ReNormAction!

IBE-BIV seminar 10 November 2022

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Maintenance factor L and B values misuse and use

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Maintenance factor L and B values misuse and use

Why a Maintenance Factor?

How to cope with it?

What's the Problem?

Too many factors/too much data:

LxBy

By

Mx

AFV

CFV

Lx

MxFy

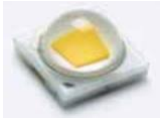
How do I use them?
Why do I need them?
What is best? L80B50 or L70B10

Why a Maintenance Factor (MF)

The lightlevel of “installed artificial light” will decrease in time of use
Therefor to guarantee the ‘maintained lightlevel (EN12464-1) a reserve is needed

This reserve depends on

- LLMF: Lamp Lumen Maintenance Factor
- LSF: Lamp Survival Factor
- LMF: Luminaire Maintenance Factor
- RMF: Room Maintenance Factor



MF = LLMF x LSF x LMF x RMF

How to calculate a Maintenance Factor (MF)

- LLMF = lowest values per product range
- LSF = 1 (we take in account spot replacement see Cx for lifetime drivers)
- LMF = 0,95 for clean offices, 0,89 for normal industrial environments
- RMF = 0,94 for clean offices (reflection factor 70/50/20) of 0,95 for normal industrial environments (50/30/20), subject to 3-yearly cleaning (in accordance to CIE97)

Example LLMF 97%

MF: 97 x 1 x 0,95 x 0,94 = 0,87

Why a Maintenance Factor

The ‘reserve’ determines also the energy consumption

Evolution in offices NBN EN 124646-1:2021 500lux →1000lux :

Reserve on 500 lux is half the reserve on 1000lux

MF = 0,87 → 500 lux gives a new value of 500/0,87 = 575 lux or 75 lux reserve

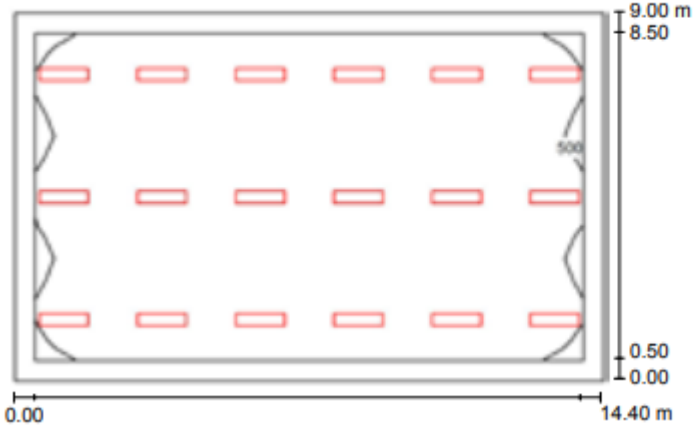
→ 1000 lux gives a new value of 1000/0,87 = 1150 lux or 150 lux reserve

The higher the MF the lower the reserve is……

…Energy costs… we ALL are aware…

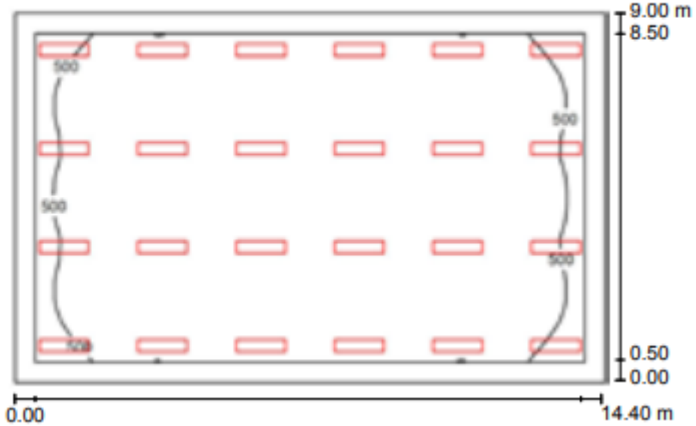
Impact on your installation

LLMF 97% after 50,000 h (maintenance factor 87%)



