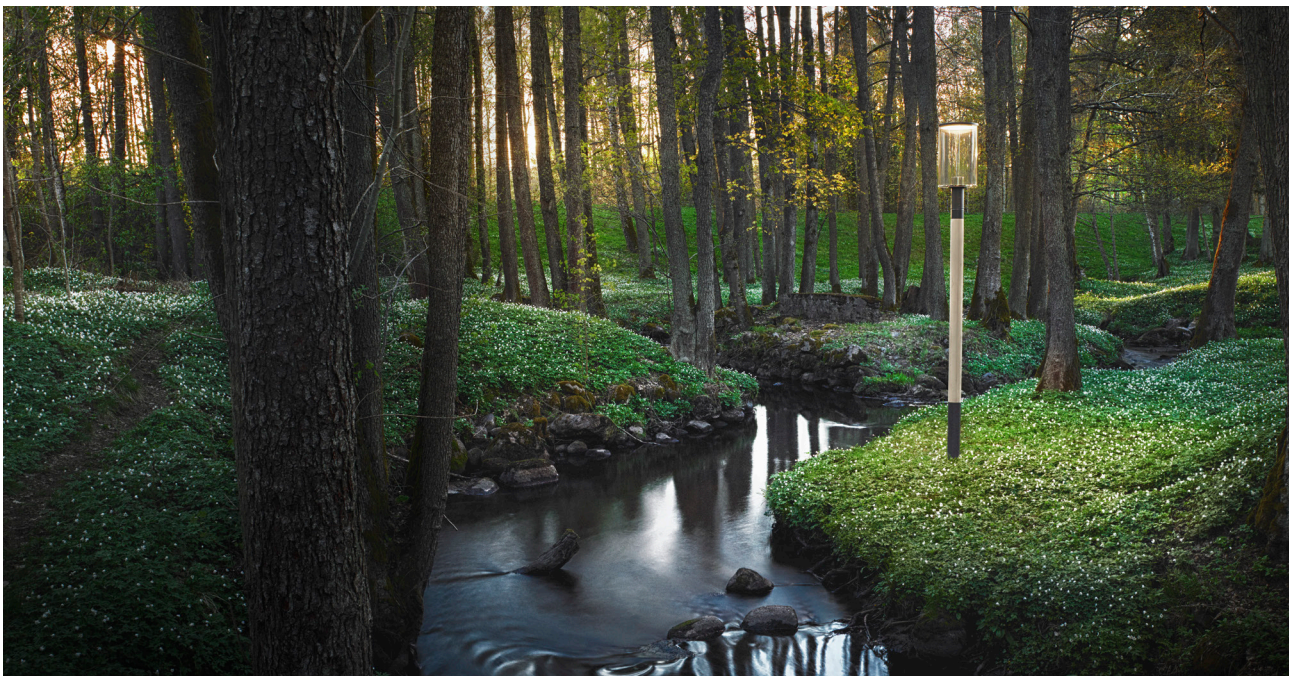


# Specifying LED luminaire lifetimes

Light depreciation and lifetime for LED luminaires have traditionally been presented as, for example, L80B50 75,000 h or L90B10 50,000 h. B-values and number of hours have varied between both products and luminaire manufacturers. This has made it difficult for customers to compare different LED luminaires. To facilitate comparison, Lighting Europe has published a document with recommendations, *Evaluating performance of LED based luminaires*. The lighting industry in Sweden has agreed to follow these recommendations. Other European countries are expected to follow suit.

## New method

The biggest changes are that B-values are entirely eliminated and L-values are presented at fixed hours. Completed analyses show that the difference between B10 and B50 is small enough to fall within the normal tolerances for luminous flux. Accordingly, there is no need to continue specifying different B-values. Fixed hours for L-values follow the most typical applications, 35,000 h, 50,000 h, 75,000 h and 100,000 h. All L-values will relate to the median, i.e. the former B50, although this is not specified. The luminaire manufacturer chooses which operating hours the product is intended for and which L-values are published. Times longer than 100,000 h should be avoided. One major advantage of the new method is that LLMF is automatically obtained. Read more about LLMF on page 2.

