Recommended Cree® ESA Series Indoor Luminaire Lumen Maintenance Factors (LMF)

Ceiling Ambient	Drive Current	Initial LMF	25K hr LMF (Projected[1])	35K hr LMF (Projected[1])	50K hr LMF (Projected[1])	75K hr LMF (Calculated[2])	100K hr LMF (Calculated[2])
25	525mA	1.00	0.95	0.93	0.90	0.84	0.79
30	525mA	0.99	0.93	0.91	0.88	0.83	0.77
40	525mA	0.96	0.91	0.88	0.85	0.79	0.74

1 In accordance with IESNA TM-21-11, **Projected Values** represent interpolated values based on time durations that are within six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ((DUT) i.e. the packaged LED chip).

2 In accordance with IESNA TM-21-11, **Calculated Values** represent time durations that exceed six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ((DUT) i.e. the packaged LED chip)

Explanation of Calculations for Recommended Cree® ESA Series Luminaire Lumen Maintenance Factors (LMF), TD-14

The following is an explanation of how the Recommended Cree ESA Series Lumen Maintenance Factors(LMF) are derived. The example calculations do not need to be repeated – refer to the Cree ESA Series Lumen Maintenance Factors (LMF) charts contained in the TD-14 document, to select the appropriate Lumen Maintenance Factor based on your specific anticipated application life (in hours), average luminaire ambient operating temperature condition and selected drive current. Lumen Maintenance Factors represent worst case conditions for ESA Indoor Luminaires based on the designated ceiling ambient conditions and drive currents.

Applied Standards, Data and Assumptions

- **IESNA LM-79-08 (Initial Photometric Performance Data)**
  Photometric data per IESNA LM-79-08 (i.e. IES Photometric File formatted per IESNA LM-63-02)
  Note: Test performed at 25˚C ambient operating condition (per IESNA LM-79-08 standard)

- **IESNA LM-80-08 and IESNA TM-21-11 (Lumen Maintenance Performance Data)**
  Cree ESA Series Luminaire Lumen Maintenance Data sets are created using correlated in-situ luminaire test methods (i.e. LED chip package temperature (T_S) measurement(s) obtained with the LED chip package(s) operating in given luminaire and in a given stabilized ambient environment. The T_S temperature(s) is correlated directly to the LED chip package manufacturer's LM-80-08 data, in conjunction with TM-21-11 described extrapolation and interpolation methods, to form data sets predicting luminaire lumen maintenance for various luminaire average ambient operating conditions.).

Average Ambient Ceiling Cavity and/or Plenum Conditions (i.e. Ambient Temperature Condition)

- Defined as the average temperature the luminaire is exposed to above and below the ceiling surface in which the luminaire is installed.
  Note: Typical installed conditions yield above ceiling temperatures higher than below ceiling temperatures.

Application Life Descriptions/References

*(Refer to chart contained in **Recommended Cree ESA Series Luminaire Lumen Maintenance Factors (LMF)** document)*

- Initial LMF – Initial luminous flux performance
- 25K hr LMF[1] (~3 hour per day operation over a 23-year (365 days/year) period)
- 35K hr LMF[2] (~12 hour per day operation over a 12-year (250 days/year) period)
- 50K hr LMF (~12 hour per day operation over a 12-year (365 days/year) period)
- 75k hr LMF (~12 hour per day operation over a 17-year (365 days/year) period)
- 100K hr LMF (~16 hour per day operation over a 17-year (365 days/year) period)

Explanation of Calculations for Recommended Cree® ESA Series Luminaire Lumen Maintenance Factors (LMF), TD-14

Derived LMF Calculation Example

APPLICATION EXAMPLE:

Ambient temperature condition: 30°C ceiling ambient

Application Life Assumption; 50k hours (approximately 12 years of 12 hour per day operation)

Product: Cree ESA 6" 28 LED Downlight – 525mA drive current

STEP ONE

Adjust initial photometric performance (initial luminous flux) to account for ambient operating temperature above or below the photometric test ambient environment (i.e. 25˚C)

Statement of Fact: The LED chip package used in Cree luminaires gains 0.25% in luminous flux (lumen output) for each degree below the photometric test ambient temperature (i.e. 25˚ C). Conversely, the chip package loses 0.25% in luminous flux for each degree above the test temperature.

For a luminaire operating in a 30˚C average ambient environment, the delivered initial luminous flux is 1.25% less than the delivered luminous flux recorded during the IESNA LM-79-08 testing procedure, conducted in the required 25°C ambient condition.

Initial Luminous Flux Change Calculation:
a. 25˚C – 30˚C = -5°C (i.e. 5°C warmer than the 25˚C photometric test ambient)
b. -5˚C x 0.25 %/°C = -1.25% or -0.0125
c. 1.00 (initial photometric performance factor) - 0.0125 (initial luminous flux decrease) = 0.9875

The result of this calculation is represented by the "**0.99**" value listed in the "**Initial LMF**" column.

STEP TWO

Determine appropriate correlated lumen maintenance multiplier to be applied to the "Initial LMF" based on in-situ luminaire test methods and IESNA LM-80-08 and IESNA TM-21-11 Standards and Practices (as described above), for the predicted application duration (i.e. 50K hours for this example)

Cree ESA Downlight product in a 30˚C ambient environment incorporating a 525 mA drive current/power condition will experience 89% lumen maintenance (or 11% lumen depreciation) after 50K hours of operation.

Note: This value is derived from in-situ luminaire temperature measurement testing and correlation to the chip package manufacturer's IESNA LM-80-08 data sets in conjunction with TM-21-11 described extrapolation and interpolation methods, as explained in the **Applied Standards, Data and Assumptions** section of this document.

Therefore, the Corresponding Lumen Maintenance Factor (LMF) is derived as follows:

0.89 (30°C **correlated lumen maintenance multiplier**) **X .99** (initial luminous flux decrease due to ambient 5°C higher than photometric test ambient) = **0.88 (value listed in the Projected 50K hr LMF column for 525mA drive current)**

CONCLUSION

The LMF for a 6" 28 LED 525 mA Cree ESA downlight luminaire in a 50K hour application with a 30˚C average ambient environment would be 0.88. Applying this Lumen Maintenance Factor (LMF) to your photometric calculations will account for the change in luminous flux (output) after 50K hours of operation. The light levels generated using this method are also known as the "lowest in service values."

Be sure to select the correct LMF chart value specific to your anticipated application life, average luminaire ambient operating temperature condition and drive current.).