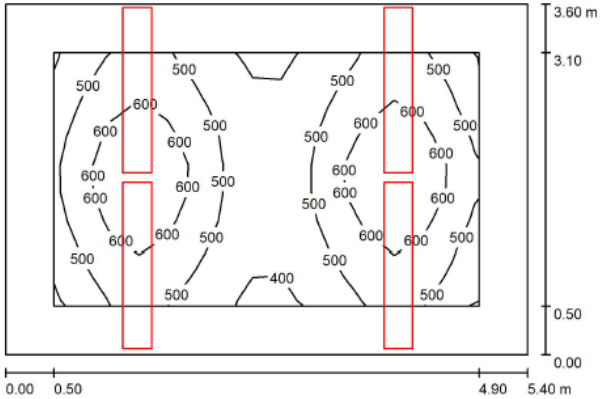
18 luminaires
0,86W/m²/100lx

LLMF 70% after 50,000 h (maintenance factor 63%)



24 luminaires
1,25W/m²/100lx

Depreciation factor in lighting studies



Hoogte van de ruimte: 2.600 m, Montagehoogte: 2.600 m, Behoudfactor: 0.87 Waarden in Lux, Schaal 1:47

Vlak	ρ [%]	E_{gem} [lx]	E_s [lx]	E_{max} [lx]	E_s / E_{gem}
Werkvlak	/	531	370	695	0.696
Vloer	20	389	222	541	0.571
Plafond	70	70	48	85	0.691
Muren (4)	50	145	52	363	/

Werkvlak:
Hoogte: 0.800 m
Raster: 15 x 9 Punten
Randzone: 0.500 m

Armaturen stuklijst

Nr.	Stuk	Type (Correctiefactor)	Φ (Armatuur) [lm]	Φ (Lampen) [lm]	P [W]
1	2	ETAP U711R1/LEDN1228D-Z1 (1.000)	2849	2849	24.4
2	2	ETAP U711R1/LEDN1228D-Z2 (1.000)	2849	2849	24.4
			Totaal: 11396	Totaal: 11396	97.6

MF ≠ LLMF

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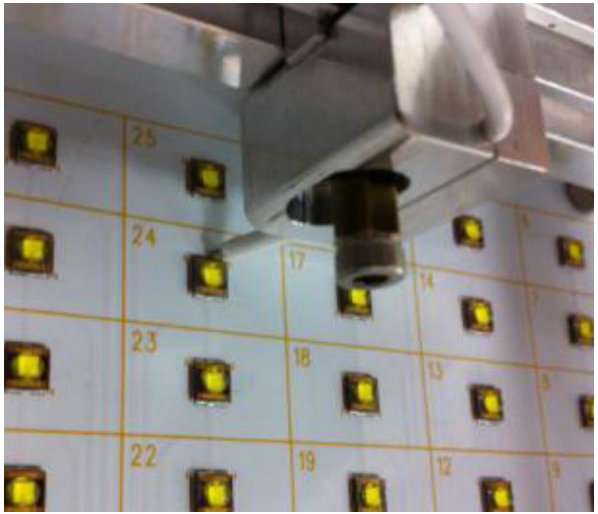
How do we calculate a Maintenance Factor

LED – LM-80-08



Projection: TM-21-11

Lamp/Luminaire – LM-84-14

Projection: TM-28-14

Luminaire LLMF is also about…

Ageing of internal components

Degradation of internal reflection:

- Yellowing of laquer and pcb coatings, plastic mixing cavities…
- Dust accumulation

Ageing of secondary optics

Optical Transmission Reduction:

- Yellowing of optical plastics triggered by UV, 455nm…
- Acceleration at evelvated temperatures (e.g. 60°C)- industrial, HB, downlights…

