

THORN

EN12464-1:2011

**Light and lighting – Lighting of workplaces
Part 1: Indoor work places**



	Societies	Associations	Standards	Laws and directives
World	CIE	WTO	ISO	UN
Continents	IESNA, CIEChina, IESAustralia	NEMA CCI AMF	ANSI, ASTM CCC ASI..	Federal Governments
European	(Lux Europa)	CELMA ELC	CEN	EU
National, in each country, f.e.	LiTG, SLL, ILP, LTG, SLG, AFE, NsVV, ...	ZVEI, FEEI, LIA, SdIE	DIN, BSI, ON, AFNOR, SNI,	National laws e.g. Building regulations

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Exploitation	Dedicated lighting experts	Companies lighting experts	Appointed national delegates	Politicians, lobbyists

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Lighting design

- Lighting design practice is influenced by lighting societies and learned bodies, lighting associations, lighting standards and legislation

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BS EN 12464-1:2011



BSI Standards Publication

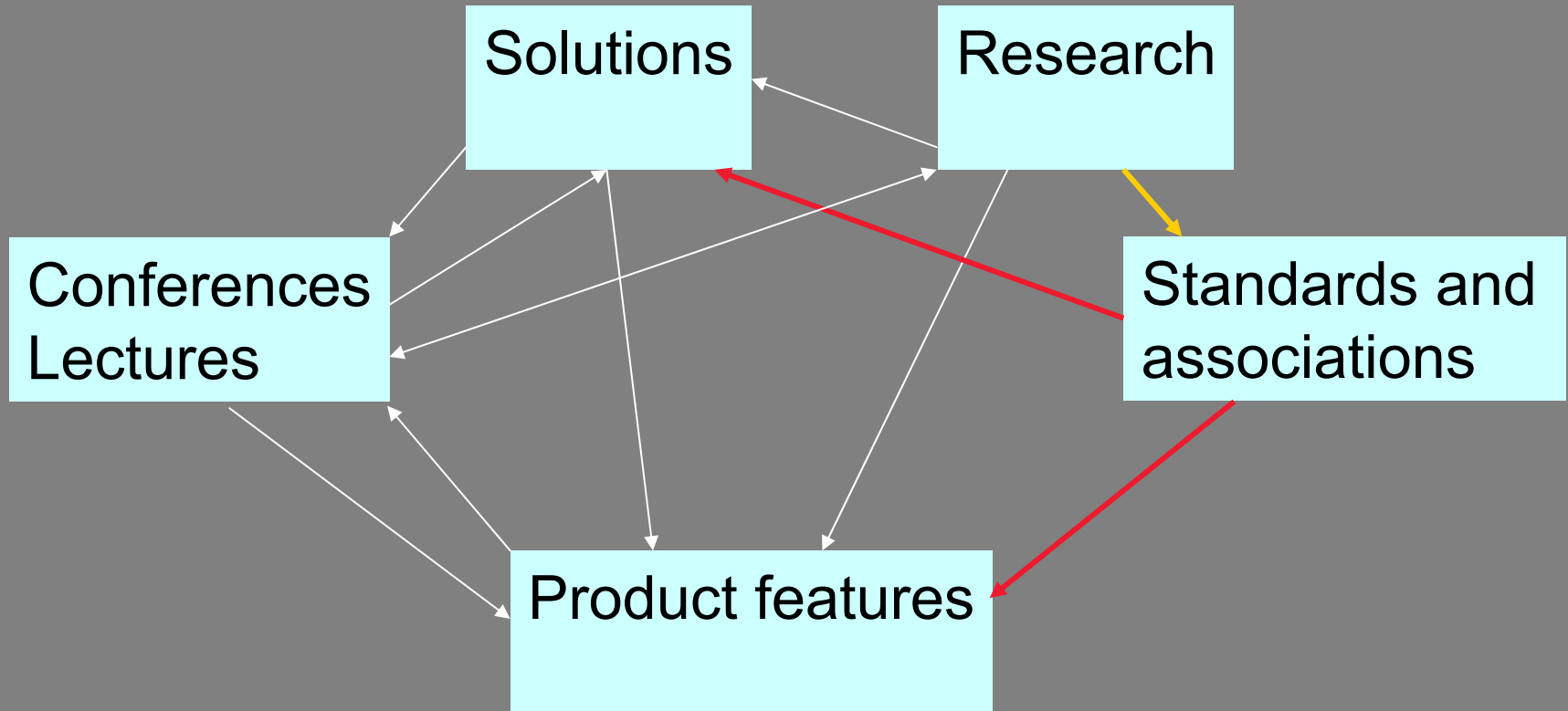
Light and lighting — Lighting of work places

Part 1: Indoor work places

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raising standards worldwide™





There is a large interaction between the different activities

Directives:	Standards:
<p data-bbox="239 586 935 654">Directives are European laws that apply to all EU member states.</p> <p data-bbox="239 718 935 822">Directives that follow Article 175 permit member states some local variation during translation into law.</p> <p data-bbox="239 886 935 953">Directives that follow Article 95 apply equally and unaltered to all member states</p> <p data-bbox="239 1018 935 1196">An example of a directive transcribed into national law is the Energy performance of buildings directive, where the requirements are incorporated into Part L of the UK Building Regulations</p>	<p data-bbox="987 586 1696 732">A standard is a document that provides rules, guidelines or characteristics for activities or their results, aimed at achieving the optimum degree of order in a given context.</p> <p data-bbox="987 796 1696 863">A standard may include recommendations for best practice</p>

Directives:	Standards:
Laws:	Recommendations:
<p>ELPD – Energy Efficiency Labelling of Products Lamp and ballast labelling to show efficiency</p>	<p>EN 12 464-1 Light and lighting – Lighting of work places – Part 1 : Indoor work places European indoor lighting standard. Defines lighting requirements for indoor work areas</p>
<p>EPBD – Energy Performance of Buildings Certification of buildings for carbon emissions and energy efficiency</p>	<p>EN 12 464-2 Light and lighting – Lighting of work places – Part 2 : Outdoor work places European outdoor lighting standard. Defines lighting requirements for outdoor work areas</p>
<p>ErPD – Energy related Product Ecodesign and energy efficiency during the life of an energy using product</p>	<p>EN 15193 Energy performance of buildings – Energy requirements for lighting Defines the energy performance of the building on an annual basis using the LENI calculation. $LENI = W/A$ (kWh/(m² x an)) where W is annual wattage used and A is the surface considered. Target values are specified.</p>
<p>WEEED – Waste of Electrical and Electronic Equipment Producer responsibility for end of life take back and recycling of products</p>	<p>EN 1838 Lighting Applications – Emergency lighting Defines the luminous requirements for emergency lighting systems installed in premises or locations where such systems are required.</p>
<p>RoHSD – Restriction of Hazardous Substances Restricts use of hazardous substances by designing out</p>	
<p>B&AD – Battery and Accumulators Ban the use of heavy metals</p>	

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Codes of practice

Codes of practice

Codes of practice are recommendations of good practice from societies or associations.

These bodies may not be internationally recognised in the same manner standards institutions are. (An example of an exception to this is CIE which is recognised by ISO and therefore some CIE documents become ISO standards).

Unless specifically mentioned in a law, directive or standard they have no official recognition although a client may refer to them in a specification.

Examples are

SLL code of lighting (similar to EN 12 464) - UK

BREEAM – Energy Limits for Buildings – Best Practise for Energy Savings - UK

Recommendations from Syndicate D L'Eclairage – France

Lighting association LIGHT GUIDE (ROOM LIGHTING) - Nordic

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CEN activities

- For most of us CEN as a producer of European standards is a very important market driver

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National, in each country, f.e.	LiTG, SLL, ILP, LTG, SLG, AFE, NsVV, ...	ZVEI, FEEI, LIA, SdIE	DIN, BSI, ON, AFNOR, SNI,	National laws f.e. Building regulations, EnEV,
Exploitation	Dedicated lighting experts	Companies lighting experts	Appointed national delegates	Politicians, lobbyists

- For lighting CEN/TC 169 Light and Lighting is most important
- CEN/TC 169 has 14 working groups (WG)
- Each WG has a convener who is responsible for the output of the WG and a team of experts to help with the work

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▪ CEN/TC 169 Light and Lighting

- WG1 – Basic terms and criteria
- WG2 – Lighting of work places
- WG3 – Emergency lighting in buildings
- WG4 – Sports lighting
- WG6 – Tunnel lighting
- WG7 – Photometry
- WG8 – Photobiology

- WG9 – Energy performance of buildings
- WG10 – Performance of optical materials for luminaires
- WG11 – Daylight
- WG12 – JWG with CEN/TC226*
Road lighting
- WG13 Non-visual effects of light on human beings
- WG14 – ErP Lighting Mandate Management Group

* CEN/TC 226 Road Equipment

EN12464-1:2011

What is EN12464-1?

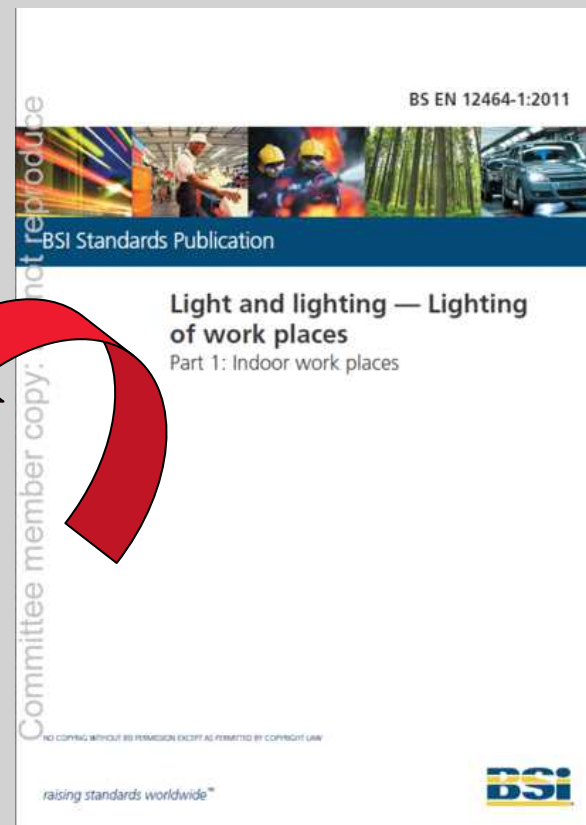
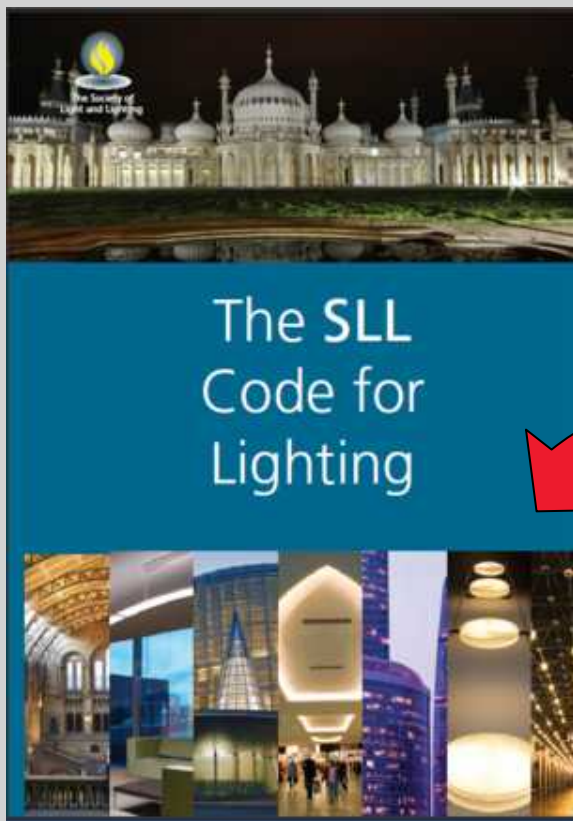
- EN12464-1 is the European standard for Indoor lighting
- Associated documents outside the EU are ISO 8995-1:2002 and CIE S 008/E:2001.
- Legally you do not have to comply with this standard, it is a recommendation
- Most lighting EU Directives, which are legally binding, refer to it.



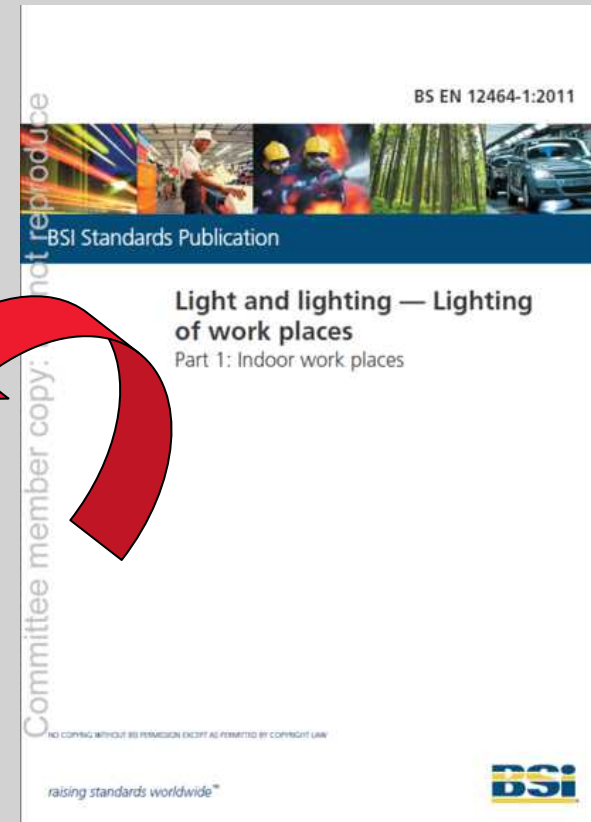
EN12464-1:2011 Influence into the UK



EN12464-1:2011 Influence into the UK



EN12464-1:2011 Influence into the UK



EN12464-1:2011 Influence into the UK

Lighting in the workplace: Good practice

39 Both interior and exterior lighting need to achieve a reasonable uniform illuminance in all relevant working areas, ie illuminance across any given task area needs to be uniform. For more information see **CIBSE Code for lighting**.

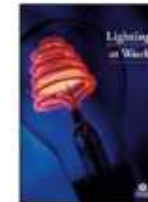
Minimum lighting recommendations

93 The illuminance needed depends on how much detail needs to be seen. It also depends on the age of the worker, and the speed and accuracy by which the task needs to be performed. These performance-related requirements and light levels are detailed in the **CIBSE Code for lighting**.



Health and Safety
Executive

Lighting at work



This is a free-to-download, web-friendly version of HSG38 (Second edition, published 1997). This version has been adapted for online use from HSE's current printed version.

You can buy the book at www.hsebooks.co.uk and most good bookshops.

ISBN 978 0 7176 1232 1
Price £9.25

This guidance explains how lighting contributes to the health and safety of people at work. It deals with assessing and managing the health and safety risks attributable to lighting in the workplace, good practice and the minimum recommended illumination levels that meet health and safety requirements.

