FAGERHULT

Declaring the life time of LED-luminaires

International standards on how life time of LED-luminaires should be declared have now been published. The standards are:

IEC 62717	LED-modules for general lighting – Performance requirements
IEC 62722-2-1	Particular requirements for LED luminaires

What's new?

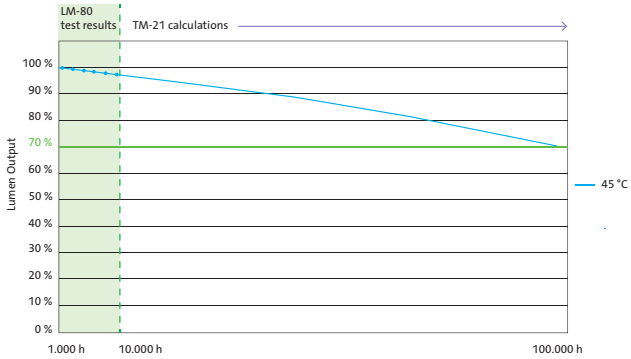
The life time for the LED-module should be declared separately to the driver. This means that there cannot be a single figure declaring the total luminaire life time. The values for the module and driver need to be combined. If the life time for the driver is shorter than that of the module, a driver replacement may be included when the LCC is done.

Life time for LED-modules

Luminaires are declared as L_{70}, L_{80} or L_{90}. L-values are combined with a calculated time. The L-value indicates how many lumens (in percentage related to the initial lumens) there are at the declared time. The L-value is combined with B- and C-values.

Example: A calculated value of L_{80} 70.000 h means that after 70.000 h the lumen output from the luminaire is 80 % of the initial lumen output.

L-values are calculated by using the TM-21 system where data from the LED supplier is used. The data from the LED supplier is called LM80 data. The TM-21 system originates in the U.S. and is globally accepted. The LED suppliers test their LEDs over a minimum of 6.000 h and measure the lumen drop every 1.000 h. These values are put into the TM-21 system and the expected life time can be extrapolated. Note: Fagerhult will not officially publish a time longer than 100.000 h. Since the L-value is based on extrapolated data from an actual test time of 6.000 hours is an expectation, we don't see presenting a longer time as relevant.



Data from the first 10.000 hours is used to extrapolate the expected time for i.e. L_{70}. The reached time is mainly depending on used LED and the temperature.

B-value

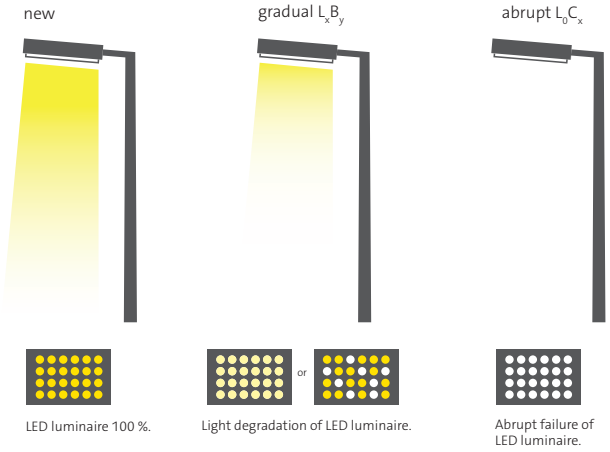
Together with the L-value a B-value is declared. The B-value, describes the failure fraction. It tells you the variation/uncertainty of the expected lumen level. The B-value is normally B_{50} and indicates that the declared L-value will be achieved by 50 % of the luminaires. It can be seen as an avarage value. If the B-value is B_{10} it tells you that 90 % of the luminaires will meet the declared L-value. A B_{10} value is

therefore better than B_{50} but it may not be available for all products.

Please note that completely failed LED-modules or failed single LEDs are not included in the B-value. The B-value has no influence on the light planning in DIALux.

C-value

The C-value describes the expected percentage of catastrophic fails during the life time for the LED-module. A catastrophic failure is when the LED-module does not produce any light. Failure of a single or several LEDs in a cluster is not included. These kinds of failures are included in the B-value. The C-value can e.g. be C_{10} or lower. C_{10} which means that after the given time 10 % of the LED-modules may have failed. The C-value for standard LED-modules is much lower (~1 %). Therefore, for most modules, the C-value can be ignored. It will not be published for indoor products as standard.



Explanation of the B- and C-value. Note that a failure of single LEDs on a multi LED-module is included in the B-value and not in the C-value.

F-value

Some manufacturers of LED-modules or LED-luminaires use the F-value instead of B- and C-value. The F-value is a sum of the B- and C-values (F=B+C) and, since the C-value normally can be neglected, it can be seen as the B-value.

Luminaires with CLO function

Luminaires with CLO, Constant Light Output, are equipped with a programmable driver. The driver will, during the expected life time, compensate for the calculated lumen drop. This is done in steps by increasing the current to the LED-module. The lumen output will be constant while the system wattage will increase. A CLO luminaire is declared as L_{100}. CLO function is mainly used for outdoor luminaires.