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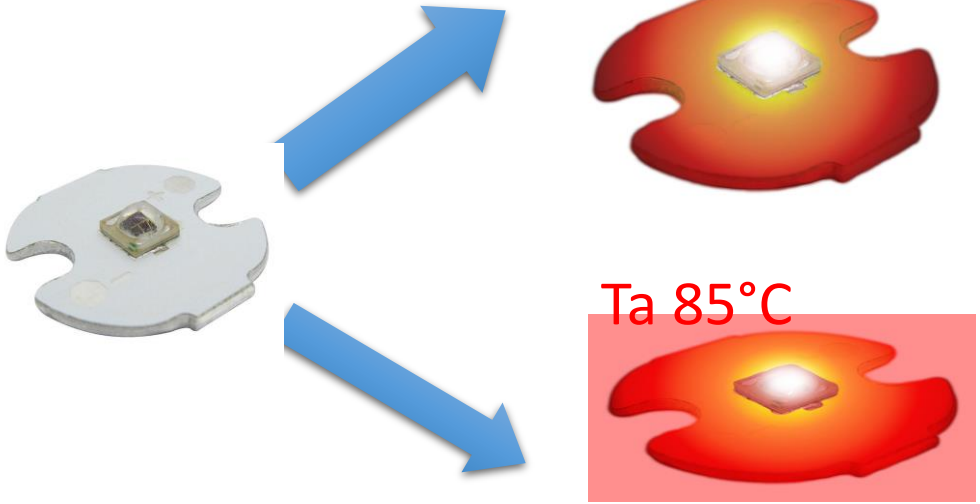
Limitations of LM-80: Test Conditions



LM-80:

- Heatsink with Ts-control
- Standard environment (25°C)

IEC62717:

- Environment integral @ Ts
- Higher stress compared to LM-80
- Closer to real life condition

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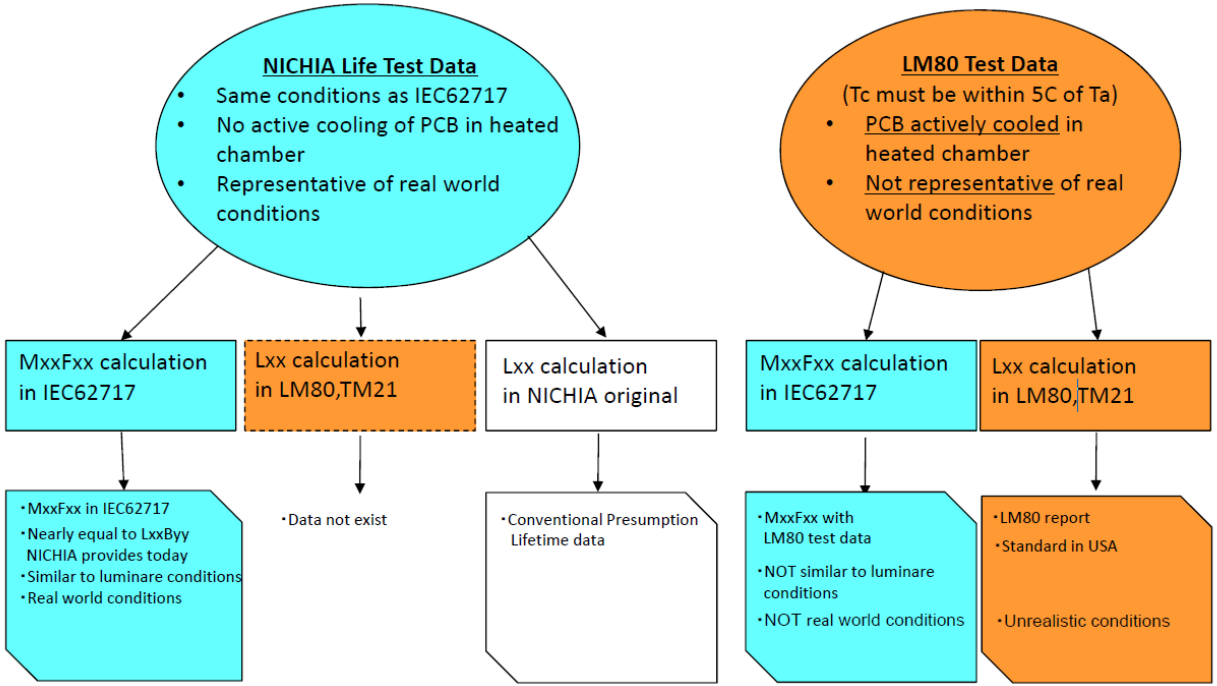
■Methodologies for Presumption of Life Calculations