Although aimed primarily at those who are responsible for health and safety at work, all employees may also find it useful.

HSE Books

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EN 12464-1: 2011 Lighting of Indoor Work Places

- This European Standard specifies requirements for lighting solutions for most indoor work places and their associated areas in terms of **quantity and quality of illumination**. In addition recommendations are given for **good lighting practice**.
- This European Standard neither provides specific solutions, nor restricts the designers' freedom from exploring new techniques nor restricts the use of innovative equipment. **The illumination can be provided by daylight, artificial lighting or a combination of both.**
- This European Standard is not applicable for the lighting of outdoor work places and underground mining or emergency lighting. For outdoor work places, see EN 12464-2 and for emergency lighting, see EN 1838 and EN 13032-3.

EN12464-1:2011

Scope

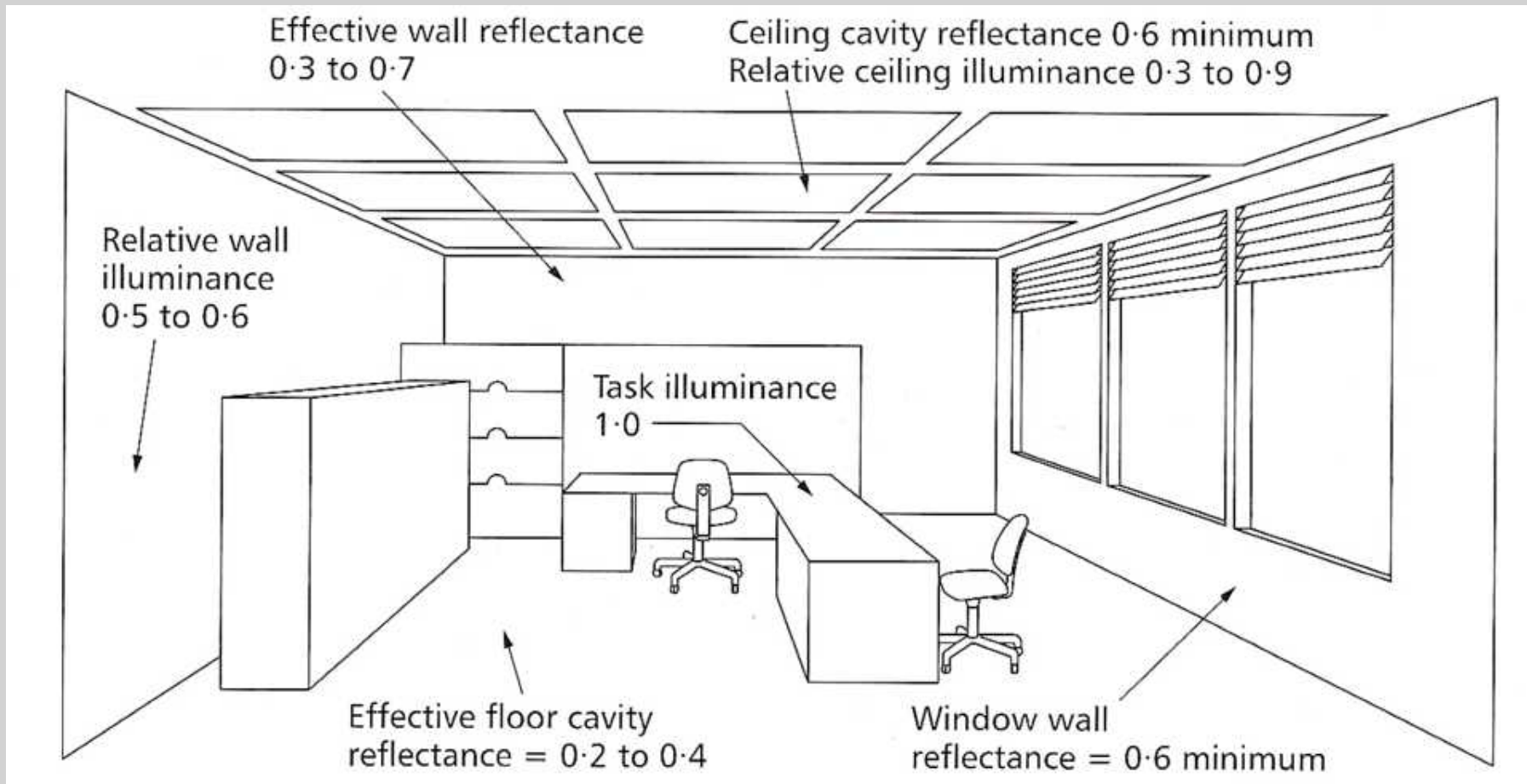
▪ Covers

- Traffic zones inside buildings
- Industrial activities and crafts
- Offices
- Retail premises
- Places of public assembly
 - Restaurants/hotels
 - Theatres/cinemas
 - Libraries/museums
 - Indoor car parks
- Educational premises
- Health care premises
- Transportation areas
 - Airports
 - Railway installations



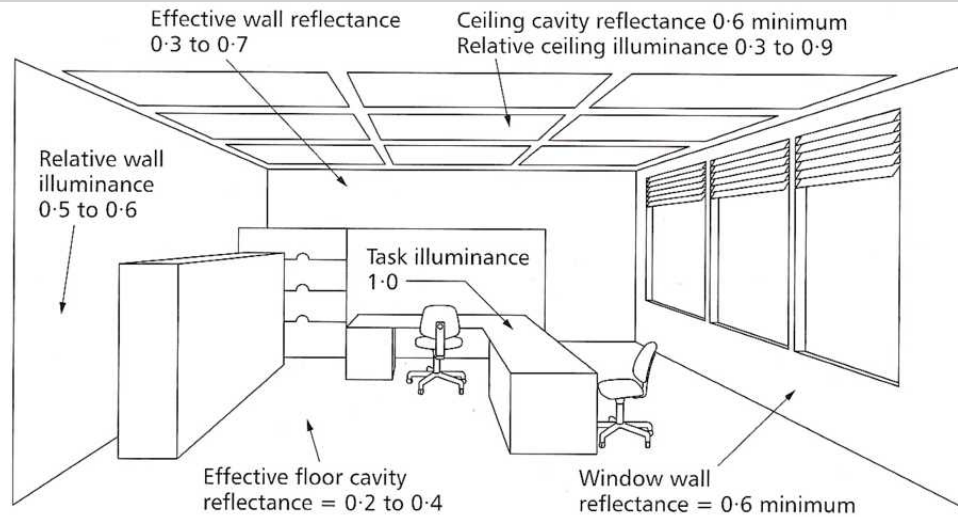
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Balanced illuminance and reflectance



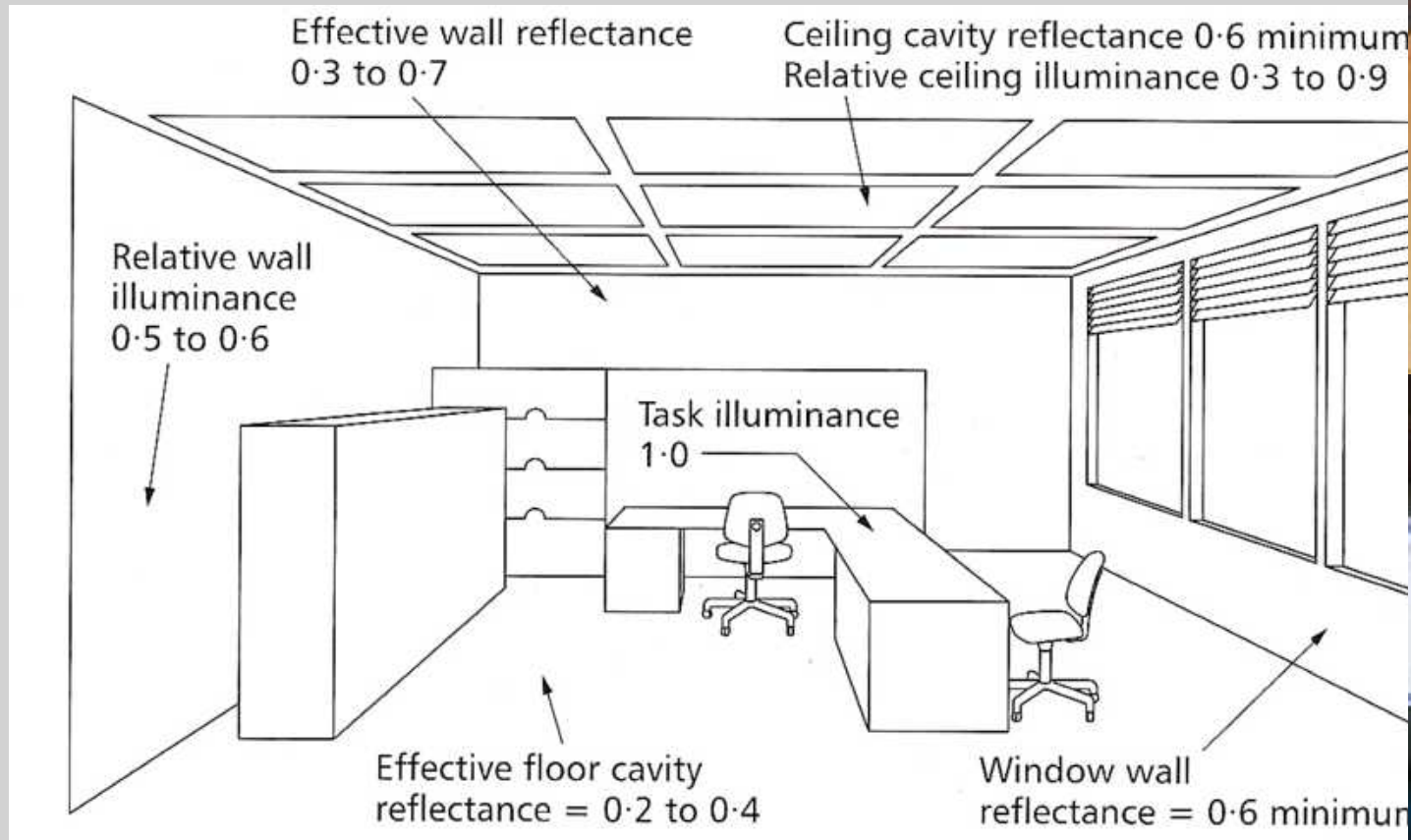
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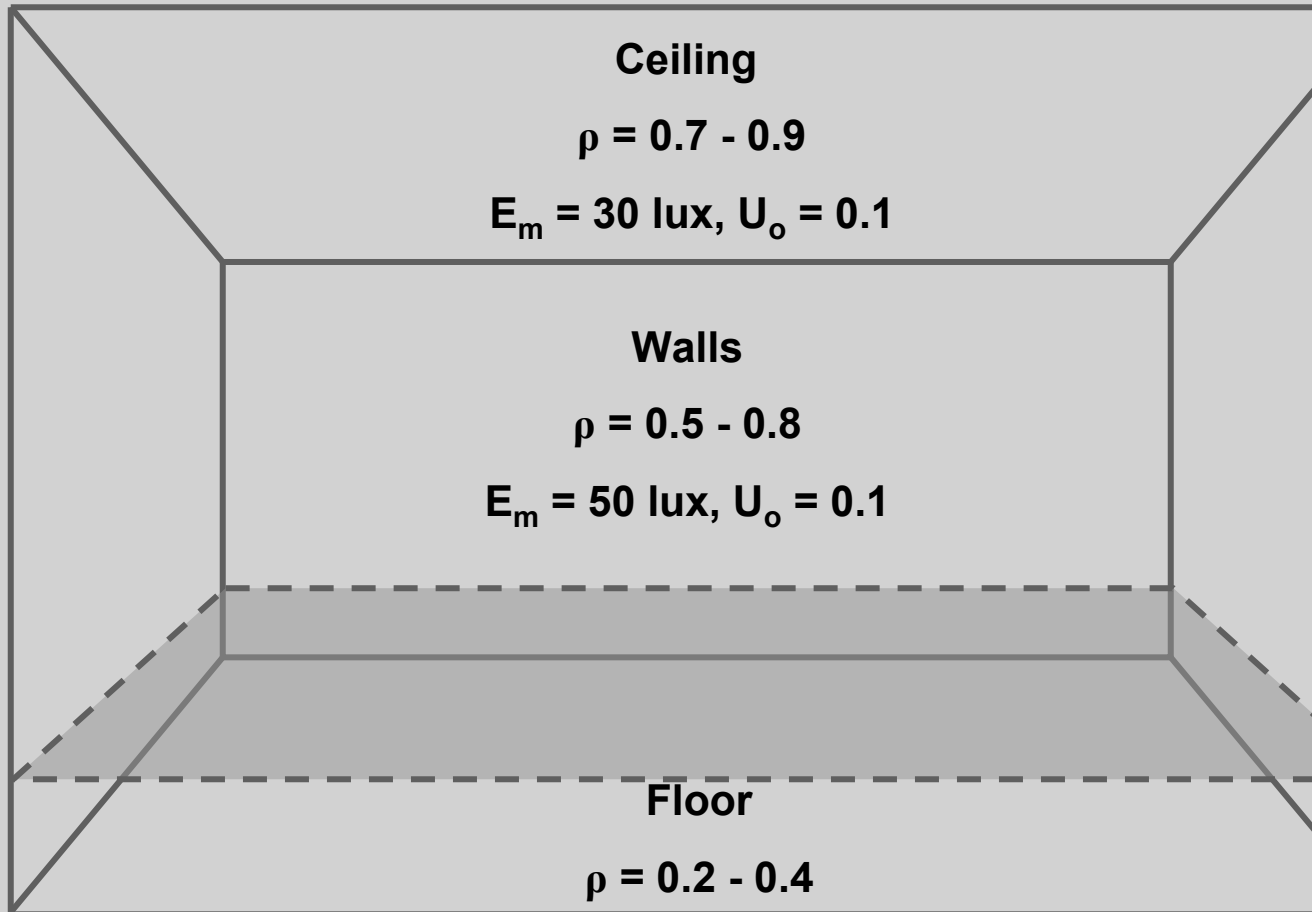
Balanced illuminance and reflectance

