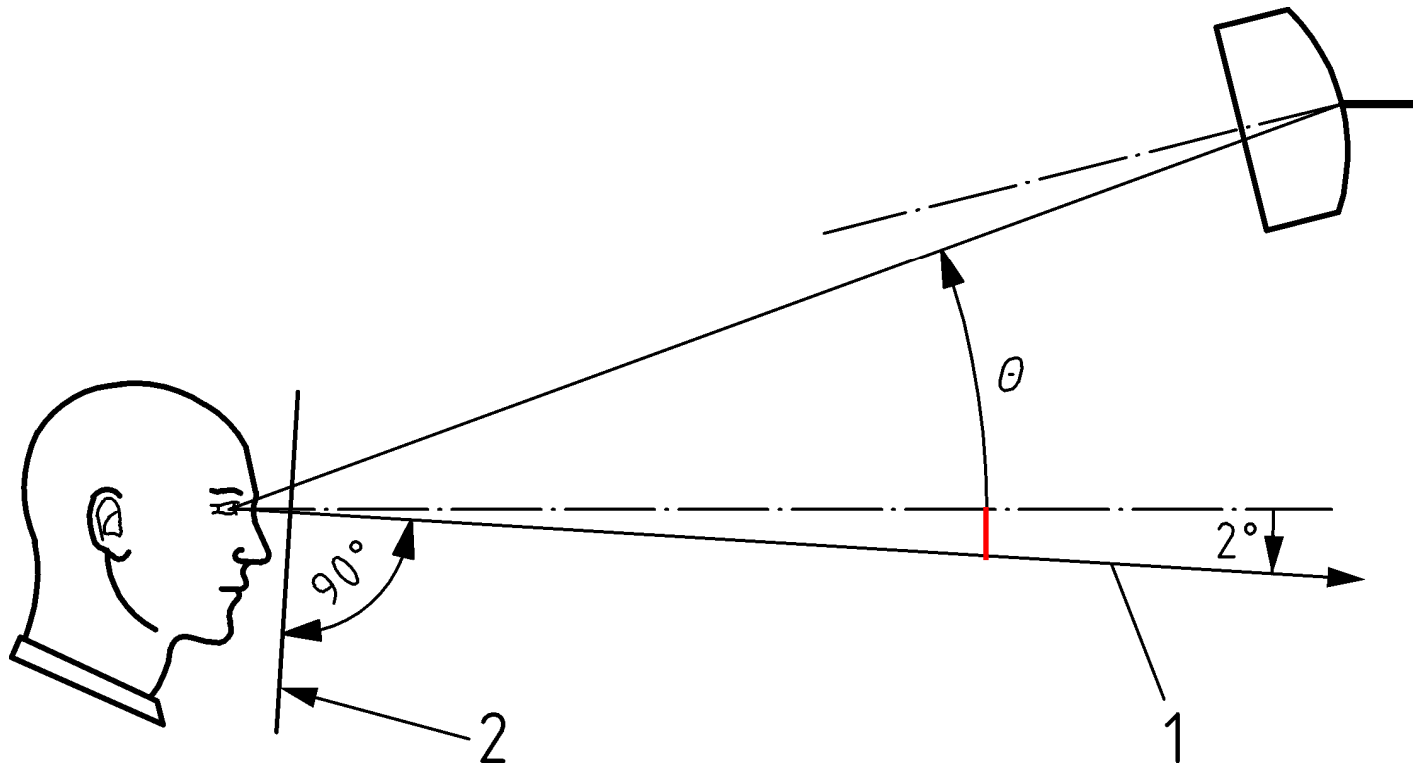
Calculation formula according to CIE 112-1994  
„Glare Evaluation System for Use within Outdoor  
Sports and Area Lighting“:

$$\mathbf{GR = 27 + 24 \cdot \log ( L_{vl} / L_{ve}^{0.9} )}$$

$L_{vl}$  ... Veiling luminance caused by the lighting  
installation

$L_{ve}$  ... Equivalent veiling luminance of the  
environment

# CIE Glare Rating Method (II)



**Angle  $\theta$  between the observer's line of sight (1)  
and the direction of the light incident  
from the individual luminaire (2)**

## CIE Glare Rating Method (III)

$L_{vI}$  ... is the total veiling luminance in  $\text{cd}/\text{m}^2$  caused by the lighting installation and is the sum of the veiling luminances produced by each (1 ... n) individual luminaire.