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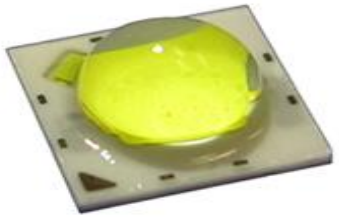
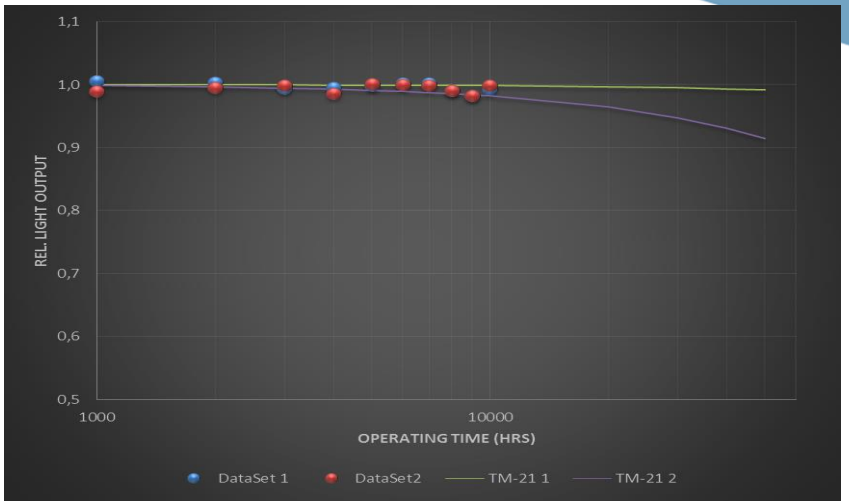
Limitations LM-80: Test Period



- Limited output reduction @ 10khrs
- Sample variations ~ measurement noise
- Big impact on TM-21



- ❖ Data Set 1 LLMF(50khrs) > 99%
- ❖ Data Set 2 LLMF(50khrs) = 93%
- ❖ Identical LED!