L-values are calculated as before using TM-21. The calculation uses data provided by the LED manufacturer. These data are referred to as LM80. The LED manufacturer tests its diodes for at least 6,000 hours. A luminous flux reading is taken every 1,000 hours. These are the values used in the TM-21 system and allow us to extrapolate the time axis. We, and Lighting Europe, do not consider it appropriate to report L-values for times longer than 100,000 hours.

## LED ballast lifetimes

As with other types of electronics, such as HF-ballasts, lifetime is affected by the design, the component electronics and the temperatures of these components. Ballasts are given a reference point called tc. The temperature of this metering point must never exceed that stated by the manufacturer. It is up to the ballast manufacturer to specify the metering point and maximum temperature limit. Some manufacturers specify a maximum temperature corresponding to the specified lifetime, others specify a maximum temperature for the actual certification process. The lifetime is often stated as, for example, 50,000 hours/10%. This means that if the temperature of the tc point is maintained at a certain specified level, a maximum of 10% of the ballasts will fail within the specified time.

Fagerhult only uses ballasts from well-known and established manufacturers and has strict policies/requirements for both performance and lifetime. Most of our products have LED ballasts

capable of 100,000 h of operation.

## Luminaires with CLO

Luminaires with constant light output, or CLO for short, use ballasts that can be configured via software. During its useful lifetime, the ballast will slowly increase the current to the LED module. This is done to counter the light depreciation seen in the module itself. The current is increased at different stages. The luminous flux will remain constant, but at the cost of system power gradually increasing. A CLO luminaire is declared as L100. The CLO function is found in both indoor and outdoor luminaires equipped with DALI ballasts.

## Declaration of light depreciation and lifetime

The product data sheets include the L-values for fixed hours (35,000 h, 50,000 h, 75,000 h and 100,000 h). Depending on the product and the intended application, different numbers of values are specified.

**Example for a product intended for industry**

L91 100,000 h, L95 75,000 h, L98 50,000 h

Ballast lifetime 100,000 h/10%

## How does the L-value affect lighting design?

In the calculation in DIALux, the maintenance factor, MF, must be specified.

MF includes the following parameters: LLMFxLSFxLMFxRSMF

**LLMF = Lamp Lumen Maintenance Factor**

$L_{70}$ = 0.7 $L_{80}$ = 0.8 $L_{90}$ = 0.9

**LSF = Lamp Survival Factor**

This factor can be considered 1 for LEDs, as in today's applications there is normally a direct replacement

**LMF = Luminaire Maintenance Factor**

Varies depending on design, type of luminaire, whether the environment is clean or dirty and cleaning interval.

**RSMF = Room Surface Maintenance Factor**

Depends on the environment, reflection factors and cleaning interval.

LMF and RSMF can vary between countries and standards/guide-

**Proportion of the maintenance factor (LMF) corresponding to the soiling of the luminaire, taking into account the luminaire type, environment and cleaning interval**

| Cleaning interval in years | 2 years | | | 3 years | | | 4 years | | | 5 years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Luminaire type | Environment | | | Environment | | | Environment | | | Environment | | |
| | 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 |
| Uplight 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 adaptation of CIE 97:2005 2nd Edition to Swedish conditions.*
*Open luminaire refers to both direct and direct/indirect distribution, while uplight luminaire is 100% indirect.*

**Proportion of the maintenance factor (RSMF) corresponding to the soiling of the surfaces of the room, taking into account the luminaire type, environment and cleaning interval For comparison, the general recommendation is to base the values on a 3-year**

| Cleaning interval in years | 2 years | | | 3 years | | | 4 years | | | 5 years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Luminaire type | Environment | | | Environment | | | Environment | | | Environment | | |
| | 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 |

*Reflection factors ceiling/wall/floor – 70/50/20 clean and 50/30/20 normal and dirty.*
*Clean environment can normally be used for offices, schools, hospitals, hotels and clean public spaces and communication areas.*
*Normal environment for industry, warehouses, shops, sports halls, restaurants, technical installations.*
*Dirty environment for industrial environments such as smelters, welding, sawmills and the like with large amounts of dust and particles in the air.*

When dimensioning lighting installations, a high maintenance factor is important. Lifetime data with L70 after 50,000 hours entails considerable over-dimensioning.