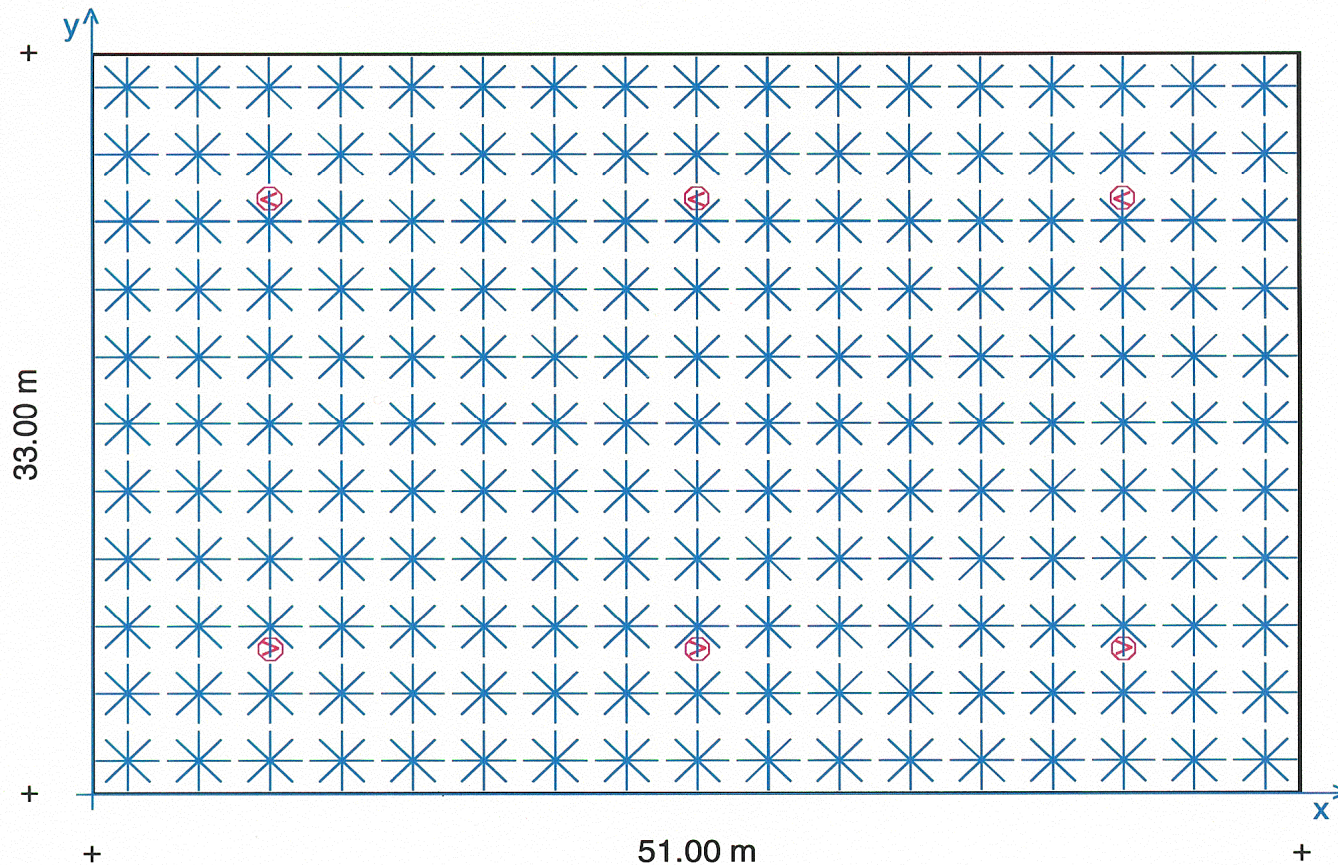
$$L_{vI} = L_{v1} + L_{v2} + \dots + L_{vn}$$