Driver life time

Like other electronics such as HF-ballasts, the expected life time of a driver depends on the design itself, used components and the temperature of these components. The drivers are marked with a reference temperature point, t_c, and this temperature should never be exceeded. It is up to the manufacturer of the driver to choose the position and the max value for the t_c-point. For some drivers the given or marked maximum t_c-temperature is a reference for the certification process of the luminaire while other manufacturers may mark with a value corresponding to the specified life time (i.e. 50.000 h/10 %). Maximum 10 % drop out during the declared life time is normal. Fagerhult only uses drivers from quality suppliers.

Life time declaration

Luminaires will be declared as per the following example:

Life time LED-module	$L_{90}B_{50}$ 100.000 h
Life time driver	50.000 h/10 %

This indicates that after 100.000 h the luminaires will on average produce 90 % of the initial lumens. Replacement of some drivers is inevitable after 50.000 h.

What L-value do I need?

As previously described the L-value is divided inTO three parts; the level (L_{70}, L_{80}, L_{90}), the accuracy (B_{50} or B_{10}) and the time in hours. The B-value itself has no influence on the light planning.

In applications with long burning hours, such as the healthcare sector or street lighting, time is most interesting. A calculated life time of 100.000 h would be most beneficial. The level and the accuracy are not so important. A $L_{70}B_{50}$ 100.000 h luminaire equipped with a driver with corresponding life time will work well.

In other applications with shorter burning hours the time is less important but what is more important is that the lumen value is consistent. In such areas $L_{90}B_{50}$ 50.000 h luminaires would be the best choice.

How does the L-value effect the DIALux calculation?

In the calculation you should choose the values to get the correct MF (=Maintenance factor). LLMF (i.e. L_{70}) is only one of the parameters when you define the total maintenance factor in the DIALux calculation.

MF includes the following parameters:

LLMF × LSF × LMF × RSMF

LLMF = Lamp Lumen Maintenance Factor

L_{70} = 0,7 L_{80} = 0,8 L_{90}= 0,9

LSF = Lamp Survival Factor

The LSF factor is in many cases negligible and spot replacement is recommended for abrupt failures, to ensure the appearance of the installation, and that light levels are always maintained.
The praxis is LSF = 1.

LMF = Luminaire Maintenance Factor

Depends on the design and type of luminaire, whether the environment is clean or "unclean" and the cleaning schedule. This value can differ between different countries and their standards or guidelines.

RSMF = Room Surface Maintenance Factor

Depends on the environment, if it's clean or "unclean" the reflectance factors and the cleaning intervals.

LMF and RSMF can differ between the standards and guides for different countries e.g. Ljusamallen in Sweden or DS 700 in Denmark.

If no specific LMF and RSMF values are defined for the project, the tables below can be used.

LMF is the depreciation of the luminaire depending on luminaire type, environment and the cleaning interval.

Number of years between group cleaning	**2 years**			**3 years**			**4 years**			**5 years**		
Luminaire type	Surroundings			Surroundings			Surroundings			Surroundings		
	clean	normal	dirty	clean	normal	dirty	clean	normal	dirty	clean	normal	dirty
Open luminaire – LMF	0.96	0.93	0.85	0.94	0.90	0.77	0.92	0.88	0.72	0.90	0.85	0.66
Closed luminaire – LMF	0.98	0.94	0.87	0.96	0.92	0.84	0.94	0.90	0.78	0.92	0.88	0.71
Indirect luminaire - LMF	0.91	0.80	0.68	0.84	0.75	0.54	0.77	0.70	0.40	0.71	0.60	0.29

The table is an adaption of CIE 97:2005 2nd Edition to normal conditions.
Open luminaire refers to both direct and direct/indicrect luminaires, while Indirect luminaire is 100 % indirect.

RSMF is the depreciation of the room surfaces depending on the luminaire type, environment and the cleaning interval. Normally the values are based on 3 years cleaning interval.

Number of years between group cleaning	**2 years**			**3 years**			**4 years**			**5 years**		
Luminaire type	Surroundings			Surroundings			Surroundings			Surroundings		
	clean	normal	dirty	clean	normal	dirty	clean	normal	dirty	clean	normal	dirty
Direct	0.97	0.96	0.95	0.97	0.96	0.95	0.97	0.96	0.95	0.97	0.96	0.95
Direct/indirect 50/50	0.95	0.93	0.90	0.95	0.93	0.90	0.95	0.93	0.90	0.95	0.93	0.90
Indirect	0.92	0.86	0.77	0.92	0.86	0.77	0.92	0.86	0.77	0.92	0.86	0.77

Reflectance ceiling/wall/floor – 70/50/20 clean and 50/30/20 normal and dirty.
Clean environment can normally be used for offices, schools, hospitals, hotel, clean general areas and communication areas.
Normal environment can be used for industry, storages, shops-supermarkets, sports halls, restaurants and technical areas.
Dirty environment can be used for industrial areas like foundries, iron and steel works, welding, sawmills and other areas with a lot of dust and particles in the air.