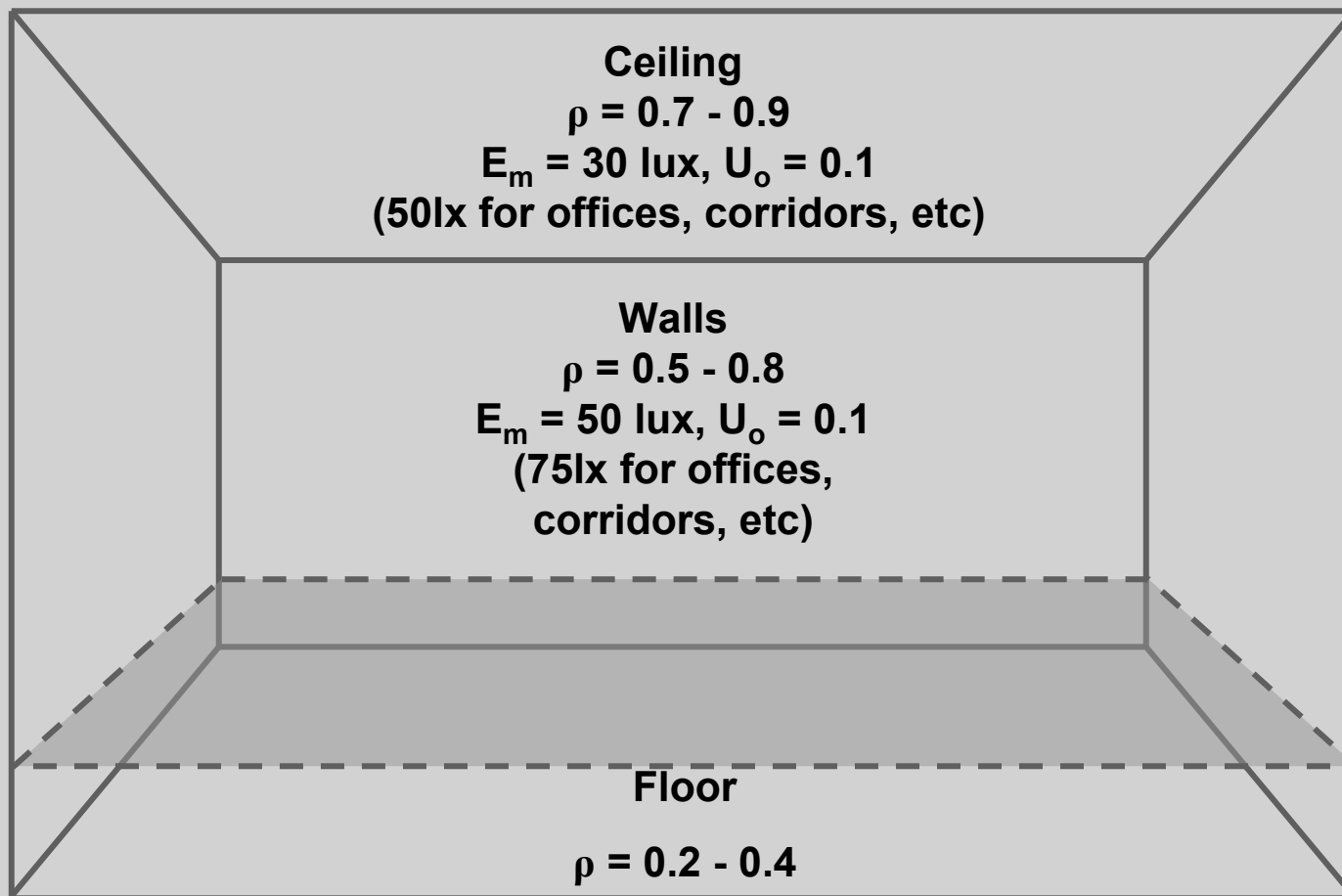


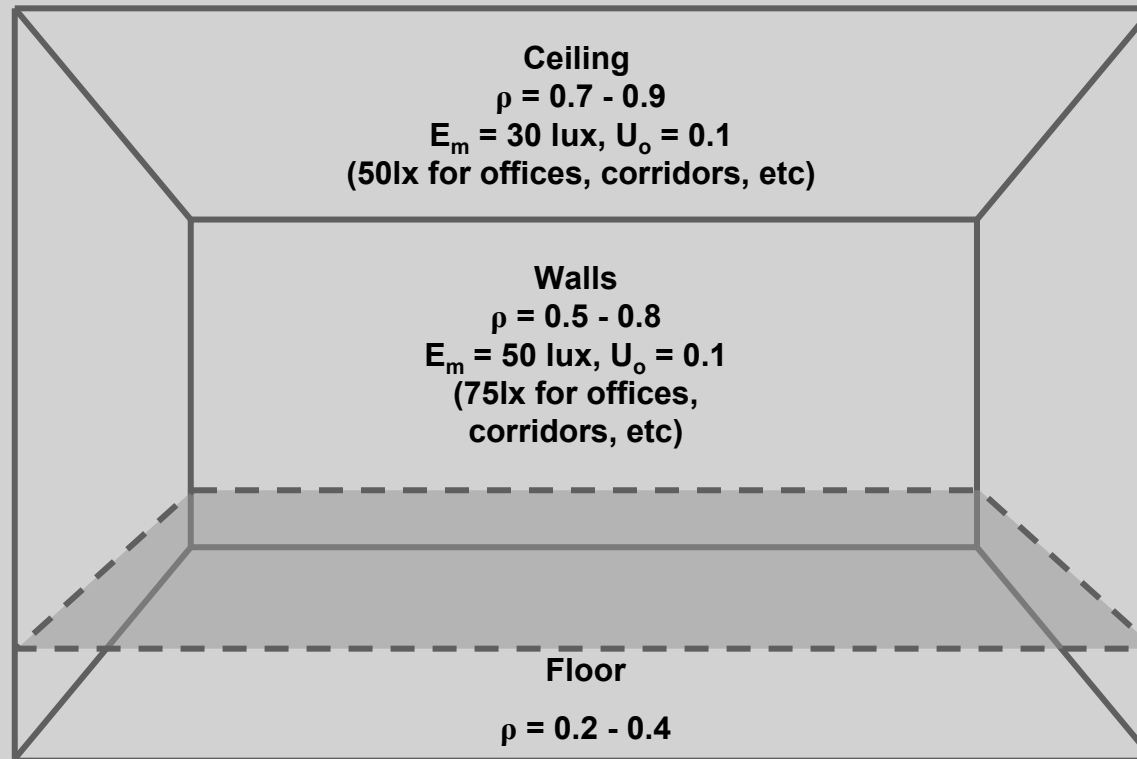
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Balanced illuminance and reflectance

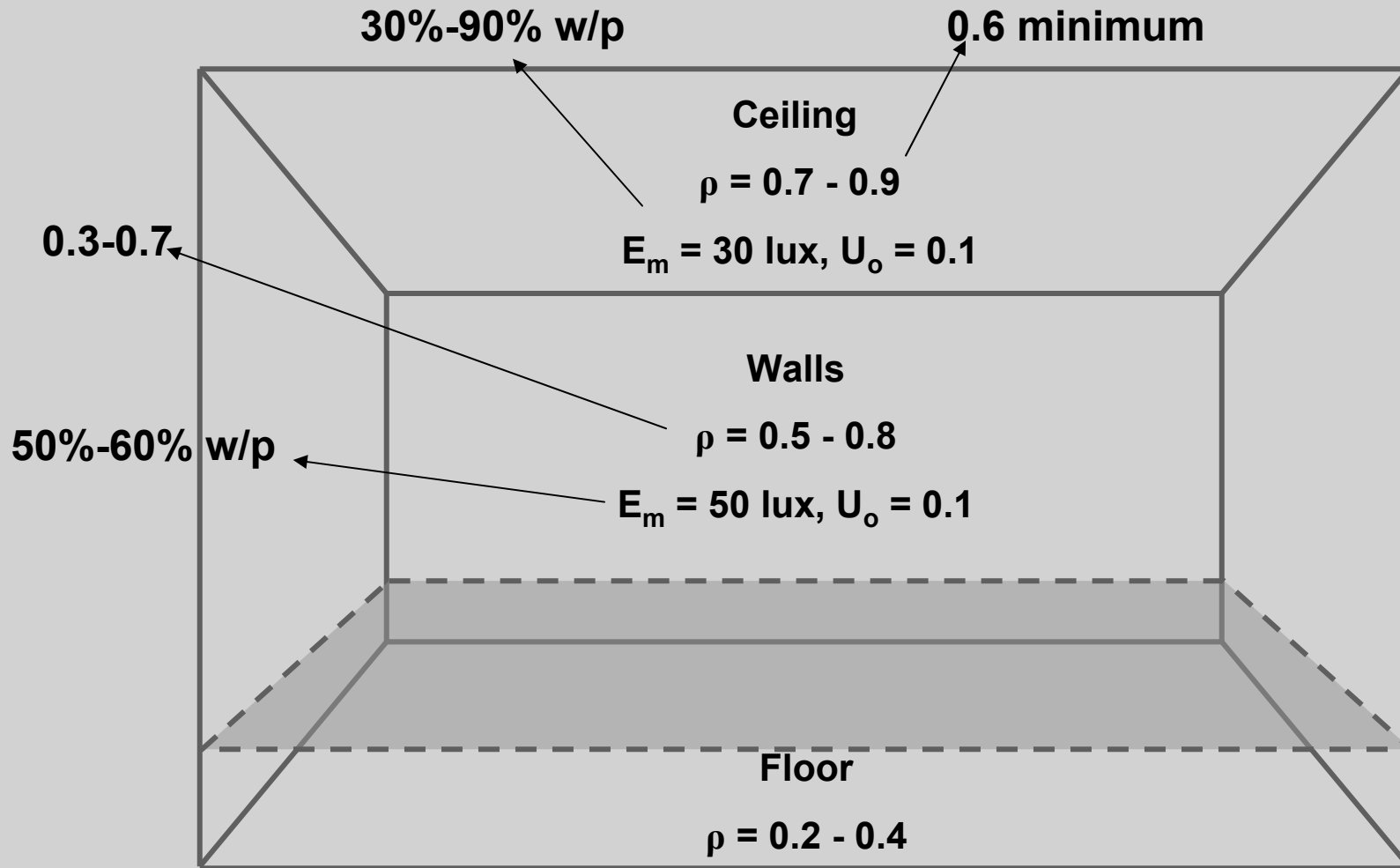






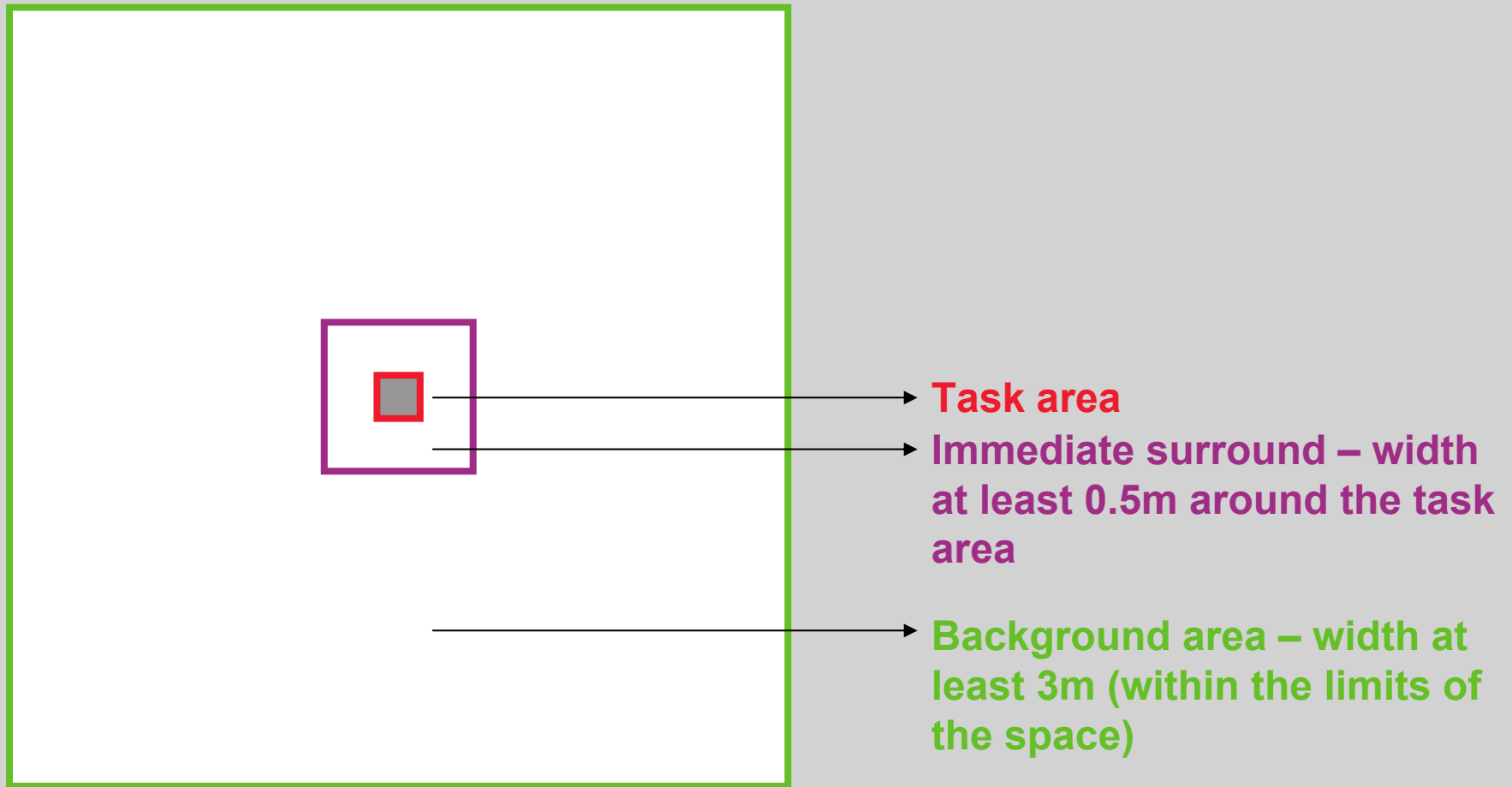


The reflectance of major objects (like furniture, machinery, etc.) should be in the range of 0,2 to 0,7.