The veiling luminance of the individual luminaires is calculated as  $L_v = 10 \cdot (E_{eye} \cdot \theta^{-2})$

$L_{ve}$  ... is the veiling luminance of the environment in  $\text{cd}/\text{m}^2$ . From the assumption that the reflection of the environment is totally diffuse, the equivalent veiling luminance from the environment may be calculated as

$$L_{ve} = 0,035 \cdot \rho \cdot E_{hav} / \pi$$

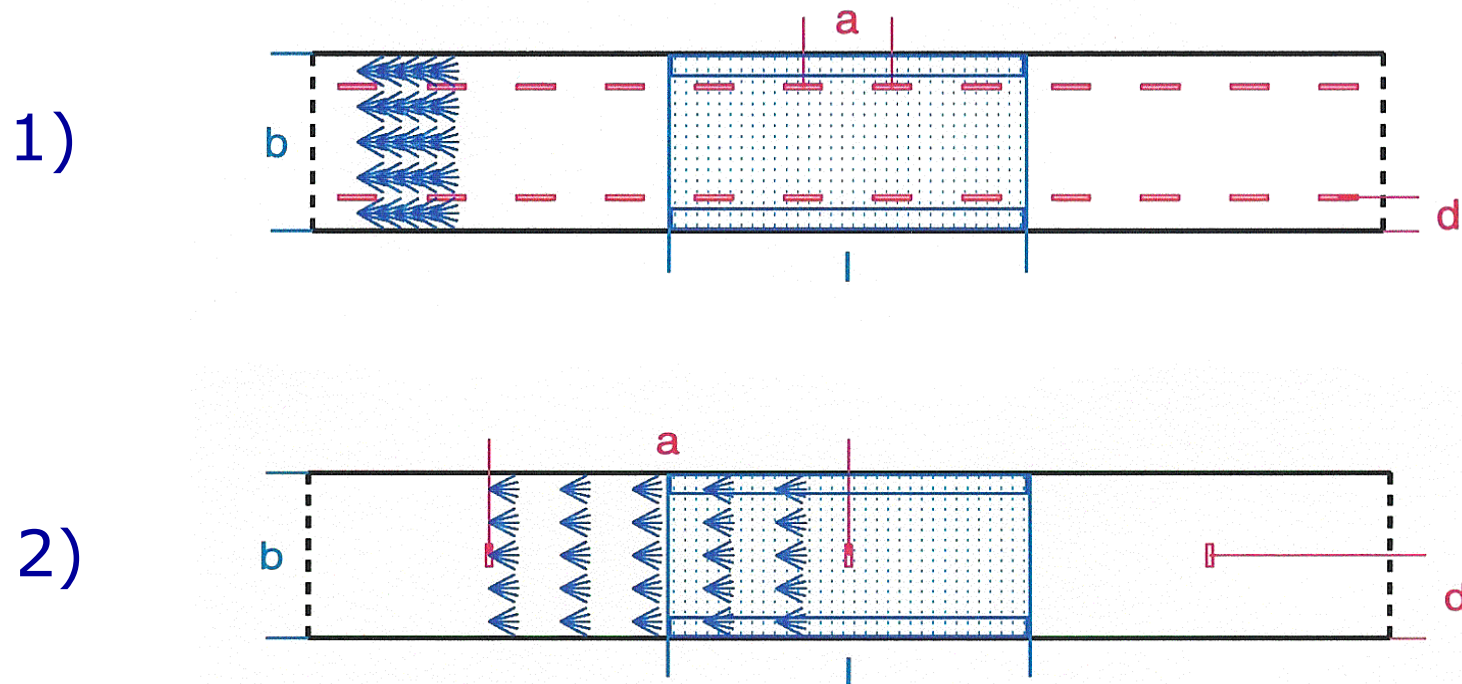
# CIE Glare Rating Method (IV)



**Observers at grid positions at 45° intervals radially about the grid points (EN 12464-2)**



# CIE Glare Rating Method (V)



**Application dependent observer positions and viewing directions every  $15^\circ$  from  $-30^\circ$  to  $+30^\circ$ :**  
**1) covered platform,      2) open platform**