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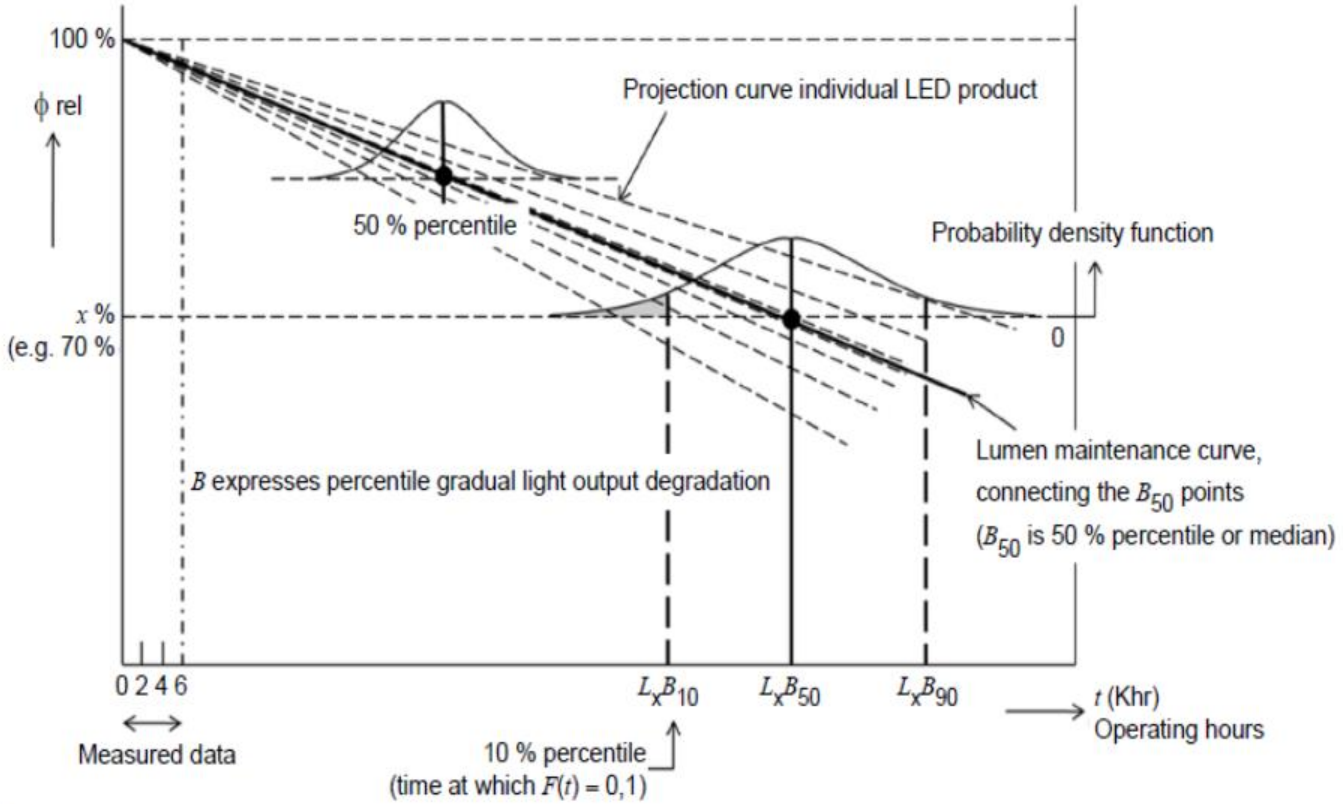
L80B50 or L70B10?

Bxx = Expected failure rate of maximal xx % within poulation
= Life expectancy of minimal 100-xx % within population
= Life expectancy with reliability of 100-xx %

LM80 = B50

B10-methodology for LED’s does not exist

B50/B10


100 %
ϕ rel
x %
(e.g. 70 %
Projection curve individual LED product
50 % percentile
Probability density function
0
Lumen maintenance curve,
connecting the B_{50} points
(B_{50} is 50 % percentile or median)
B expresses percentile gradual light output degradation
0 2 4 6
L_xB_{10}
L_xB_{50}
L_xB_{90}
t (Khr)
Operating hours
Measured data
10 % percentile
(time at which $F(t) = 0,1$)