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Illuminance



EN12464-1:2011

Illuminance



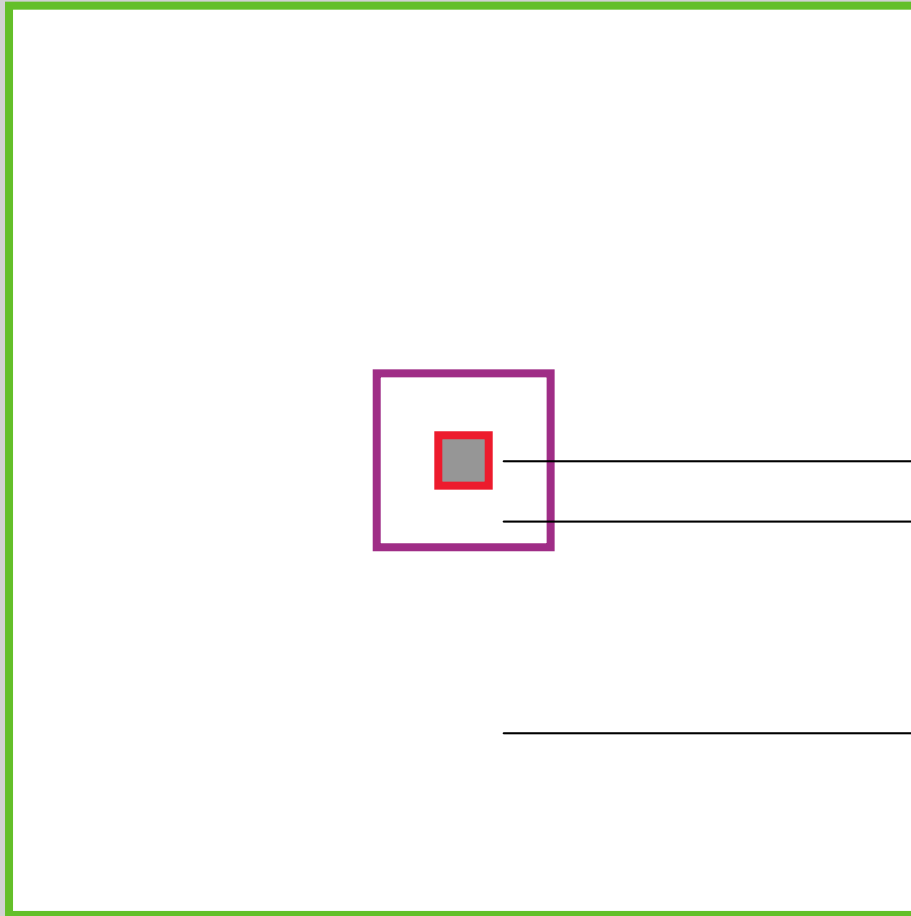
Task Area

**Immediate
Surrounding
Area
+0.5m**

**Background
Area
≥3m**

EN12464-1:2011

Illuminance



Task lx	Immediate Surround lx	Background lx
≥ 750	500	100
500	300	100
300	200	50
200	150	50
150	E_{task}	50
100	E_{task}	50
< 50	E_{task}	$E_{task}/2$
	$U_o > 0.4$	$U_o > 0.1$

→ **Task area**

→ **Immediate surround – width at least 0.5m around the task area**

→ **Background area – width at least 3m (within the limits of the space)**

For work stations where the size and/or location of the task area(s) is/are unknown, either:

- **the whole area is treated as the task area or**
- **the whole area is uniformly ($U_o \geq 0,40$) lit to an illuminance level specified by the designer; if the task area becomes known, the lighting scheme shall be re-designed to provide the required illuminances.**

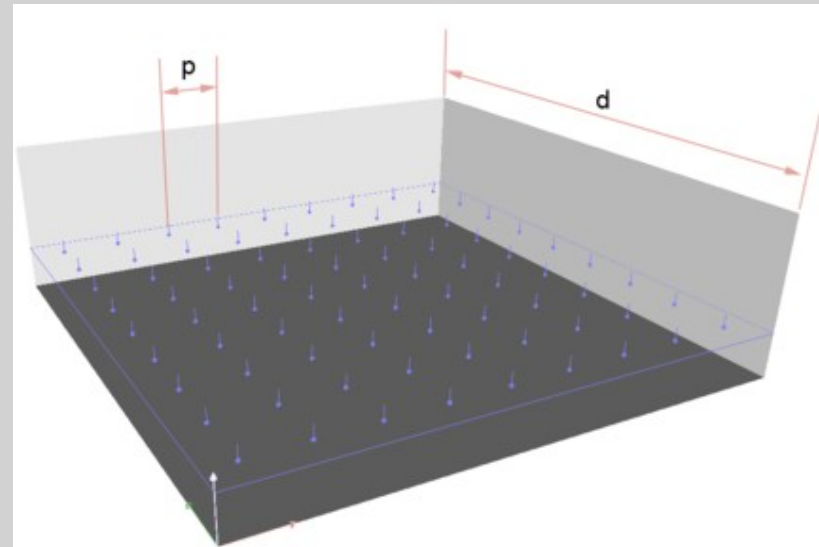
If the type of the task is not known the designer has to make assumptions about the likely tasks and state task requirements.

A new definition of the illuminance grid for calculation and verification.

- Using this method the maximum grid size shall be:

$$p = 0.2 \times 5^{\log_{10}(d)}$$

- where p is the maximum grid cell size
- d is the longer dimension of the area (m).
- The number of grid points is then d/p .



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Illuminance – Calculation Grids

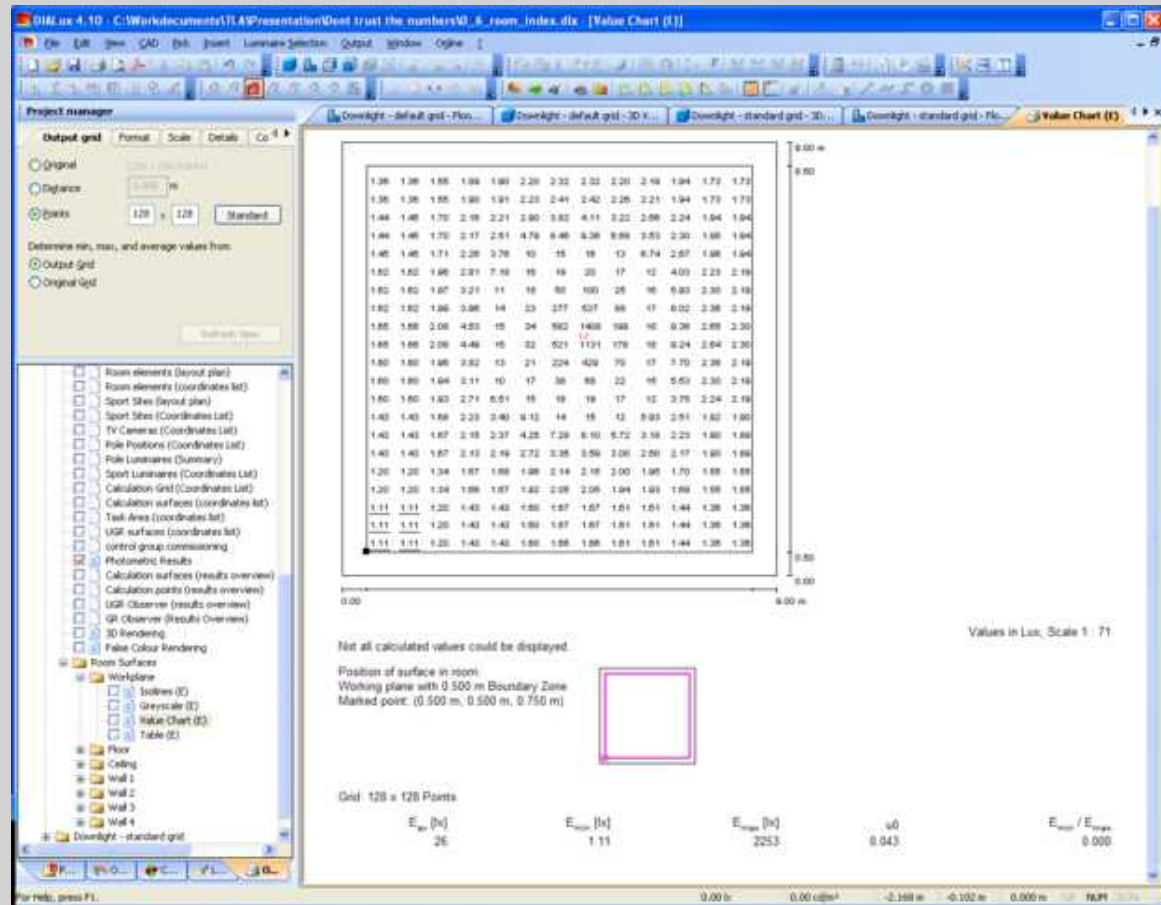
A new definition of the illuminance grid for calculation and verification.

Length of the area (m)	Max. distance between grid points (m)	Min. number of grid points
0.40	0.15	3
0.60	0.20	3
1.00	0.20	5
2.00	0.30	6
5.00	0.60	8
10.00	1.00	10
25.00	2.00	12
50.00	3.00	17
100.00	5.00	20

EN12464-1:2011 Illuminance – Calculation Grids

▪ I place a spotlight in a room and calculate...

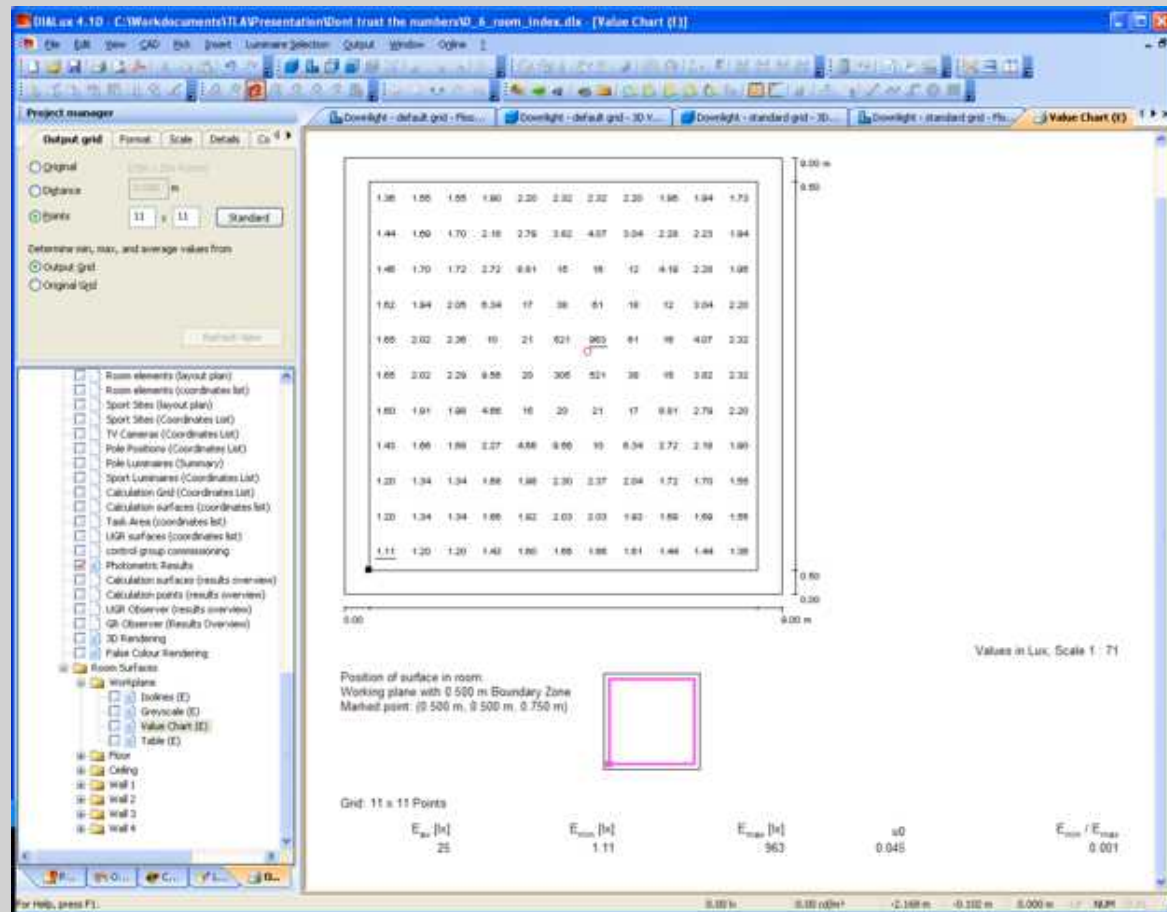
- E_{av} 26 lx
- E_{min} 1.11 lx
- E_{max} 2253 lx



EN12464-1:2011 Illuminance – Calculation Grids

▪ I modify it to use the standard grid and calculate...

- E_{av} 25 lx
- E_{min} 1.11lx
- E_{max} 963lx

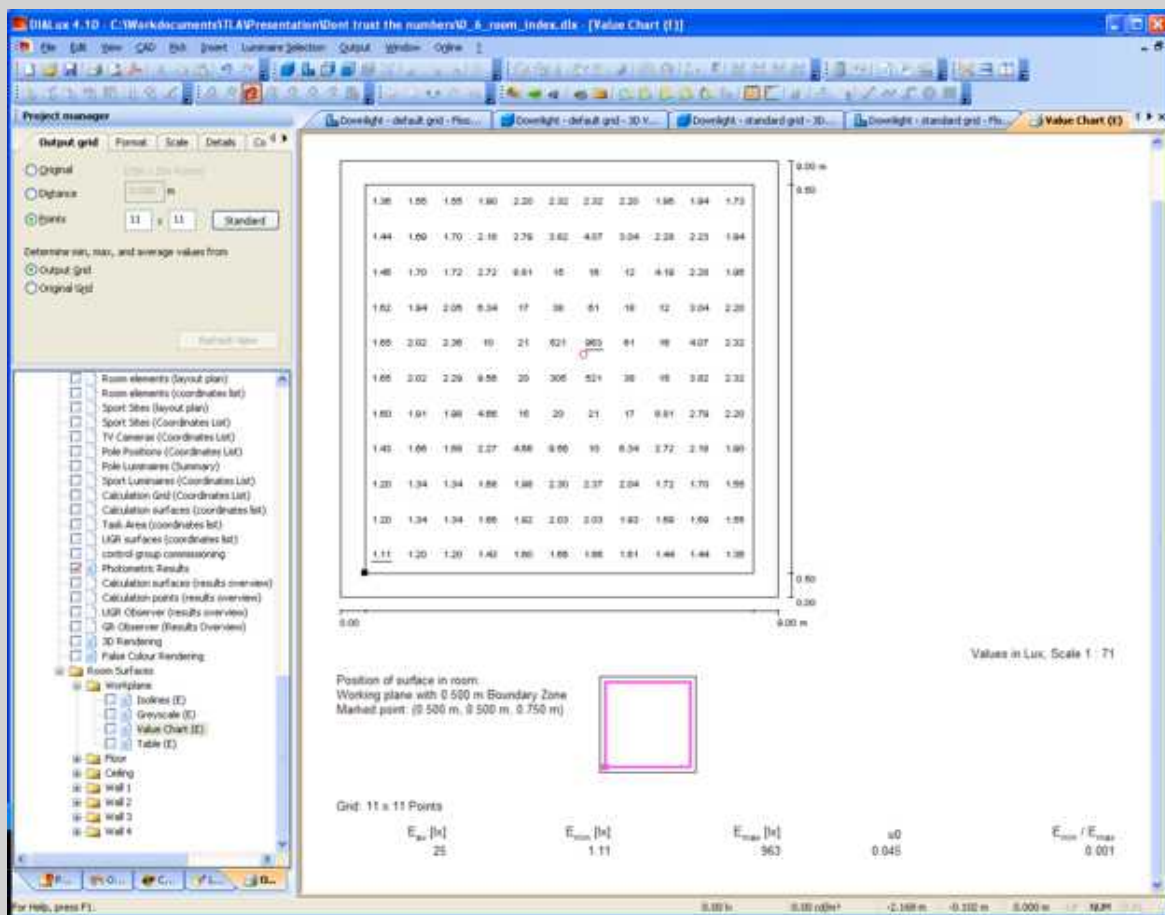


EN12464-1:2011 Illuminance – Calculation Grids

▪ I modify it to use the standard grid and calculate...