# Limitation of Obtrusive Light (EN 12464-2), Definitions as given in CIE 150:2003

- **Obtrusive Light:** Light, outside the area to be lit, which, because of quantitative, directional or spectral attributes in a given context, gives rise to annoyance, discomfort, distraction or a reduction in the ability to see essential information
- **Curfew:** The time after which stricter requirements (for the control of obtrusive light) will apply; often a condition of use of lighting applied by a government controlling authority, e.g. the local government

# Limitation of Obtrusive Light (EN 12464-2), Environmental Lighting Zones

<b>Zone</b>	<b>Surrounding</b>	<b>Lighting Environment</b>	<b>Examples</b>
<b>E1</b>	Natural	Intrinsically dark	National parks, protected sides
<b>E2</b>	Rural	Low district brightness	Industrial or residential rural areas
<b>E3</b>	Suburban	Medium district brightness	Industrial or residential suburbs
<b>E4</b>	Urban	High district brightness	Town centres, commercial areas

# Limits of Obtrusive Light for Outdoor Lighting, EN 12464-2

- Maximum vertical illuminance ( $E_v$ ) on properties (for pre- and post-curfew hours)
- Maximum luminous intensities of individual light sources into potentially obtrusive directions (for pre- and post-curfew hours)
- Maximum upward light ratios (ULR)
- Maximum average luminances of building facades ( $L_b$ ) and signs ( $L_s$ )
- **Maximum threshold increments (TI) for users of nearby transport systems**

# CIE 150:2003 Methodology(I), Maximum Obtrusive Light permitted

Zone	Illuminance on Properties		Luminaire Intensity		Upward Light Ratio ULR in %	Luminance	
	$E_v$ in lx		I in cd			$L_b$ in cd/m <sup>2</sup>	$L_s$ in cd/m <sup>2</sup>
	Pre- curfew	Post- curfew	Pre- curfew	Post- curfew	Building facade	Signs	
<b>E1</b>	2	0	2500	0	0	0	50
<b>E2</b>	5	1	7500	500	5	5	400
<b>E3</b>	10	2	10000	1000	15	10	800
<b>E4</b>	25	5	25000	2500	25	15	1000

# CIE 150:2003 Methodology (II), Maximum Values of Threshold Increments

	<b>Road lighting class (EN 13201-2)</b>			
	No road lighting	ME5	ME4/ME3	ME2/ME1
<b>Threshold increment (TI)</b>	15% based on adaptation luminance of 0.1 cd/m <sup>2</sup>	15% based on adaptation luminance of 1.0 cd/m <sup>2</sup>	15% based on adaptation luminance of 2.0 cd/m <sup>2</sup>	15% based on adaptation luminance of 5.0 cd/m <sup>2</sup>

**Values given are for relevant positions and for viewing directions in the path of travel.**

# Platform Lighting (Example I)



**Pinzberg, natural, E1 (CIE 150:2003)**



# Platform Lighting (Example II)



**Rosbach, rural, E2 (CIE 150:2003)**

# Platform Lighting (Example III)



**Wittenberg-Lutherstadt , suburban, E3 (CIE 150:2003)**



# Platform Lighting (Example IV)



**Kiel, urban, E4 (CIE 150:2003)**

# Lighting Requirements for Areas, Tasks and Activities, EN 12464-2

- General circulation areas at outdoor work places
- Airports
- Building sites
- Canals, locks and harbours
- Farms
- Fuel filling stations
- Industrial sites and storage areas
- Off-shore gas and oil structures
- Parking areas
- Petrochemical and other hazardous industries
- Power, electricity, gas and heat plants
- **Railways and tramways (5.12)**
- Saw mills
- Shipyards and docks
- Water and sewage plants