B50 /B10

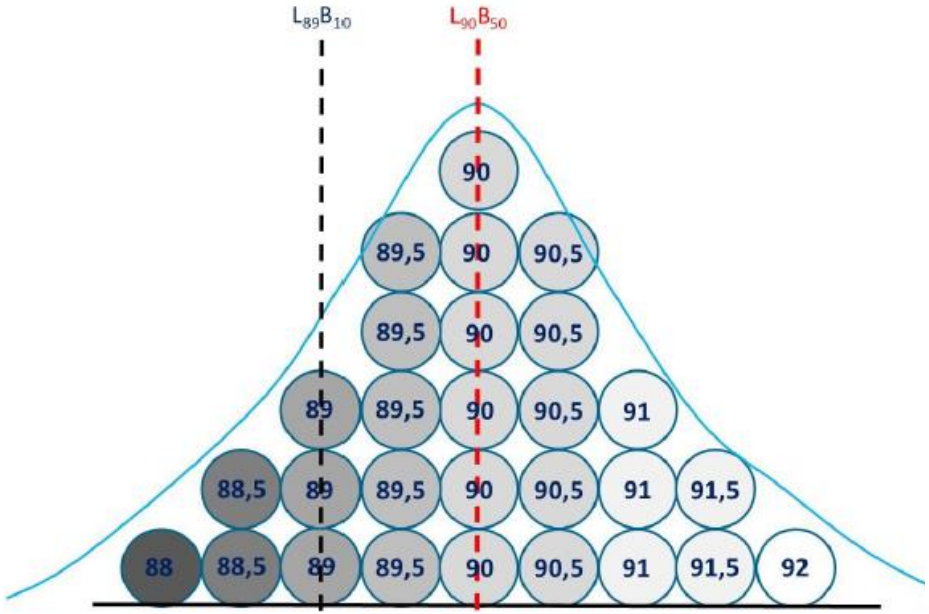


Fig 3 – *Typical normal distribution for a L_{90} rated product*

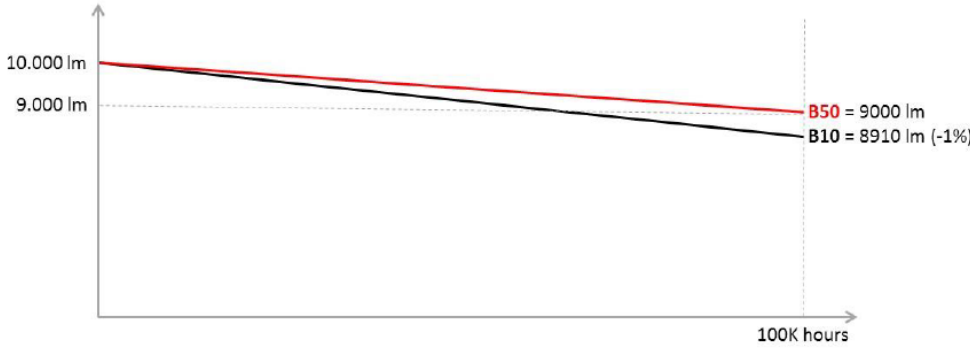


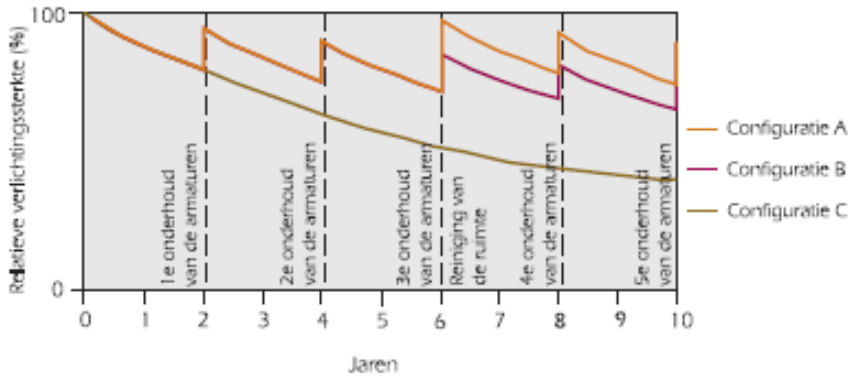
Fig 4 – *Product data analysis of an example of a LED based luminaire*

B50/B10 conclusion

Statistically the median (B_{50}) value represents with a sufficient degree of accuracy the lumen deprecation behavior of a population of LED based luminaires at the projected lifetime. Therefore, LightingEurope recommends promoting and expressing Median Useful Life as L_x without B_{50} notification.