- E_{av} 25 lx
- E_{min} 1.11lx
- E_{max} 963lx

So E_{max} has changed by **234%!**



EN12464-1:2011 Discomfort Glare

UGR table (CIE)											
UGR based on 3600 lm						Spacing: 1.00 H					
Useful plane		70/50/20	70/30/20	50/50/10	50/30/10	30/30/10	70/50/20	70/30/20	50/50/10	50/30/10	30/30/10
X	Y	Transverse direction of view					Parallel direction of view				
2H	2H	2.7	4.0	3.0	4.3	4.6	12.1	13.4	12.5	13.7	14.1
2H	3H	2.6	3.7	2.9	4.0	4.4	12.0	13.2	12.4	13.5	13.8
2H	4H	2.5	3.6	2.9	3.9	4.3	11.9	13.0	12.3	13.3	13.7
2H	6H	2.5	3.4	2.9	3.8	4.2	11.9	12.8	12.3	13.2	13.6
2H	8H	2.5	3.4	2.9	3.7	4.1	11.9	12.8	12.3	13.1	13.5
2H	12H	2.4	3.3	2.9	3.7	4.1	11.8	12.7	12.2	13.1	13.5
4H	2H	2.5	3.6	2.9	3.9	4.3	11.9	13.0	12.3	13.3	13.7
4H	3H	2.4	3.3	2.8	3.6	4.1	11.8	12.7	12.2	13.0	13.5
4H	4H	2.4	3.1	2.9	3.6	4.0	11.8	12.5	12.2	12.9	13.3
4H	6H	2.5	3.1	3.0	3.6	4.0	11.8	12.4	12.3	12.8	13.3
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4H	12H	2.3	2.8	2.8	3.3	3.8	11.6	12.1	12.1	12.6	13.1
8H	4H	2.3	2.9	2.8	3.3	3.8	11.6	12.2	12.1	12.6	13.1
8H	6H	2.3	2.7	2.8	3.2	3.7	11.5	12.0	12.0	12.5	13.0
8H	8H	2.3	2.7	2.8	3.2	3.7	11.5	11.9	12.0	12.4	12.9
8H	12H	2.2	2.6	2.8	3.1	3.7	11.4	11.8	11.9	12.3	12.8
12H	4H	2.2	2.8	2.7	3.2	3.7	11.5	12.1	12.0	12.5	13.0
12H	6H	2.2	2.6	2.7	3.1	3.7	11.4	11.9	12.0	12.4	12.9
12H	8H	2.2	2.6	2.7	3.1	3.6	11.4	11.8	11.9	12.3	12.8

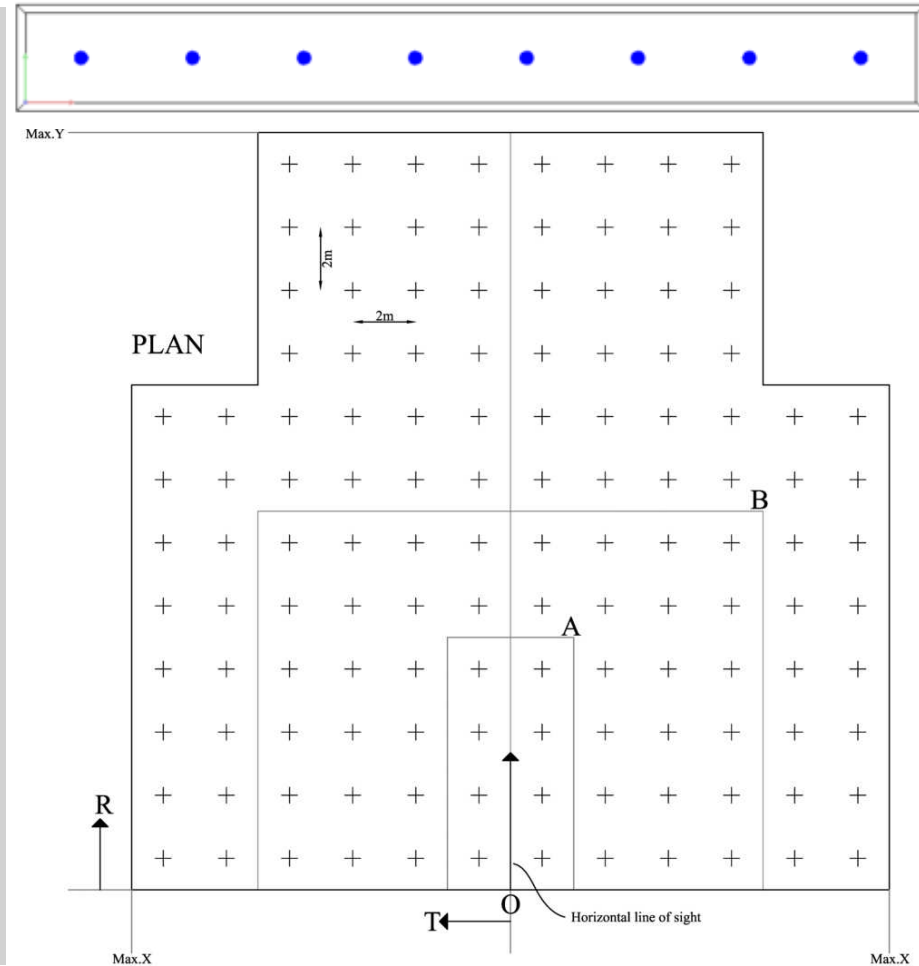
$$UGR = 8 \log_{10} \left(\frac{0.25}{L_B} \sum \frac{L^2 \omega}{p^2} \right)$$

Based on CIE 117-1996

EN12464-1:2011 Discomfort Glare

The rating of discomfort glare caused directly from the luminaires of an indoor lighting installation shall be determined using the CIE Unified Glare Rating (*UGR*) tabular method, based on the formula:

Walls		70/50/20	70/30/20	50/50/10	50/30/10	30/30/10	70/50/20	70/30/20	50/50/10	50/30/10	30/30/10
Ceiling		70/50/20	70/30/20	50/50/10	50/30/10	30/30/10	70/50/20	70/30/20	50/50/10	50/30/10	30/30/10
X	Y	Transverse direction of view					Parallel direction of view				
2H	2H	2.7	4.0	3.0	4.3	4.6	12.1	13.4	12.5	13.7	14.1
2H	3H	2.6	3.7	2.9	4.0	4.4	12.0	13.2	12.4	13.5	13.8
2H	4H	2.5	3.6	2.9	3.9	4.3	11.9	13.0	12.3	13.3	13.7
2H	6H	2.5	3.4	2.9	3.8	4.2	11.9	12.8	12.3	13.2	13.6
2H	8H	2.5	3.4	2.9	3.7	4.1	11.9	12.8	12.3	13.1	13.5
2H	12H	2.4	3.3	2.9	3.7	4.1	11.8	12.7	12.2	13.1	13.5
4H	2H	2.5	3.6	2.9	3.9	4.3	11.9	13.0	12.3	13.3	13.7
4H	3H	2.4	3.3	2.8	3.6	4.1	11.8	12.7	12.2	13.0	13.5
4H	4H	2.4	3.1	2.9	3.6	4.0	11.8	12.5	12.2	12.9	13.3
4H	6H	2.5	3.1	3.0	3.6	4.0	11.8	12.4	12.3	12.8	13.3
4H	8H	2.3	2.9	2.8	3.4	3.9	11.6	12.2	12.1	12.7	13.1
4H	12H	2.3	2.8	2.8	3.3	3.8	11.6	12.1	12.1	12.6	13.1
8H	4H	2.3	2.9	2.8	3.3	3.8	11.6	12.2	12.1	12.6	13.1
8H	6H	2.3	2.7	2.8	3.2	3.7	11.5	12.0	12.0	12.5	13.0
8H	8H	2.3	2.7	2.8	3.2	3.7	11.5	11.9	12.0	12.4	12.9
8H	12H	2.2	2.6	2.8	3.1	3.7	11.4	11.8	11.9	12.3	12.8
12H	4H	2.2	2.8	2.7	3.2	3.7	11.5	12.1	12.0	12.5	13.0
12H	6H	2.2	2.6	2.7	3.1	3.7	11.4	11.9	12.0	12.4	12.9
12H	8H	2.2	2.6	2.7	3.1	3.6	11.4	11.8	11.9	12.3	12.8



EN12464-1:2011 Discomfort Glare

UGR table (C)											
UGR based on 3600 lm											
Useful plane		70/50/20	70/30/20	50/50/10	50/30/10	30/30/10	70/50/20	70/30/20	50/50/10	50/30/10	30/30/10
Walls											
Ceiling											
X	Y	Transverse direction of view					Parallel direction of view				
2H	2H	2.7	4.0	3.0	4.3	4.6	12.1	13.4	12.5	13.7	14.1
2H	3H	2.6	3.7	2.9	4.0	4.4	12.0	13.2	12.4	13.5	13.8
2H	4H	2.5	3.6	2.9	3.9	4.3	11.9	13.0	12.3	13.3	13.7
2H	6H	2.5	3.4	2.9	3.8	4.2	11.9	12.8	12.3	13.2	13.6
2H	8H	2.5	3.4	2.9	3.7	4.1	11.9	12.8	12.3	13.1	13.5
2H	12H	2.4	3.3	2.9	3.7	4.1	11.8	12.7	12.2	13.1	13.5
4H	2H	2.5	3.6	2.9	3.9	4.3	11.9	13.0	12.3	13.3	13.7
4H	3H	2.4	3.3	2.8	3.6	4.1	11.8	12.7	12.2	13.0	13.5
4H	4H	2.4	3.1	2.9	3.6	4.0	11.8	12.5	12.2	12.9	13.3
4H	6H	2.5	3.1	3.0	3.6	4.0	11.8	12.4	12.3	12.8	13.3
4H	8H	2.3	2.9	2.8	3.4	3.9	11.6	12.2	12.1	12.7	13.1
4H	12H	2.3	2.8	2.8	3.3	3.8	11.6	12.1	12.1	12.6	13.1
8H	4H	2.3	2.9	2.8	3.3	3.8	11.6	12.2	12.1	12.6	13.1
8H	6H	2.3	2.7	2.8	3.2	3.7	11.5	12.0	12.0	12.5	13.0
8H	8H	2.3	2.7	2.8	3.2	3.7	11.5	11.9	12.0	12.4	12.9
8H	12H	2.2	2.6	2.8	3.1	3.7	11.4	11.8	11.9	12.3	12.8
12H	4H	2.2	2.8	2.7	3.2	3.7	11.5	12.1	12.0	12.5	13.0
12H	6H	2.2	2.6	2.7	3.1	3.7	11.4	11.9	12.0	12.4	12.9
12H	8H	2.2	2.6	2.7	3.1	3.6	11.4	11.8	11.9	12.3	12.8

Fitting1

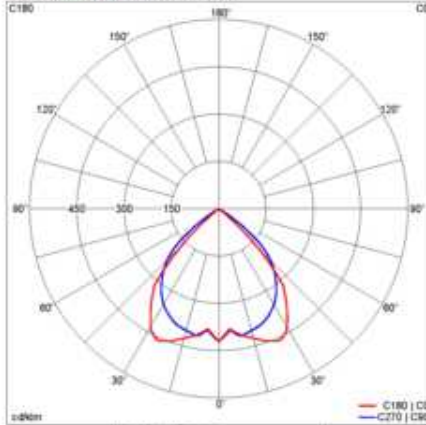
UGR table (C)											
UGR based on 3600 lm											
Useful plane		70/50/20	70/30/20	50/50/10	50/30/10	30/30/10	70/50/20	70/30/20	50/50/10	50/30/10	30/30/10
Walls											
Ceiling											
X	Y	Transverse direction of view					Parallel direction of view				
2H	2H	15.9	16.9	17.7	18.9	19.1	17.3	18.3	19.1	20.3	20.5
2H	3H	15.8	16.7	17.7	18.8	19.0	17.1	18.0	19.1	20.1	20.4
2H	4H	15.7	16.5	17.7	18.7	19.0	17.1	17.9	19.1	20.1	20.3
2H	6H	15.6	16.4	17.7	18.6	18.9	17.0	17.8	19.1	20.0	20.3
2H	8H	15.6	16.3	17.7	18.6	18.9	16.9	17.7	19.1	20.0	20.3
2H	12H	15.5	16.2	17.7	18.6	18.9	16.9	17.6	19.1	19.9	20.2
4H	2H	15.8	16.7	17.8	18.8	19.1	17.1	17.9	19.1	20.1	20.4
4H	3H	15.7	16.4	17.9	18.7	19.0	16.9	17.6	19.1	20.0	20.3
4H	4H	15.6	16.2	17.9	18.6	19.0	16.9	17.5	19.2	19.9	20.2
4H	6H	15.5	16.1	17.9	18.6	18.9	16.8	17.3	19.2	19.9	20.2
4H	8H	15.5	16.0	17.9	18.5	18.9	16.7	17.3	19.2	19.8	20.2
4H	12H	15.4	15.9	17.9	18.5	18.9	16.7	17.2	19.2	19.8	20.2
8H	4H	15.5	16.0	17.9	18.5	18.9	16.7	17.2	19.2	19.8	20.2
8H	6H	15.4	15.8	18.0	18.5	18.9	16.7	17.1	19.2	19.8	20.2
8H	8H	15.3	15.7	18.0	18.5	18.9	16.6	17.0	19.3	19.7	20.2
8H	12H	15.3	15.6	18.0	18.4	18.9	16.6	16.9	19.3	19.7	20.1
12H	4H	15.4	15.9	17.9	18.5	18.9	16.7	17.2	19.2	19.8	20.2
12H	6H	15.3	15.7	18.0	18.5	18.9	16.6	17.0	19.3	19.7	20.2
12H	8H	15.3	15.6	18.0	18.4	18.9	16.6	16.9	19.3	19.7	20.1

Fitting2

EN12464-1:2011 Discomfort Glare

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CINQUELINE MK14

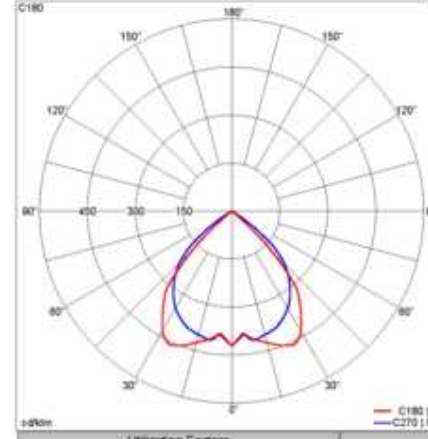
Description: Specular beam
Manufacturers: LISPE
Catalogue: FRMTS2314MBMK14
Number: 3 x T18 14W
Lamps: 81 %
LDI: 0 %
ULOR: 0 %
DLOR: 81 %

Utilization Factors		UGR table (CIE)																					
From Reference Catalogue/Type	Room index											Spacing: 1.00 m											
	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00						
70/150/20	86	71	75	78	82	84	86	88	89	89	89	89	89	89	89	89	89	89					
70/180/20	81	66	72	75	78	80	82	83	84	84	84	84	84	84	84	84	84	84					
70/120/20	58	46	50	52	53	54	54	54	54	54	54	54	54	54	54	54	54	54					
80/150/20	84	69	74	76	80	82	84	85	86	86	86	86	86	86	86	86	86	86					
80/180/20	81	67	71	74	77	79	81	82	83	83	83	83	83	83	83	83	83	83					
80/120/20	58	44	48	50	51	52	52	52	52	52	52	52	52	52	52	52	52	52					
90/150/20	83	68	73	75	79	81	83	84	85	85	85	85	85	85	85	85	85	85					
90/180/20	80	65	70	72	75	77	79	80	81	81	81	81	81	81	81	81	81	81					
90/120/20	58	44	48	50	51	52	52	52	52	52	52	52	52	52	52	52	52	52					
90/0/0	57	42	46	48	50	51	51	51	51	51	51	51	51	51	51	51	51	51					

THE SAME FITTING!!