# Lighting Requirements for Areas, Tasks and Activities I (table 5.12 of EN 12464-2)

Ref. no.	Type of area, task or activity	$E_m$ lx	$U_o$ -	$GR_L$ -	$R_a$ -	Remarks
	Railway areas including light railways, tramways, monorails, miniature rails, metro, etc.					Avoid glare for vehicle drivers.
5.12.1	Tracks in passenger station areas, including stabling	10	0,25	50	20	$U_d \geq 1/8$
5.12.2	Railway yards: flat marshalling, retarder and classification yards	10	0,40	50	20	$U_d \geq 1/5$
5.12.3	Hump areas	10	0,40	45	20	$U_d \geq 1/5$
5.12.4	Freight track, short duration operations	10	0,25	50	20	$U_d \geq 1/8$
5.12.5	Open platforms, rural and local trains, small number of passengers	15	0,25	50	20	1. Special attention to the edge of the platform 2. $U_d \geq 1/8$
5.12.6	Walkways	20	0,40	50	20	
5.12.7	Level crossings	20	0,40	45	20	
5.12.8	Open platforms, suburban and regional trains with large number of passengers or inter-city services with small number of passengers	20	0,40	45	20	1. Special attention to the edge of the platform 2. $U_d \geq 1/5$
5.12.9	Freight track, continuous operation	20	0,40	50	20	$U_d \geq 1/5$
5.12.10	Open platforms in freight areas	20	0,40	50	20	$U_d \geq 1/5$

**Avoid glare for vehicle driver,  
special attention is to be paid to the edge of the platform**

# Lighting Requirements for Areas, Tasks and Activities II (table 5.12 of EN 12464-2)

Ref. no.	Type of area, task or activity	$E_m$ lx	$U_o$ -	$GR_L$ -	$R_o$ -	Remarks
	Railway areas including light railways, tramways, monorails, miniature rails, metro, etc.					Avoid glare for vehicle drivers.
5.12.11	Servicing trains and locomotives	20	0,40	50	40	$U_d \geq 1/5$
5.12.12	Railway yards handling areas	30	0,40	50	20	$U_d \geq 1/5$
5.12.13	Coupling area	30	0,40	45	20	$U_d \geq 1/5$
5.12.14	Stairs, small and medium-size stations	50	0,40	45	40	
5.12.15	Open platforms, inter-city services	50	0,40	45	20	1. Special attention to the edge of the platform 2. $U_d \geq 1/5$
5.12.16	Covered platforms, suburban or regional trains or inter-city services with small number of passengers	50	0,40	45	40	1. Special attention to the edge of the platform 2. $U_d \geq 1/5$
5.12.17	Covered platforms in freight areas, short duration operations	50	0,40	45	20	$U_d \geq 1/5$
5.12.18	Covered platforms, inter-city services	100	0,50	45	40	1. Special attention to the edge of the platform 2. $U_d \geq 1/3$
5.12.19	Stairs, large stations	100	0,50	45	40	
5.12.20	Covered platforms in freight areas, continuous operation	100	0,50	45	40	$U_d \geq 1/5$
5.12.21	Inspection pit	100	0,50	40	40	Use low-glare local lighting

**Avoid glare for vehicle driver,  
special attention is to be paid to the edge of the platform**



# Railway Yard Lighting (Example I)



Main station Frankfurt/M

# Railway Yard Lighting (Example II)



Main station Mannheim

# Railway Yard Lighting (Example III)



Main station München

# General Remarks (I)

- **Roof mounted** fluorescent luminaires along platform edge do not cause glare problems for passengers, personal, and train drivers if the glare rating limits given in EN 12464-2 are fulfilled
- This requires luminaires for direct illumination in horizontal mounting position with virtually no light emission for angles of elevation greater or equal  $90^\circ$
- **Pole mounted** luminaires require appropriate luminous intensity distributions dependent on installation geometry (mounting height, spacing)
- Luminaires for direct illumination with restricted light emission at an angle of elevation of  $85^\circ$  and no light emission at  $90^\circ$  would be the best choice



# Platform Lighting (Example IV)



Celle, fluorescent night time lighting

## General Remarks (II)

- **High pole lighting** using floodlights could cause glare for all users
- Glare rating limits  $GR_L$  for passengers and personnel given in EN 12464-2 could be exceeded
- Maximum values of threshold increment  $TI_{max}$  for train drivers and users of nearby roads according to EN 12464-2 could be exceeded
- Maximum vertical illuminances  $E_v$  on properties given in EN 12464-2 could be exceeded
- Maximum luminous intensities in potentially obtrusive directions could exceed limits
- Upward light ratio (ULR) could exceed limits