Documents :

BIV Code van goede praktijk - Code de bonne pratique(2007 no LED…)



Figuur 18 : Vermindering van de verlichtingssterkte in de tijd

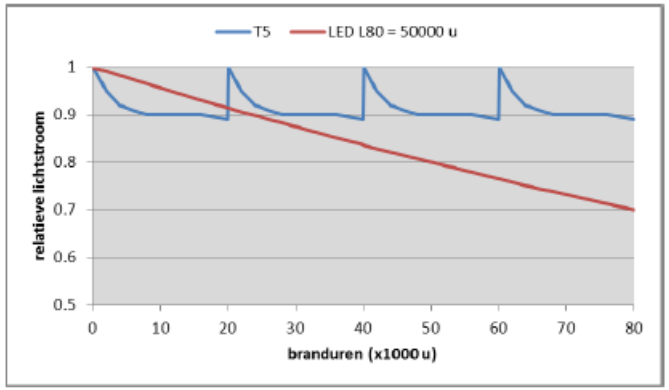
MF	Vervuilingsgraad			
	Minimaal	Laag	Gemiddeld	Hoog
Open armaturen voor een rechtstreekse verlichting (downlights)				
T5 of T8 – reeks 800				
Vervanging van de groep	0,85	0,80	0,75	0,70
Vervanging van de defecte lampen + vervanging van de groep	0,90	0,85	0,80	0,70
Correctiefactor voor				
Armaturen met afdekplaat voor een rechtstreekse verlichting	MF x 0,95			
Armaturen met beschilderde reflector	MF × 0,90			
Armaturen voor een onrechtstreekse verlichting (up-light)				
T5 ou T8 – série 800				
Vervanging van de groep	0,85	0,70	0,65	0,65
Vervanging van de defecte lampen + vervanging van de groep	0,90	0,75	0,70	0,65
Armaturen met afdekplaat	MF × 0,95		MF × 0,90	
Correctiefactor voor armaturen met beschilderde reflector	MF × 0,90			
Pendelarmaturen met rechtstreekse en onrechtstreekse verlichting (up-light en downlight)				
T5 of T8 – reeks 800				
Vervanging van de groep	0,85	0,75	0,70	0,65
Vervanging van de defecte lampen + vervanging van de groep	0,90	0,80	0,75	0,70
Armaturen met afdekplaat	MF × 0,95			
Correctiefactor voor armaturen met beschilderde reflector	MF × 0,90			

Tabel 1: Standaardwaarden van de onderhoudsfactor

Documents :

Groen Licht Vlaanderen MF en levensduur (2017)

De LLMF voor led verlichtingstoestellen is niet constant en wordt lager als een grotere gebruiksduur gekozen wordt.



Maintenance factor Vermogen voor 3000 behouden lumen	1 shift 5 dag/week 10 jaar	1 shift 5 dag/week 15 jaar	2 shift 6 dag/week 15 jaar	Continu 12 jaar
	25.800 u	38.700 u	74.400 u	105.120 u
armatuur T5 85 lm/W	0,80 43,9 W	0,80 43,9 W	0,80 43,9 W	0,80 43,9 W
led 100 lm/W L_{80} = 50.000u	0,80 37,7 W	0,75 39,9 W	0,64 46,8 W	0,56 53,7 W
led 100 lm/W $L_{80}B_{10}$ = 50.000u	0,82 36,5 W	0,79 38,1 W	0,70 42,8 W	0,63 47,3 W
led 125 lm/W L_{80} = 50.000u	0,80 30,2 W	0,75 31,9 W	0,64 37,5 W	0,56 43,0 W
led 110 lm/W L_{97} = 50.000u	0,88 31,0 W	0,87 31,3 W	0,85 32,0 W	0,84 32,6 W

Tabel 1 Bovenstaande tabel geeft de maintenance factor en het geïnstalleerd vermogen per 3000 behouden lumen voor enkele varianten in initieel rendement en lichtstroombehoud en dit voor enkele gebruiksduren. De waarde bovenaan is de *maintenance factor* MF = LLMF x RSMF (0,94) x LMF (0,95). De waarde onderaan is het vermogen voor 3000 behouden lumen.