# Example calculation for luminaires with different L-values

Lighting requirements can be met with a smaller investment and less extensive installation work. At the same time, energy consumption – and thereby even environmental impact – is greatly reduced.

Conditions: The luminaire has the same initial luminous flux, the room is the same (15x15 m) and the requirement is set at 500 lux. The only difference is the L-value of the luminaire.

Using $L_{90}$ luminaires rather than standard $L_{70}$ luminaires means that fewer luminaires are required. Over illumination, i.e. installing too much lighting to meet requirements when the life of the lighting system is achieved, is avoided.

**MF, standard $L_{70}$ luminaire:**

LLMF $L_{70}$ = **0.7**

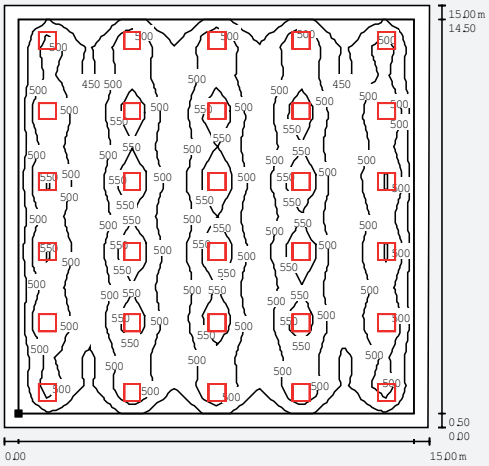
LSF = 1

LMF clean environment = 0.94

RSMF clean environment = 0.97

MF= **0.7**x1x0.94x0.97 => **0.64**

Approx. **30** luminaires are required




**MF, with an $L_{90}$ declared luminaire:**

LLMF $L_{90}$ = **0.9**

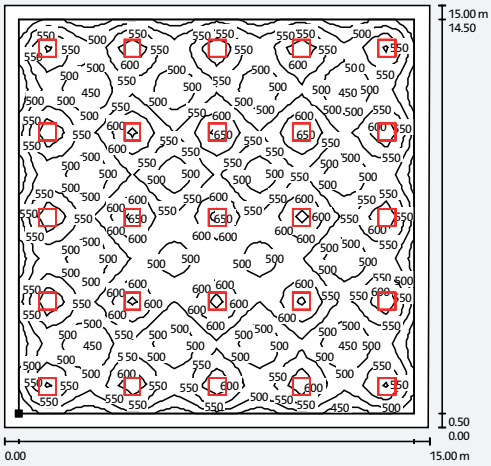
LSF = 1

LMF clean environment = 0.94

RSMF clean environment = 0.97

MF= **0.9**x1x0.94x0.97 => **0.82**

Only **25**luminaires are required!




## Outdoor maintenance

The maintenance factor (MF) includes the following parameters: LLMFxLSFxLMF

The Swedish Transport Administration recommends LMF 0.9 at installation heights > 4 metres and ingress protection > IP6x.

This can be considered a general value for LMF, while it may be necessary to reduce LMF to 0.85 in areas with particularly heavy soiling, such as certain industrial environments with high emissions.

**Example for outdoor luminaire with $L_{90}$:**

LLMF $L_{90}$ = 0.9

LSF = 1

LMF = 0.9

MF = 0.9x1x0.9 = 0.81 (0.8 can be considered a general recommendation).

**Example for outdoor luminaire with CLO (constant light output):**

LLMF CLO = 1

LSF = 1

LMF = 0.9

MF = 1x1x0.9 = 0.9