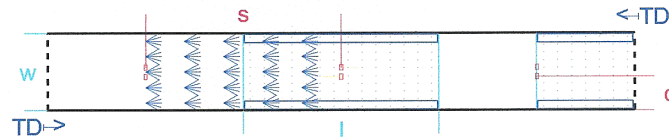
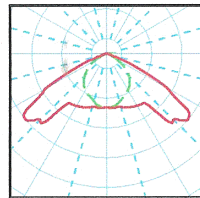
# Energy Efficiency (I)

- The ratio of the achievable illumination level, expressed in terms of an average illuminance on a reference surface, here the platform, to the necessary electric power depends on the selected lamps, ballasts, and luminaires as well as on the luminaire layout
- For **lamps and ballasts** there are appropriate measures, **efficacy and ballast-lamp circuit power** respectively, which serve as a basis for the evaluation of energy efficiency
- However, for **luminaires** the obvious measure, the **light output ratio**, is **not** a suitable quantity, as there exists no well-defined relationship to the achievable illumination level

## Energy Efficiency (II)

- The energy efficiency of a particular luminaire in a given layout can be evaluated using the Utilization Factor Platform (UFP)
- The **U**tilization **F**actor **P**latform is defined as the ratio of the total flux received by the reference area of a platform to the total lamp flux of the installation
- Values of the utilization factor platform close to the light output ratio (LOR) indicate a risk of inadequate uniformities and/or insufficient illuminances along the platform edge
- Values of the utilization factor platform small compared to the light output ratio indicate a poor performance and a tendency to higher light pollution (luminous flux spread around)

# Platform Lighting Design Table (EN 12464-2), CEN Flux Code 43 86 99 100 **77** (EN 13032-2)



Platform Lighting Design Table (EN 12464-2)

Lamp SON-T PLUS PIA 50W (4400 lm) Mounting height h = 6.0 m Tilt of luminaire 10° Maintenance factor = 0.67												
w (m) d (m)	s (m)	Eav (lx)	Uo	reference area / central					reference area / endwise			
				Ud	ER (%)	GR	UFP (%)	TI (%)	Eav (lx)	Uo	Ud	ER (%)
6.00 2.50	15.0	27.2	0.71	0.58	85	40	42	6.9	22.6	0.60	0.42	83
	18.0	22.7	0.67	0.47	85	40	41	7.8	20.7	0.47	0.30	84
	20.0	20.4	0.50	0.31	85	39	42	8.4	19.3	0.33	0.19	84
	22.0	18.6	0.36	0.21	85	41	42	9.0	18.0	0.23	0.13	84
	25.0	16.3	0.21	0.10	85	44	42	10	16.1	0.13	0.07	84
7.00 3.00	15.0	26.0	0.70	0.55	78	41	46	6.4	21.6	0.57	0.38	76
	18.0	21.7	0.65	0.44	78	40	46	7.3	19.8	0.47	0.29	77
	20.0	19.5	0.50	0.30	78	39	46	7.9	18.4	0.34	0.19	77
	22.0	17.7	0.35	0.19	78	42	46	8.4	17.1	0.23	0.12	77
	25.0	15.6	0.22	0.10	78	45	46	9.3	15.3	0.14	0.07	78
8.00 3.50	15.0	24.9	0.65	0.49	72	41	51	6.1	20.5	0.53	0.34	70
	18.0	20.7	0.62	0.40	72	41	51	6.9	18.8	0.44	0.26	71
	20.0	18.6	0.49	0.29	72	40	51	7.5	17.5	0.33	0.18	71
	22.0	17.1	0.35	0.19	72	42	51	8.0	16.4	0.23	0.12	71
	25.0	15.0	0.22	0.10	72	45	51	8.7	14.7	0.15	0.07	72
9.00 4.00	15.0	23.8	0.60	0.44	66	42	54	5.7	19.5	0.49	0.30	64
	18.0	19.8	0.60	0.37	66	41	54	6.4	17.9	0.42	0.24	64
	20.0	17.8	0.49	0.27	66	40	54	6.9	16.8	0.33	0.17	65
	22.0	16.3	0.35	0.18	66	43	55	7.4	15.7	0.23	0.11	65
	25.0	14.2	0.23	0.11	66	46	54	8.1	13.9	0.17	0.07	66
10.0 4.50	15.0	22.5	0.56	0.39	61	42	57	5.2	18.5	0.47	0.27	58
	18.0	18.8	0.58	0.34	61	42	57	5.8	17.0	0.42	0.22	58
	20.0	17.0	0.47	0.25	61	41	58	6.2	16.0	0.32	0.16	59
	22.0	15.4	0.35	0.17	61	43	57	6.7	14.8	0.25	0.12	59
	25.0	13.5	0.23	0.10	61	46	57	7.3	13.3	0.16	0.07	60

