



Maintenance factors and LED Luminaires – Dispelling some myths

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There is a growing belief that the move to LED as a light source for luminaires has resulted in a “fit and forget” approach to cleaning and any de-rating of light output during the design process can either be reduced or ignored altogether.

This factfile is intended to provide guidance to those commissioning, designing, installing and maintaining lighting installations, as well as provide an overview for facilities managers and building owners about some of the environmental factors that can affect their lighting design over its life which will affect LED luminaires.

Why do we need to de-rate light output from luminaires?

Manufacturers can provide accurate information on the light output from their luminaires and it is a relatively simple exercise to calculate the illuminance level on surfaces within a space if we know the dimensions, surface colours and textures. However this simplistic approach discounts factors that, once a building is in use, will have a detrimental effect on the illumination levels. Factors that we usually consider are:

- How often the ceilings, walls, and floors are cleaned or re-decorated
- How often the luminaires are dusted or cleaned
- How quickly the light output is expected to depreciate
- What the failure rate of the lamps is

Once we have the answers to these 4 questions, we can determine how the lighting design will perform in its environment and make adjustments at the design stage to ensure it delivers the correct illumination level for the occupants of the associated space. This adjustment is known as the Maintenance Factor (M_f).

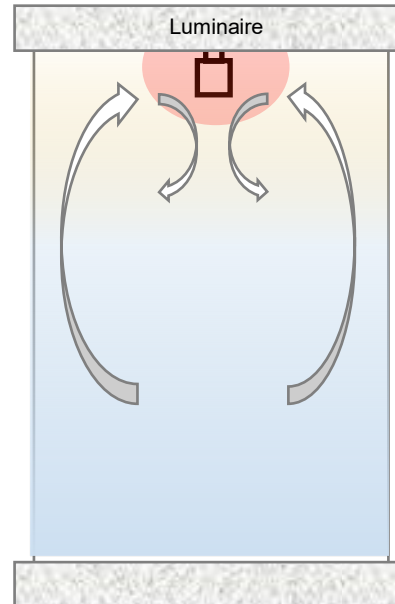
For outdoor lighting designs, the same approach can be applied with the exception of the “room” surface cleanliness as that obviously is not involved. However, the proximity of walls and the floor to external luminaires will have an effect, as will the cleanliness of the local environment.

If we chose to ignore these factors or apply unrealistic expectations, then the lighting design will not perform as intended.

All luminaires get dirty

Luminaires are electrical devices and all equipment that consumes electrical energy will convert some of that energy to heat. Usually it is this heat that results in the failure of electrical equipment by gradually degrading the components within. The more heat, the quicker the failure is a rule that will generally hold true.

Heat has another property when localised in an environment and this can either be an advantage or disadvantage. By introducing a heat source in to a room, the air locally will have its temperature raised above its surroundings and that difference in temperature will also cause a pressure change. The air around the heat source will have its pressure reduced. This change will cause high pressure air to move towards the lower pressure, a process known as convection which we use to heat our homes. Whilst a luminaire produces relatively little heat, it is sufficient to start the process of convection and air will flow towards and across it.



Once the air begins to flow it will carry airborne dust particles with it which can be deposited on the surface of the luminaire or lamp if this is exposed to the air flow.

As air is moving across all surfaces of the room, dirt can be deposited on those as well. This can be compounded by other heat sources such as radiators, computers, photocopiers, printers, etc.

LED luminaires run cool so what's the problem?

As discussed above, all electrical equipment will convert some of the energy it uses to heat. Therefore it is not correct to say that because LED luminaires run cool, they will not attract dirty deposits. They are the coolest lamp type and therefore will suffer the least. That much is true.

The other heat sources within the room will add to the convection of air which will pass across the luminaires so the fact that LED has a lower operating temperature will not in itself have such a significant reduction in the build-up of dirty deposits unless no other heat source is present.

LED luminaires do not need to have their lamps changed

Whilst it is true that LED luminaires do not need their lamps changing as often as conventional lamps, their output will degrade over time and a point will come where replacement is necessary. As with most things on the market, there are different qualities available at different price points so it is worth consulting luminaire manufacturers about the performance over time of their products.

Cheaper products will not necessarily degrade quicker so making judgements on price is not a good indicator of quality in LED luminaires.

How do I apply the maintenance factor to my design using LED luminaires?

The four considerations mentioned earlier represent the 4 combining factors that determine a lighting design's maintenance factor.

- How often the ceilings, walls, and floors are cleaned or re-decorated. This consideration is referred to as the "room surface maintenance factor" (RSMF)
- How often the luminaires are dusted or cleaned. This consideration is referred to as the "luminaire maintenance factor" (LMF)
- How quickly the light output is expected to depreciate. This consideration is referred to as the "lamp lumen maintenance factor" (LLMF).
- What the failure rate of the lamps is. This consideration is referred to as the "lamp survival factor" (LSF).

Regardless of the type of lamp used, the RSMF will always apply to indoor spaces as it is not directly related to the type of luminaire used so will be the same for LED or any other source.

For outdoor lighting designs, consideration will need to be given to the location of the luminaire. For example, a wall mounted luminaire could gain some benefit from the proximity of the wall behind it, particularly if that wall were a light colour. Conversely, a column mounted street light would have no adjacent surfaces from which to gain a benefit.

The LMF may differ for LED luminaires in that as they run cooler, they will attract fewer deposits of dirt from the passing air flow. A consideration will need to be made depending on the environment and the other heat sources in the space. For example a clean office with a single low temperature heat source such as underfloor heating could result in a very good LMF. However an industrial space with a high temperature localised heat source such as a furnace or kiln is likely to create so much convection and movement of airborne particles, that the operating temperature of the luminaires will give little improvement in LMF terms. Most indoor environments will be somewhere in between and the designer will need to consider the specific situation they are faced with.

External luminaires can be subject to changing environmental conditions. The effects of rain, snow and wind on the design considerations, as well as how "dirty" the local environment is, can have a significant impact on how often the luminaires need to be cleaned.

Whilst it is acknowledged that LED luminaires may not require lamp changes, the factors applied for LLMF and LSF cannot be discounted completely. The heat energy produced by the luminaire, be that in the control system or LED array itself will ultimately lead to a failure of the equipment and the output from the LED array will decay over time. Higher quality equipment should reduce the level of decay but ultimately all will fail. Please see Appendix A for more details about how this issue is considered by the lighting industry.

The timespan over which this occurs can be considerable and may lead the lighting designer to conclude that they can be treated as unity components in the calculation of the maintenance factor. However, the luminaires will be affected by their environment and whilst those placed in locations where they can easily transfer heat to their surroundings or in generally cooler environments should perform well. Conversely, those recessed into ceilings with little opportunity to dissipate heat or those using smaller insulating enclosures are likely to fail quicker.

The International Commission on Illumination (CIE) publishes guidance (CIE 97:2005) on how to apply maintenance factors, however given the date of the last revision, it does not take account of LED development in the intervening years. Information provided in CIE 97:2005 for RSMF and LMF can be used for LED luminaires. For data on LLMF and LSF, the appropriate manufacturer should be consulted.

