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Maintenance factor determination in lighting design

A.1 Example 1: Parking area project 100 000 h, using spot replacement

Project information:
— Installation lifetime: 50 000 h;
— Burning hours per year: /;
— Repair strategy: Spot replacement;
— Luminaire cleaning interval: 3 years;
— Pollution category: median.

Luminaire information:
— Luminaire type: Flood lighting LED luminaire with integrated driver;
— Median useful life L80 : 100 000 h (no CLO);
— IP Class: IP66;
— Driver failure rate: 0.5 % per 5 000 h.

Determination:
1. Luminous flux factor: Installation lifetime is half of the given median useful life at L80. As such, the luminous flux factor LLMF =0.90;
2. Survival factor: Project employs a spot replacement strategy. As such, the mentioned failure rate is not relevant, the survival factor LSM = 1.00;
3. Luminaire maintenance factor: Based on Table 1, an IP6X luminaire, with pollution category "low", with a 3 years cleaning interval results in a luminaire maintenance factor LMF = 0.87;
4. Surface maintenance factor: Only relevant for indoor installations and outdoor tunnels and underpasses. Not applicable for this situation, RSMF = 1.00.
Maintenance factor MF = 0.90 × 1.00 × 0.87 × 1.00 = 0.783.

Maintenance factor determination in lighting design

A.2 Example 2: Urban street project 100 000 h, with CLO, using group replacement

Project information:

— Installation lifetime: 50 000 h;

— Burning hours per year: /;

— Repair strategy: group replacement;

— Luminaire cleaning interval: 2 years;

— Pollution category: Low.

Luminaire information:

— Luminaire type: LED luminaire with integrated CLO driver

— Luminous flux: 6 000 lm non-CLO/4 800 lm CLO;

— Median useful life L80 : 100 000 h using CLO based on L80 ,

— Luminaire flux given as both non-CLO luminous flux (case A) and CLO luminous flux (case B);

— IP Class: IP66;

— Light source failure: abrupt failure value AFV = 1 % at 50 000 h

— Driver failure rate: 1 % per 5 000 h.

Determination:

1. Luminous flux factor: Installation lifetime is equal to the given median useful lifetime at L80.
However, as this is a CLO luminaire, this warrants further investigation. Depending on how the luminaire is specified, there are two options:

a) Luminous flux is specified as if no CLO is used. This means that the luminous flux depreciation needs to be taken into account in the maintenance factor. As such: The installation lifetime is similar to the given median useful life at L80. As such, the luminous flux factor LLMF = 0.80.

b) Flux is specified with the CLO correction already applied. As such, depreciation is already accounted for in the luminaire and is not taken into account in the maintenance factor.
Luminous flux factor LLMF = 1.00.

2. Survival factor: as the project uses group replacement, the individual components need to be checked. The light source has a failure of 1 % over the lifetime of the luminaire, which corresponds to a survival probability p s of 0.99 (p s = 1.0 – 0.01). The driver has a failure rate of 1 % per 5 000 h which corresponds to a total of 10 % for 50 000 h (failure probability Pf = 10/100 = 0.10). This corresponds to a survival probability Ps of 0.90 (Ps = 1.00 – 0.10) over the installation lifetime. As the driver has the lowest survival probability, survival factor LSM = 0.9.

3. Luminaire maintenance factor: Based on Table 1, an IP6X luminaire, with pollution category "low", with a 2 years cleaning interval results in a luminaire maintenance factor LMF = 0.91.

4. Surface maintenance factor: Only relevant for indoor installations and outdoor tunnels and underpasses. Not applicable for this situation, RSMF = 1.00.

Case A maintenance factor MF = 0.80 × 0.90 × 0.91 × 1.00 = 0.655.

Case B maintenance factor MF = 1.00 × 0.90 × 0.91 × 1.00 = 0.819.

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A.3 Example 3: Warehouse project, 10 years, using group replacement

Project information:

— Installation lifetime: 10 years;
— Burning hours per year: 3 000 h;
— Repair strategy: spot replacement;
— Cleaning interval: 3 years;
— Surface cleaning/painting interval: 5 years;
— Surface reflections: 0.50/0.30/0.20 (ceiling/wall/floor).

Luminaire information:

— Luminaire type: LED highbay luminaire with integrated driver, IP65;
— Distribution type: Direct;
— Median useful life L80: 50 000 h;
— Light source failure: abrupt failure value AFV = 1 % at 50 000 h;
— Driver failure rate: 1 % per 5 000 h

1. Luminous flux factor: Installation lifetime is 10 years with 3 000 burning hours per year. This results in a total of 30 000 burning hours for the full project. As the provide specifications only provide the depreciation for 50 000 h, the depreciation after 30 000 h can be estimated based on L80 = 50 000 h, the estimated luminous flux factor LLMF = 1 – 0.20 X 30000 / 50000 = 0.88.
2. Survival factor: as project employs a spot replacement strategy, so driver failure rate is not relevant, survival factor LSF = 1.00.
3. Luminaire maintenance factor: Based on Tables C.1, C.2 and C.3 in attachment, warehouses fall in pollution category "normal", and a luminaire with an IP over 5X in luminaire category E. With a 3 years cleaning interval this results in a luminaire maintenance factor LMF = 0.84 (Table C.4 in attachment).
4. Surface maintenance factor: As this example uses a direct flux distribution, we need to look at table on CIE 097:2005 standard. Based on the given reflectance values (0.50/0.30/0.20), and surface refurbishment interval (5 years) in a normal environment, surface maintenance factor RSMF = 0.95.
Maintenance factor MF = 0.88 × 1.00 × 0.84 × 0.95 = 0.702.