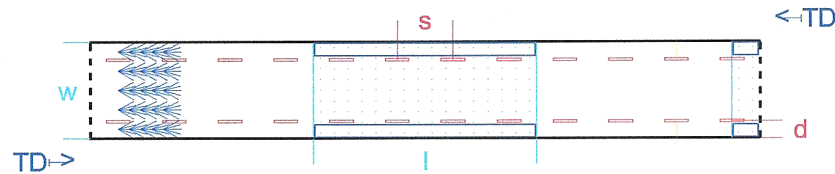
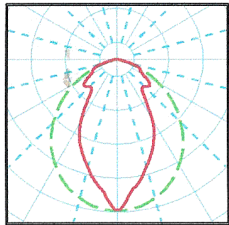


# Passenger Volume Dependent Lighting Requirements for Platforms (EN 12464-2)

Type of Platform	$E_m$	$U_o$	$U_d$	$GR_L$
Open platforms, rural and local trains, small number of passengers	15 lx	0.25	0.125	50
Open platforms, suburban and regional trains with large number of passengers or inter-city services with small number of passengers	20 lx	0.40	0.20	45
Open platforms, inter-city services	50 lx	0.40	0.20	45
Covered platforms, suburban or regional trains or inter-city services with small number of passengers	50 lx	0.40	0.20	45
Covered platforms, inter-city services	100 lx	0.50	0.33	45

## Illuminance level as function of passenger number

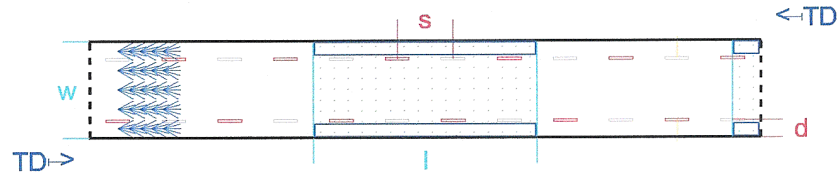
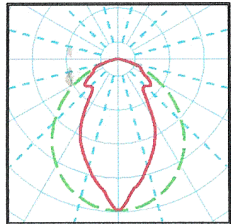
# Platform Lighting Design Table (EN 12464-2), CEN Flux Code 58 85 98 100 **74** (EN 13032-2)



Platform Lighting Design Table (EN 12464-2)

Lamp T26/58W (5200 lm)		Mounting height h = 4.0 m							Tilt of luminaire 0°				Maintenance factor = 0.80			
w (m) d (m)	s (m)	reference area / central							reference area / endwise							
		Eav (lx)	Uo	Ud	ER (%)	GR	UFP (%)	TI (%)	Eav (lx)	Uo	Ud	ER (%)				
6.00 1.00	3.0	212	0.90	0.77	102	31	46	7.2	134	0.81	0.62	103				
	4.0	159	0.89	0.74	102	31	46	7.2	109	0.77	0.57	103				
	5.0	128	0.86	0.69	102	32	46	7.7	94.5	0.73	0.52	102				
	6.0	106	0.80	0.59	102	32	46	7.8	83.8	0.62	0.40	103				
7.00 1.25	3.0	198	0.82	0.66	99	32	50	6.5	126	0.81	0.65	99				
	4.0	149	0.80	0.64	99	32	50	6.4	102	0.70	0.49	100				
	5.0	119	0.79	0.60	99	33	50	6.7	87.7	0.68	0.45	99				
	6.0	99.0	0.75	0.54	99	33	50	6.7	78.1	0.63	0.40	99				
8.00 1.50	3.0	183	0.75	0.60	95	32	53	6.2	116	0.74	0.59	95				
	4.0	137	0.72	0.57	95	32	53	6.0	93.6	0.62	0.44	96				
	5.0	110	0.71	0.55	95	33	53	6.2	80.7	0.61	0.41	96				
	6.0	91.6	0.69	0.49	95	33	53	6.4	71.9	0.58	0.37	95				
10.0 1.75	3.0	157	0.53	0.38	96	33	57	6.3	98.9	0.52	0.36	96				
	4.0	117	0.51	0.36	96	33	56	6.0	79.4	0.44	0.27	97				
	5.0	93.5	0.51	0.34	96	34	56	6.2	68.6	0.42	0.25	97				
	6.0	78.4	0.51	0.32	96	34	57	6.2	61.4	0.41	0.23	96				