A high maintenance factor is important when you make the lighting dewsign for a project. If you were to base your scheme on a rating of L_{70} 50.000 h, you will have a substantial increase of the numbers of luminaires needed. In order to calculate with more relevant data, the tables below can be used with reasonable accuracy if not all the L values can be defined. 50.000 h can normally be used for a like-for-like comparison, but for a more detailed and specific operating hours the table below can be used.

LED life time			**Operating time 1.000 h**										
			1	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
L90	50.000 h	LLMF	1	0.98	0.96	0.94	0.92	0.90	0.88	0.86	0.84	0.82	0.80
		LSF	1	1	1	1	1	1	0.99	0.99	0.99	0.99	0.99
L90	100.000 h	LLMF	1	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90
		LSF	1	1	1	1	1	1	1	1	0.99	0.99	0.99
L80	50.000 h	LLMF	1	0.96	0.92	0.88	0.84	0.80	0.76	0.72	0.68	0.64	0.60
		LSF	1	1	1	1	1	1	0.99	0.99	0.99	0.99	0.98
L80	100.000 h	LLMF	1	0.98	0.96	0.94	0.92	0.90	0.88	0.86	0.84	0.82	0.80
		LSF	1	1	1	1	1	1	1	0.99	0.99	0.99	0.99
L70	50.000 h	LLMF	0.99	0.94	0.88	0.82	0.76	0.70	0.64	0.58	0.52	0.46	0.40
		LSF	1	1	1	1	1	0.99	0.99	0.99	0.99	0.98	0.98
L70	100.000 h	LLMF	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.70
		LSF	1	1	1	1	1	0.99	0.99	0.99	0.99	0.99	0.99

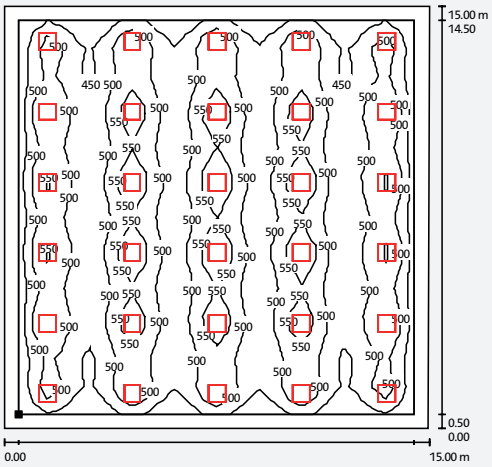
Calculation example, luminaires with different L-values

Luminaires with the same initial lumen output, installed in the same type of environment (room 15×15 m) with a requirement of 500 lux. The only difference between the examples is the L-value.

When using LED-luminaires with L_{90} instead of L_{70}, it is possible to reduce the number of luminaires required, reach the same light level at a lower cost while at the same time saving energy.

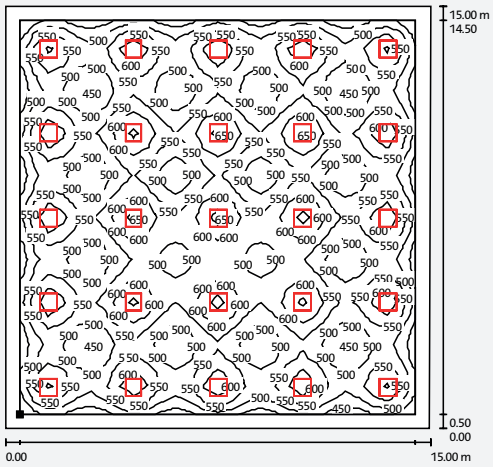
MF, standard L_{70} rated luminaire:
LLMF L_{70} = **0,7**
LSF = 1
LMF clean environment = 0,94
RSMF clean environment = 0,97
MF= **0,7**×1×0,94×0,97 => **0,64**

30 luminaires needed



MF, when using L_{90} rated luminaire:
LLMF L_{90} = **0,9**
LSF = 1
LMF clean environment = 0,94
RSMF clean environment = 0,97
MF= 0,9×1×0,94×0,97 => **0,82**

Only **25** luminaires are needed!



Maintenance factor outdoor

The maintenance factor MF includes the following parameters: LLMF×LSF×LMF

The Swedish Transport Administration recommends LMF 0,9 at mounting heights >4 meters with IP classification > IP 6X.

This can be considered as a general LMF value, except for areas with very high pollution, for example some industrial areas, where you may need to reduce LMF to 0,85.

Example for an outdoor luminaire with L_{90}:
LLMF L_{90} = 0,9
LSF = 1
LMF = 0,9
MF = 0,9×1×0,9 = 0,81 (0,8 could be seen as a general recommendation).

Example for an outdoor luminaire with CLO (constant light output):
LLMF CLO = 1
LSF = 1

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