THORN

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CINQUELINE MK14

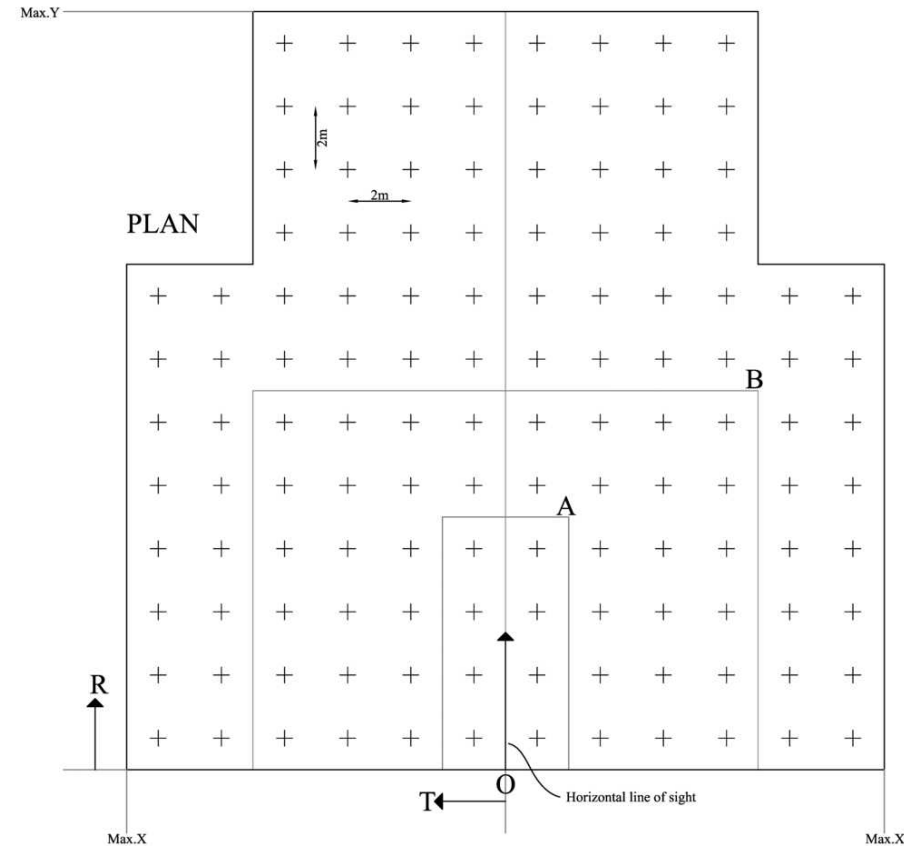
Description: Specular beam
Manufacturers: LISPE
Catalogue: FRMTS2314MBMK14
Number: 3 x T18 14W
Lamps: 81 %
LDI: 0 %
ULOR: 0 %
DLOR: 81 %

Utilization Factors		UGR table (CIE)																					
From Reference Catalogue/Type	Room index											Spacing: 0.25 m											
	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00						
70/150/20	86	71	75	78	82	84	86	88	89	89	89	89	89	89	89	89	89	89					
70/180/20	81	66	72	75	78	80	82	83	84	84	84	84	84	84	84	84	84	84					
70/120/20	58	46	50	52	53	54	54	54	54	54	54	54	54	54	54	54	54	54					
80/150/20	84	69	74	76	80	82	84	85	86	86	86	86	86	86	86	86	86	86					
80/180/20	81	67	71	74	77	79	81	82	83	83	83	83	83	83	83	83	83	83					
80/120/20	58	44	48	50	51	52	52	52	52	52	52	52	52	52	52	52	52	52					
90/150/20	83	68	73	75	79	81	83	84	85	85	85	85	85	85	85	85	85	85					
90/180/20	80	65	70	72	75	77	79	80	81	81	81	81	81	81	81	81	81	81					
90/120/20	58	44	48	50	51	52	52	52	52	52	52	52	52	52	52	52	52	52					
90/0/0	57	42	46	48	50	51	51	51	51	51	51	51	51	51	51	51	51	51					

EN12464-1:2011

Discomfort Glare

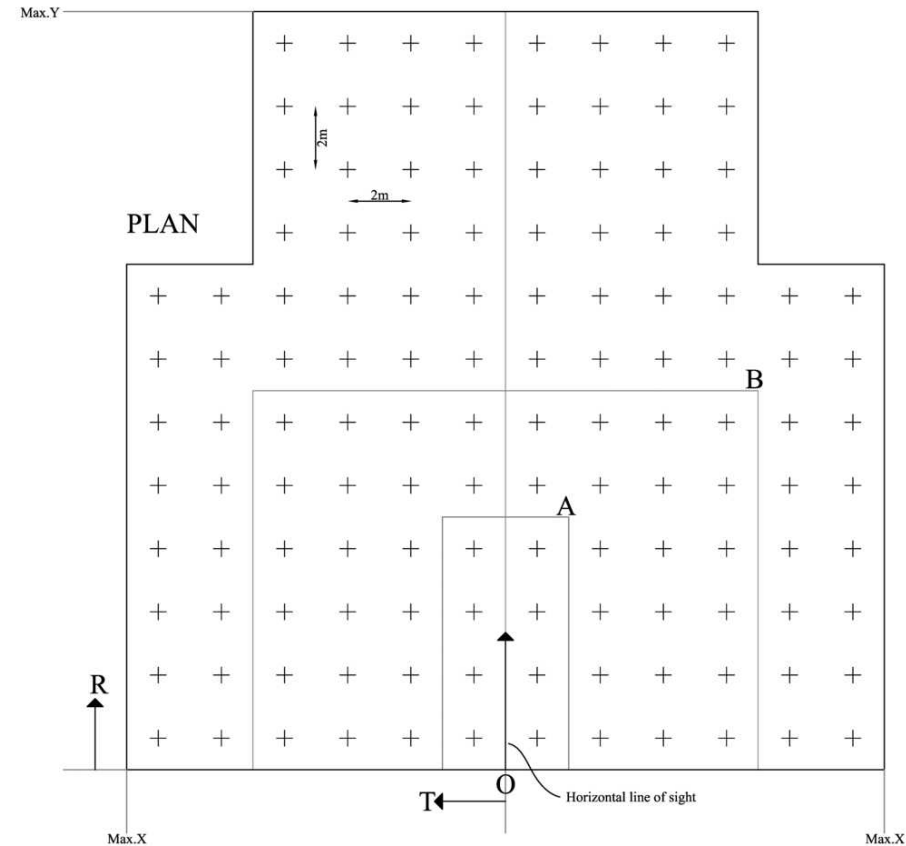
- **UGR can be calculated with two arrangements**
 - Spacing equal to mounting height above observer eye (2m : 2m)
 - Spacing equal to one quarter of the mounting height above observer eye (0.5m : 2m)
- **The limiting criteria in EN 12464-1 is identical for both situations**



EN12464-1:2011

Discomfort Glare

- UGR can be calculated with two arrangements
- Generally this makes little difference...
- ...unless the distribution cut-off hits the boundary and
 - Is cut-off for 1:1 spacing
 - Is NOT cut-off for 0.25:1 spacing

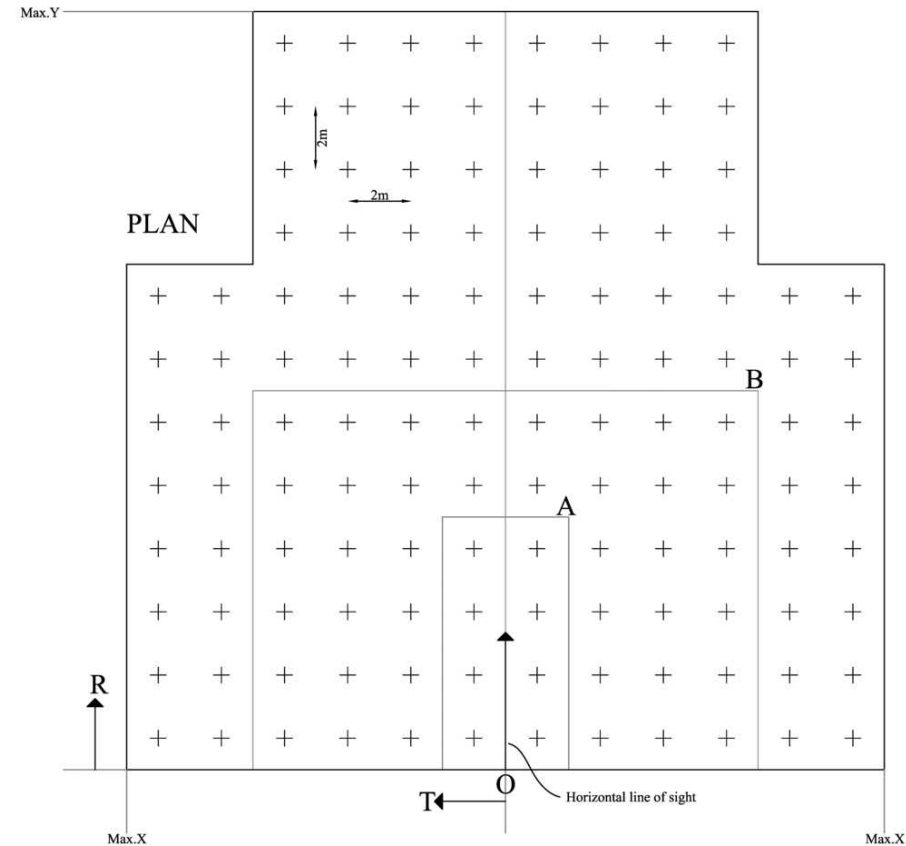


EN12464-1:2011

Discomfort Glare

- Different countries require the calculation to be performed a specific way, e.g.

- UK 1:1
- Germany 0.25:1



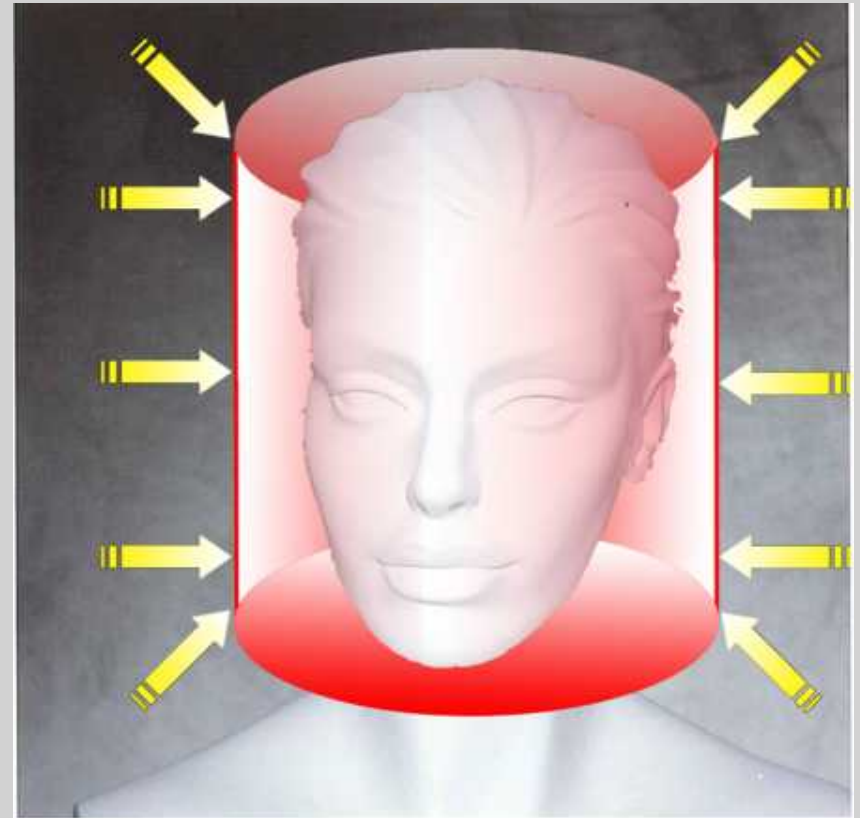
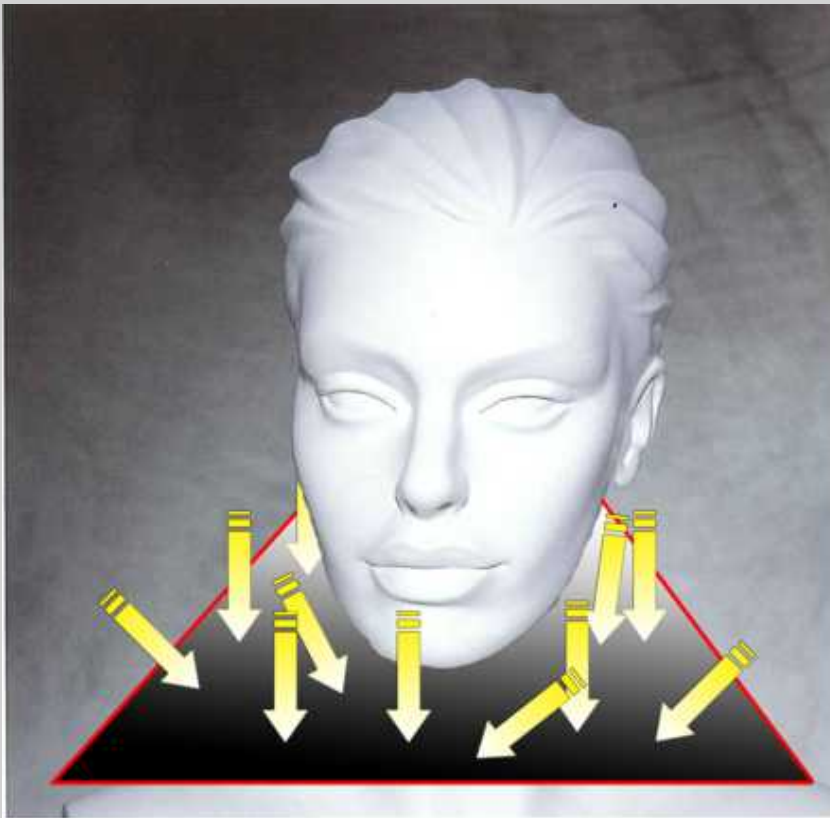
EN12464-1:2011 Discomfort Glare