Documents :

Lighting Europe Evaluating performance of LED based Luminaires (2018)

Indoor applications	Default annual operating hours (EN15193)	Average time to refurbishment	Average installation life
	t_o	years	hours
Offices	2500	20	50.000
Education	2000	25	50.000
Hospitals	5000	10	50.000
Hotels	5000	10	50.000
Restaurants	2500	10	25.000
Sports	4000	25	100.000
Retail	5000	10	50.000
Manufacturing	4000	25	100.000

Table 2 – Possible examples of *average installation life for different indoor applications*

Outdoor applications	Default annual operating hours (EN13201-5)	Average time to refurbishment	Average installation life
	t_o	years	hours
Street	4000	25	100.000
Tunnel (entrance)	4000	25	100.000
Tunnel (interior)	8760	12	100.000
Sport (recreational)	1250	20	25.000
Area	4000	25	100.000

Table 3 - *Possible examples of average installation life for different outdoor applications*

Documents :

ISO CIE TS 22012 (2019)

C.1 Indoor luminaires

Table C.1 — Recommended inspection intervals of lighting systems in different working environments (from CIE 097:2005, Table 2.1)

Inspection interval	Environment	Activity or task area
3 years	Very Clean (VC)	Clean rooms, semiconductor plants, hospital clinical areas[a], computer centres
	Clean (C)	Offices, schools, hospital wards
2 years	Normal (N)	Shops, laboratories, restaurants, warehouses, assembly areas, workshops
1 year	Dirty (D)	Steelworks, chemical works, foundries, welding, polishing, woodwork

[a] For reason of hygiene control, more frequent inspection may be required.

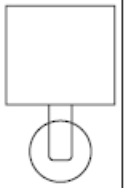
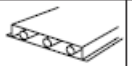
C.2 Outdoor luminaires

Table C.5 — Example of outdoor luminaire maintenance factors f_{LM} (CIE 154:2003, Table 3.3)

Optical compartment IP Rating	Pollution Category	Exposure time[a] (years)				
		1,0	1,5	2,0	2,5	3,0
IP2X	High	0,53	0,48	0,45	0,43	0,42
	Medium	0,62	0,58	0,56	0,54	0,53
	Low	0,82	0,80	0,79	0,78	0,78
IP5X	High	0,89	0,87	0,84	0,80	0,76
	Medium	0,90	0,88	0,86	0,84	0,82
	Low	0,92	0,91	0,90	0,89	0,88
IP6X	High	0,91	0,90	0,88	0,85	0,83
	Medium	0,92	0,91	0,89	0,88	0,87
	Low	0,93	0,92	0,91	0,90	0,90

[a] Equivalent to cleaning interval as used in this document.

Table C.2 — Approximate cleaning intervals (marked X) for luminaires used in various environments (VC, C, N or D, see Table C.1) (from CIE 097:2005, Table 2.2, modified — symbols adjusted)

Luminaire type	Cleaning intervals								
	3 years			2 years			1 year		
	VC C	N	D	VC C	N	D	VC C	N	D
A, Bare batten 	X				X				X
B, Open top housing (natural ventilated) 	X				X				X
C, Closed top housing (unventilated) 	X			(X)				X	
D, Enclosed IP2X 	X			(X)				X	
E, Dust proof IP5X 	X	X				X			
F, Enclosed indirect (uplight) 				X			(X)	X	
G, Air handling, forced ventilated 	X	X				X			

Conclusions

- LM-80 results cannot be projected directly to luminaire lifetime
- LM-84 as alternative too expensive/time consuming
- B10-methodology for led luminaires does not exist!
- B50 from LM-80 most simple/correct – but no warranty neither!
- Best practice proposal: publication of single B-lifetime with omission of any percentile (reminder - just an estimate, not exact science)

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L and B values

Questions?