# Platform Lighting Design Table (EN 12464-2), CEN Flux Code 58 85 98 100 **74** (EN 13032-2)



**Platform Lighting Design Table (EN 12464-2) (every second luminaire switched off)**

Lamp T26/58W (5200 lm)		Mounting height h = 4.0 m							Tilt of luminaire 0° Maintenance factor = 0.80			
w (m) d (m)	s (m)	reference area / central							reference area / endwise			
		Eav (lx)	Uo	Ud	ER (%)	GR	UFP (%)	TI (%)	Eav (lx)	Uo	Ud	ER (%)
6.00 1.00	3.0	106	0.83	0.61	102	32	46	7.8	67.2	0.44	0.23	103
	4.0	79.8	0.67	0.42	102	34	46	8.0	54.6	0.33	0.15	103
	5.0	63.8	0.55	0.30	102	35	46	9.1	47.2	0.25	0.10	102
	6.0	53.1	0.45	0.21	102	36	46	9.8	41.9	0.20	0.07	103
7.00 1.25	3.0	99.0	0.79	0.57	99	33	50	6.7	62.9	0.49	0.27	99
	4.0	74.3	0.66	0.39	99	34	50	7.0	50.8	0.30	0.13	100
	5.0	59.4	0.52	0.27	99	35	50	7.6	43.9	0.23	0.09	99
	6.0	49.5	0.43	0.19	99	37	50	8.2	39.1	0.20	0.07	99
8.00 1.50	3.0	91.6	0.71	0.52	95	33	53	6.4	58.1	0.47	0.25	95
	4.0	68.7	0.63	0.38	95	35	53	6.5	46.8	0.27	0.12	96
	5.0	54.9	0.50	0.25	95	36	53	7.1	40.3	0.19	0.08	96
	6.0	45.8	0.39	0.17	95	37	53	7.5	35.9	0.15	0.05	95
10.0 1.75	3.0	78.4	0.52	0.33	96	34	57	6.2	49.5	0.44	0.20	96
	4.0	58.5	0.48	0.25	96	36	56	6.4	39.7	0.25	0.09	97
	5.0	46.8	0.46	0.20	96	37	56	7.1	34.3	0.17	0.05	97
	6.0	39.2	0.38	0.14	96	38	57	7.2	30.7	0.12	0.03	96



# Current and Future Practice (I)

- Use of luminaires for direct illumination at relatively low mounting heights (no high pole lighting for platforms); this causes no problems in terms of vertical illuminances on buildings, of luminous intensities in potentially obtrusive directions, and of the proportion of luminous flux emitted above the horizontal
- Application of energy efficient lighting systems using lamps with higher efficacy, ballasts with lower losses, and luminaires providing higher utilization factors platform in particular layouts

## Current and Future Practice (II)

- Adjustment of illumination levels according to the type of trains/services as specified in EN 12464-2
- Reduction of illumination levels dependent on passenger volume according to EN 12464-2
- Further reduction of average illuminance during night time; but for safety reasons the minimum illuminance along platform edge will be kept at around 4 lx
- Application of task area lighting concept to a larger number of activities according to EN 12464-2

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# **Energy Efficient Railway Lighting** according to EN 12464-2

## **„Lighting of work places – Part 2: Outdoor work places“**

**Thank you very much for your attention !**