UGR table (CIE)											
UGR based on 3600 lm						Spacing: 1.00 H					
Useful plane		70/50/20	70/30/20	50/50/10	50/30/10	30/30/10	70/50/20	70/30/20	50/50/10	50/30/10	30/30/10
Walls											
Ceiling											
X	Y	Transverse direction of view					Parallel direction of view				
2H	2H	2.7	4.0	3.0	4.3	4.6	12.1	13.4	12.5	13.7	14.1
2H	3H	2.6	3.7	2.9	4.0	4.4	12.0	13.2	12.4	13.5	13.8
2H	4H	2.5	3.6	2.9	3.9	4.3	11.9	13.0	12.3	13.3	13.7
2H	6H	2.5	3.4	2.9	3.8	4.2	11.9	12.8	12.3	13.2	13.6
2H	8H	2.5	3.4	2.9	3.7	4.1	11.9	12.8	12.3	13.1	13.5
2H	12H	2.4	3.3	2.9	3.7	4.1	11.8	12.7	12.2	13.1	13.5
4H	2H	2.5	3.6	2.9	3.9	4.3	11.9	13.0	12.3	13.3	13.7
4H	3H	2.4	3.3	2.8	3.6	4.1	11.8	12.7	12.2	13.0	13.5
4H	4H	2.4	3.1	2.9	3.6	4.0	11.8	12.5	12.2	12.9	13.3
4H	6H	2.5	3.1	3.0	3.6	4.0	11.8	12.4	12.3	12.8	13.3
4H	8H	2.3	2.9	2.8	3.4	3.9	11.6	12.2	12.1	12.7	13.1
4H	12H	2.3	2.8	2.8	3.3	3.8	11.6	12.1	12.1	12.6	13.1
8H	4H	2.3	2.9	2.8	3.3	3.8	11.6	12.2	12.1	12.6	13.1
8H	6H	2.3	2.7	2.8	3.2	3.7	11.5	12.0	12.0	12.5	13.0
8H	8H	2.3	2.7	2.8	3.2	3.7	11.5	11.9	12.0	12.4	12.9
8H	12H	2.2	2.6	2.8	3.1	3.7	11.4	11.8	11.9	12.3	12.8
12H	4H	2.2	2.8	2.7	3.2	3.7	11.5	12.1	12.0	12.5	13.0
12H	6H	2.2	2.6	2.7	3.1	3.7	11.4	11.9	12.0	12.4	12.9
12H	8H	2.2	2.6	2.7	3.1	3.6	11.4	11.8	11.9	12.3	12.8

UGR table (CIE)											
UGR based on 3600 lm						Spacing: 0.25 H					
Useful plane		70/50/20	70/30/20	50/50/10	50/30/10	30/30/10	70/50/20	70/30/20	50/50/10	50/30/10	30/30/10
Walls											
Ceiling											
X	Y	Transverse direction of view					Parallel direction of view				
2H	2H	15.9	16.9	17.7	18.9	19.1	17.3	18.3	19.1	20.3	20.5
2H	3H	15.8	16.7	17.7	18.8	19.0	17.1	18.0	19.1	20.1	20.4
2H	4H	15.7	16.5	17.7	18.7	19.0	17.1	17.9	19.1	20.1	20.3
2H	6H	15.6	16.4	17.7	18.6	18.9	17.0	17.8	19.1	20.0	20.3
2H	8H	15.6	16.3	17.7	18.6	18.9	16.9	17.7	19.1	20.0	20.3
2H	12H	15.5	16.2	17.7	18.6	18.9	16.9	17.6	19.1	19.9	20.2
4H	2H	15.8	16.7	17.8	18.8	19.1	17.1	17.9	19.1	20.1	20.4
4H	3H	15.7	16.4	17.9	18.7	19.0	16.9	17.6	19.1	20.0	20.3
4H	4H	15.6	16.2	17.9	18.6	19.0	16.9	17.5	19.2	19.9	20.2
4H	6H	15.5	16.1	17.9	18.6	18.9	16.8	17.3	19.2	19.9	20.2
4H	8H	15.5	16.0	17.9	18.5	18.9	16.7	17.3	19.2	19.8	20.2
4H	12H	15.4	15.9	17.9	18.5	18.9	16.7	17.2	19.2	19.8	20.2
8H	4H	15.5	16.0	17.9	18.5	18.9	16.7	17.2	19.2	19.8	20.2
8H	6H	15.4	15.8	18.0	18.5	18.9	16.7	17.1	19.2	19.8	20.2
8H	8H	15.3	15.7	18.0	18.5	18.9	16.6	17.0	19.3	19.7	20.2
8H	12H	15.3	15.6	18.0	18.4	18.9	16.6	16.9	19.3	19.7	20.1
12H	4H	15.4	15.9	17.9	18.5	18.9	16.7	17.2	19.2	19.8	20.2
12H	6H	15.3	15.7	18.0	18.5	18.9	16.6	17.0	19.3	19.7	20.2
12H	8H	15.3	15.6	18.0	18.4	18.9	16.6	16.9	19.3	19.7	20.1

Illuminance – Mean Cylindrical Illuminance

- A new illuminance measure to help light for good communication
- New guidance on the maintained mean cylindrical illuminance requirements to ensure good visual communication.



- A new illuminance measure to help light for good communication
- New guidance on the maintained mean cylindrical illuminance requirements to ensure good visual communication.



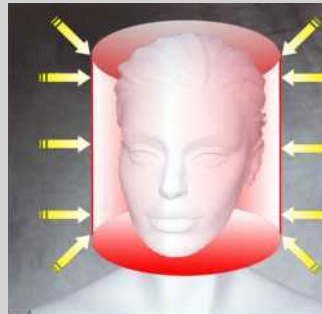
Recommended $\bar{E}_z \geq 50 \text{ lx}$ with $U_o \geq 0.1$ on a horizontal plane

1.2m above the floor, seated people,
1.6m above the floor, standing people.

Where good visual communication is important, for example some office spaces, meeting and teaching areas, the recommended level of \bar{E}_z is $\geq 150 \text{ lx}$ with $U_o \geq 0.10$.



- A new section has been added giving guidance on the modelling within a space to reveal form and texture with respect to structural features, people and objects within the space.
- This section defines the concept of modelling index, which is the ratio of cylindrical to horizontal illuminance at a point.



Tight cut off luminaires or directional lighting

- Strong directional lighting will lead to strong modelling, shadows, high contrast which in turn will inhibit performance, and communication.
- Used correctly it will create visual interest and lightness.



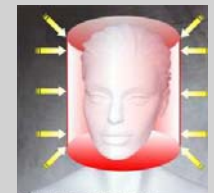
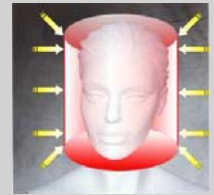
Directional light and possible problems

Tight cut off luminaires or directional lighting

- Strong directional lighting will lead to strong modelling, shadows, high contrast which in turn will inhibit performance, and communication.
- Used correctly it will create visual interest and lightness.



- **Mean cylindrical illuminance (E_c) requirements in the activity space**
 $E_c = 50 \text{ lx}$ Uo 0.10 (in offices, teaching areas 150 lx) at 1.2m above floor
- **Modelling**
 E_c/E_h of $0.30 - 0.60$ at 1.2m above floor is an indicator of good modelling
- **Directional lighting of visual task**
Lighting from specific direction can reveal more details in the visual task, increase the task visibility and form, and create helpful shadows



EN12464-1:2011

Lighting the interior space – Modelling Index



0.1



0.3



0.6



1.0

EN12464-1:2011

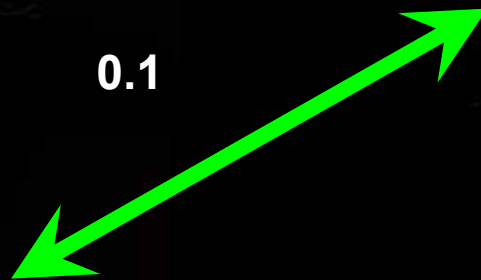
Lighting the interior space – Modelling Index



0.1



0.3



0.6



1.0

EN12464-1:2011

Category system

In LG3 : 1989

- **Category 1 luminaire : Average luminance ≤ 200 cd/m² above 55°**
- **Category 2 luminaire : Average luminance ≤ 200 cd/m² above 65°**
- **Category 3 luminaire : Average luminance ≤ 200 cd/m² above 75°**

- **LG3 : 1989 had 32 pages**
- **The category system was discussed in pages 11-12**

- **Generally people ignored the rest of the document!**

EN12464-1:2011

Category system

In LG3 : 1989

- **Category 1 luminaire : Average luminance ≤ 200 cd/m² above 55°**
- **Category 2 luminaire : Average luminance ≤ 200 cd/m² above 65°**
- **Category 3 luminaire : Average luminance ≤ 200 cd/m² above 75°**

- **LG3 : 1989 had 32 pages**
- **The category system was discussed in pages 11-12**

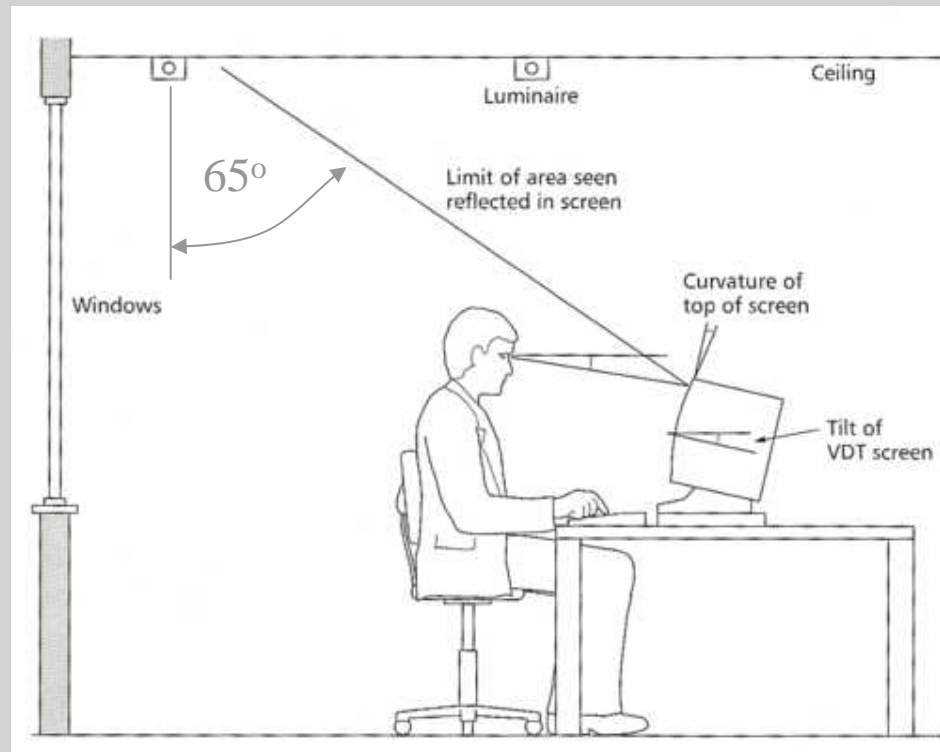
- **Generally people ignored the rest of the document!**



EN12464-1:2011

Category system

- The category rating system was withdrawn a number of years ago, though we do talk of luminance limits still at 65° .



EN12464-1:2011 Luminance problems or myth?

- Why limit the brightness of light sources?



Luminaire reflection



Window reflection



No reflection



Three screen types and appropriate luminance limits:

Screen type	Maximum Luminance (cd/m ²) where some Negative polarity software used
Type I and II Good or moderate screen treatment	1000 cd/m ²
Type III No screen treatment	200 cd/m ²

Negative polarity



Positive polarity



Where positive polarity software **only** is being used on Type I and II screens the luminance limit can be increased to 1500 cd/m² .

Where positive polarity software **only** is being used on Type III screens the luminance limit can be increased to 500 cd/m²

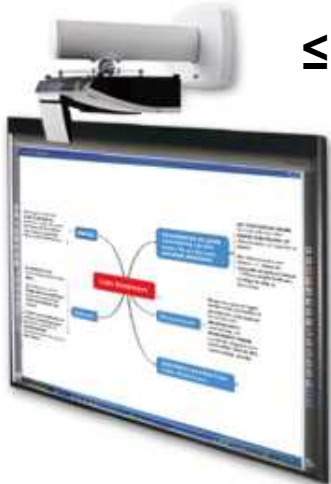
EN12464-1:2011 Lighting Display Screen Equipment – Limiting Luminance

ISO2419 and EN12464 recognise screen technology has moved on



$\leq 6\text{kcd/m}^2$

$\leq 200\text{cd/m}^2$



Negative polarity



Positive polarity



Based on ISO 9241-307 luminance limits for luminaires likely to be reflected in display screen equipment tilted by up to 15°

Screen high state Luminance of Flat screen	High > 200 cd/m ²	Medium < 200 cd/m ²
Case A	≤ 3000 cd/m ²	≤ 1500 cd/m ²
Case B	≤ 1500 cd/m ²	≤ 1000 cd/m ²

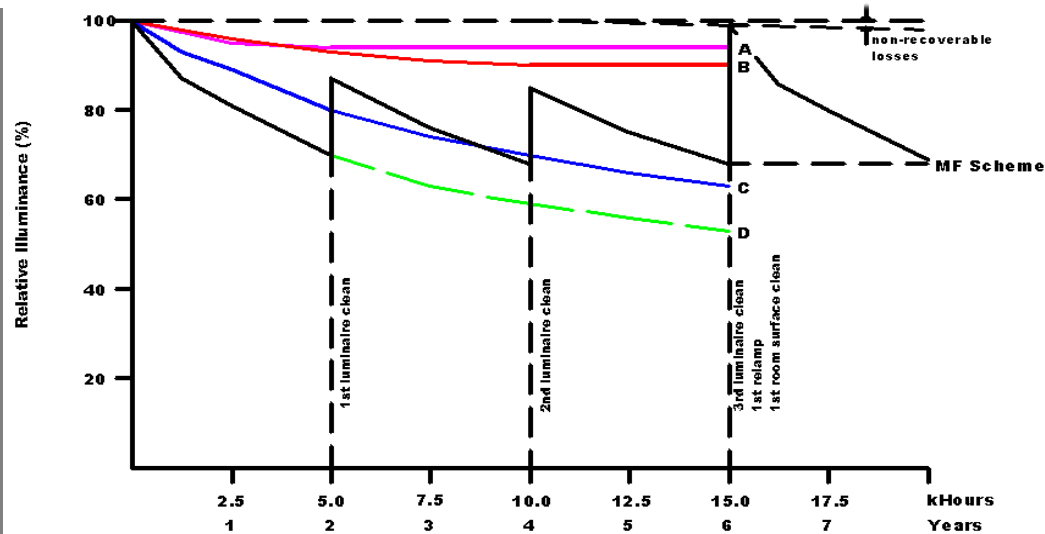
Case A: positive polarity and normal requirements concerning colour and details of the shown information (like those used in office, education etc)

Case B: negative polarity and/or higher requirements concerning colour and details of the shown information (like those used for CAD, colour inspection, etc)

EN12464-1:2011

Maintenance factor

- The lighting scheme should be designed with an overall maintenance factor (MF) calculated for the selected lighting equipment, environment and specified maintenance schedule.
- The MF has a great impact on energy efficiency. The assumptions made in the derivation of the MF shall be optimized in a way that leads to a high value. Guidance on the derivation of MF for artificial lighting systems can be found in CIE 97-2005.



EN12464-1:2011

Maintenance factor

$$MF = LLMF * LSF * LMF * RSMF$$

$$MF = 0.91 * 0.95 * 0.80 * 0.94$$

$$MF = 0.65$$

This means to ensure that the installation never falls below the maintained light level (assuming the maintenance schedule is adhered to) we must **OVERLIGHT** the area to 154% of the design level. So for example

Maintained light level = 500lx

Initial light level = 769lx

Office (lit with T5 lamps)

Operating hours 2500 hours/year

Clean surfaces every 5 years

Clean luminaires every 2 years

Bulk change lamps every 4 years

EN12464-1:2011

Energy efficiency requirements

- **LENI is the total annual energy used for lighting per square meter (kWh/(m² year))**
- **It is composed of 3 main parts**
 - Energy required to fulfill the illumination function (W_L)
 - Parasitic energy of emergency lighting and lighting controls in standby (W_P)
 - Total useful floor area (A)

BRITISH STANDARD

BS EN
15193:2007

Energy performance of buildings — Energy requirements for lighting

The European Standard EN 15193:2007 has the status of a
British Standard

BSI 15193:2007

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BSI
British Standards

EN12464-1:2011

Energy efficiency requirements

- Energy required to fulfill the illumination function (W_L)

Daylight usage adjusted for daylight supply and occupancy

Installed power adjusted for constant illuminance control

Non-daylight usage adjusted for occupancy

$$\sum \frac{\{(P_n \times F_c) \times [(t_D \times F_o \times F_D) + (t_N \times F_o)]\}}{1000}$$



EN12464-1:2011

Energy efficiency requirements

- Parasitic energy of emergency lighting and lighting controls in standby (W_P)

Annual hours lights are turned off

Installed parasitic power
Emergency lighting charging power

$$\sum \frac{\{P_{pc} \times [t_y - (t_D + t_N)]\} + (P_{em} \times t_e)}{1000}$$



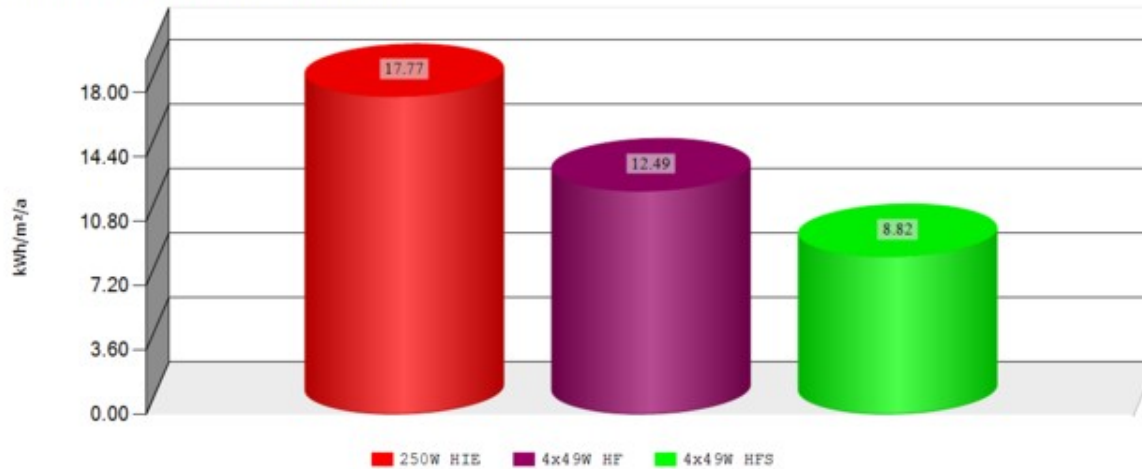
EN12464-1:2011

Energy efficiency requirements

- LENI

$$\frac{W_L + W_P}{A}$$

Average energy consumption per m² and year (LENI)



The values are valid for normal visual conditions and take into account the following factors:

- **psycho-physiological aspects such as visual comfort and well-being;**
- **requirements for visual tasks;**
- **visual ergonomics;**
- **practical experience;**
- **contribution to functional safety;**
- **economy**

The required maintained illuminance should be increased when:

- **visual work is critical;**
- **errors are costly to rectify;**
- **accuracy, higher productivity or increased concentration is of great importance;**
- **task details are of unusually small size or low contrast;**
- **the task is undertaken for an unusually long time;**
- **the visual capacity of the worker is below normal.**

The required maintained illuminance may be decreased when:

- **task details are of an unusually large size or high contrast;**
- **the task is undertaken for an unusually short time.**

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Schedule of lighting requirements

Table 5.24 — Industrial activities and crafts – Vehicle construction and repair

Ref. no.	Type of area, task or activity	E_m lx	UGR_L –	U_0 –	R_a –	Specific requirements
5.24.1	Body work and assembly	500	22	0,60	80	
5.24.2	Painting, spraying chamber, polishing chamber	750	22	0,70	80	
5.24.3	Painting: touch-up, inspection	1 000	19	0,70	90	$4\ 000\ K \leq T_{CP} \leq 6\ 500\ K$
5.24.4	Upholstery manufacture (manned)	1 000	19	0,70	80	
5.24.5	Final inspection	1 000	19	0,70	80	
5.24.6	General vehicle services, repair and testing	300	22	0,60	80	Consider local lighting.

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Schedule of lighting requirements

Table 5.20 — Industrial activities and crafts – Power stations

Ref. no.	Type of area, task or activity	E_m lx	UGR_L –	U_0 –	R_a –	Specific requirements
5.20.1	Fuel supply plant	50	-	0,40	20	Safety colours shall be recognisable.
5.20.2	Boiler house	100	28	0,40	40	
5.20.3	Machine halls	200	25	0,40	80	
5.20.4	Side rooms, e.g. pump rooms, condenser rooms, etc.; switchboards (inside buildings)	200	25	0,40	60	
5.20.5	Control rooms	500	16	0,70	80	<ol style="list-style-type: none"> 1. Control panels are often vertical. 2. Dimming may be required. 3. DSE-work, see 4.9.

6.2 Illuminances

When verifying conformity to the illuminance requirements the measurement points shall coincide with any design points or grids used. Verification shall be made to the criteria of the relevant surfaces.

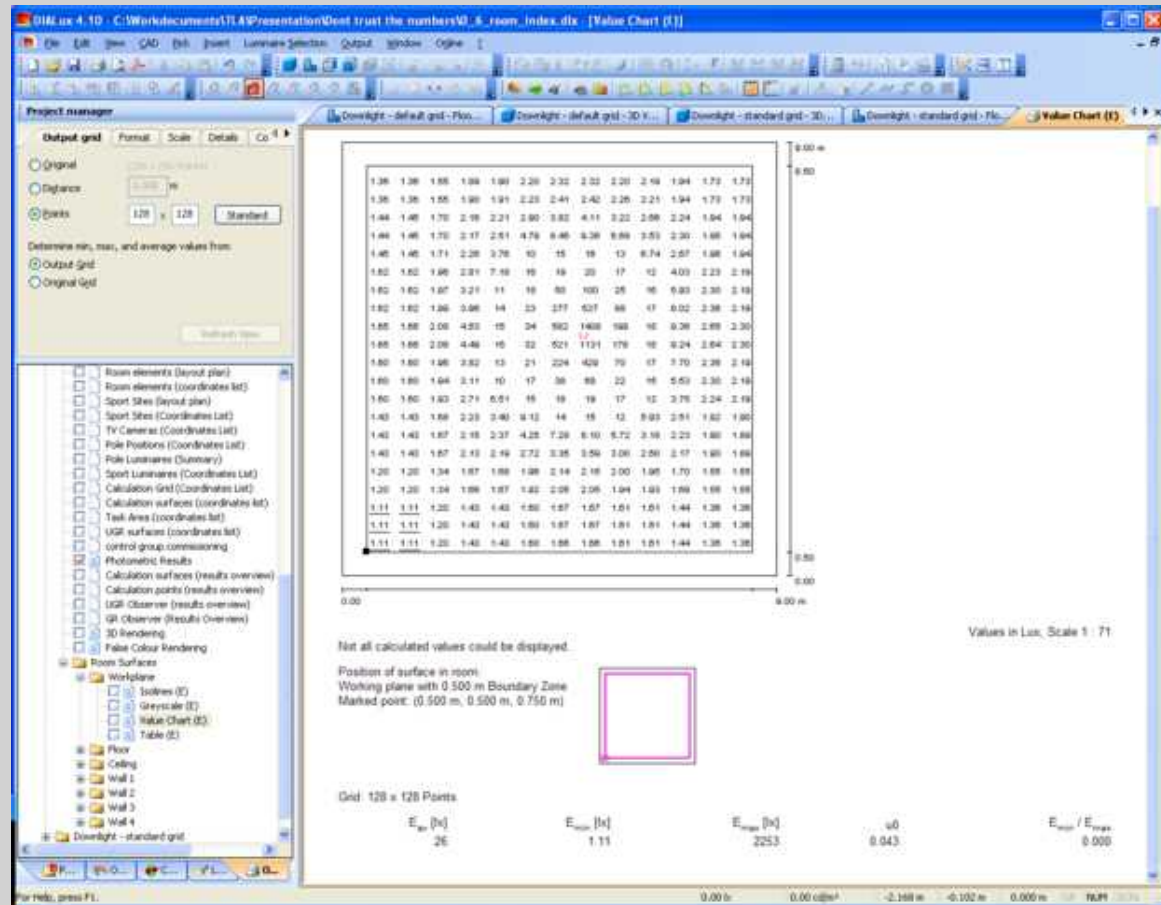
6.3 Unified Glare Rating

Authenticated UGR data produced by the tabular method shall be provided for the luminaire scheme by the manufacturer of the luminaire. The spacing shall be declared for the UGR-tables provided.

EN12464-1:2011 Illuminance – Calculation Grids

▪ I place a spotlight in a room and calculate...

- E_{av} 26 lx
- E_{min} 1.11lx
- E_{max} 2253lx



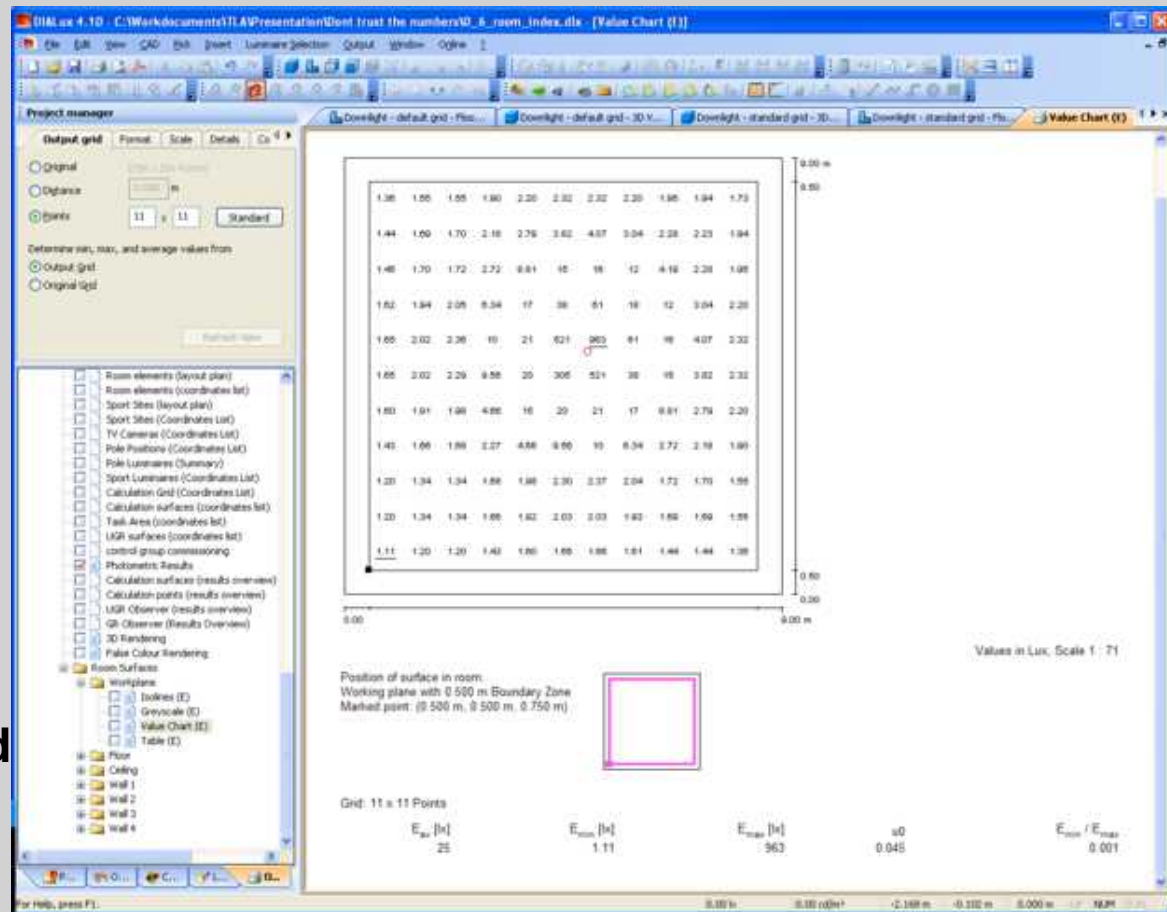
EN12464-1:2011 Verification

▪ I modify it to use the standard grid and calculate...

- E_{av} 25 lx
- E_{min} 1.11lx
- E_{max} 963lx

So E_{max} has changed by 234%!

However EN 12464-1 verification procedures may mean you have to measure EVERY calculated point (121 points vs. 16384 points)



THORN

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**Light and lighting – Lighting of workplaces
Part 1: Indoor work places**

