

Municipal Solid-State

STREET LIGHTING

**CONSORTIUM**

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# IESNA LM-80-08 and TM-21-11

Mark Hodapp, CRE  
Senior Application Engineer

**PHILIPS**  
**LUMILEDS**

Philips Lumileds  
370 West Trimble Road  
San Jose, CA 95131

# What is lumen maintenance?

Well understood that LEDs are very long life light sources.  
However, the light output of SSL products gradually goes down over time.

Rated lumen maintenance life of the LED ( $L_p$ ) is the elapsed operating time over which the LED light source will maintain the percentage,  $p$ , of its initial light output

$L_{70}$  (hours) = time to 70% lumen maintenance

$L_{50}$  (hours) = time to 50% lumen maintenance

# Lumen maintenance and EPA

EPA is using a simple exponential model for lumen maintenance until TM-21 is published:

$$\phi(\text{time}) = \exp(-\alpha \text{ time})$$

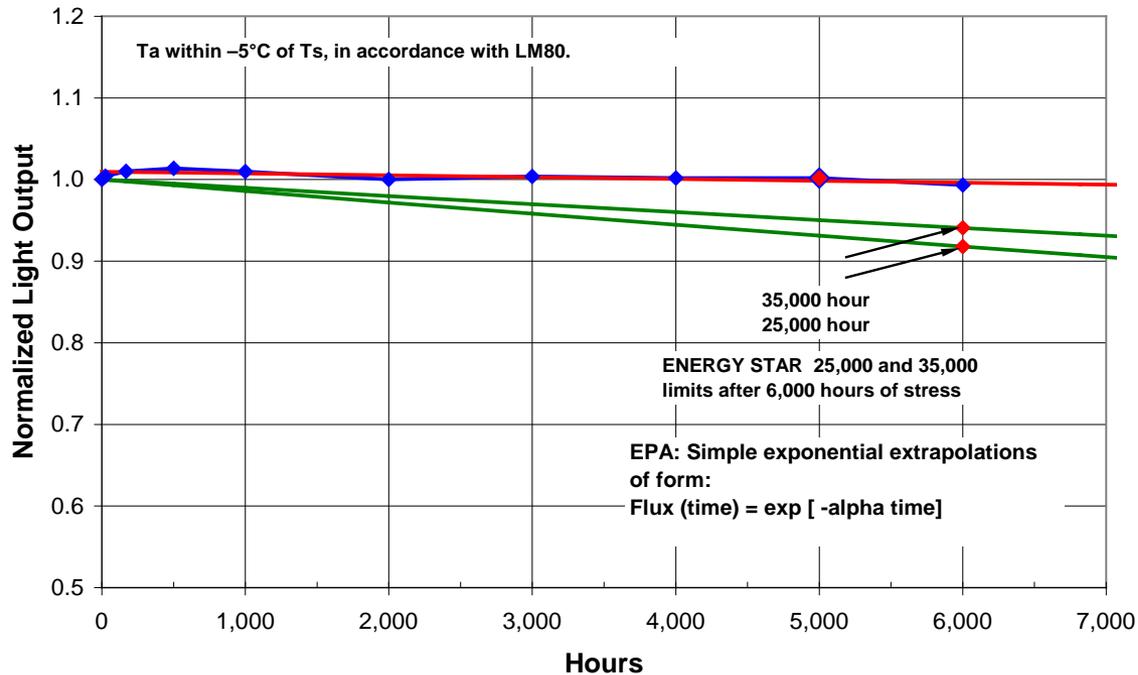
$$\alpha = -\frac{\ln(0.7)}{\text{time}}$$

$$\alpha(25,000 \text{ hour}) = -\frac{\ln(0.7)}{25,000} = 1.4267 e - 5$$

$$\text{EPA limit } LM(25,000) = \exp[-(1.467 e - 5)(6,000)] = 0.918$$

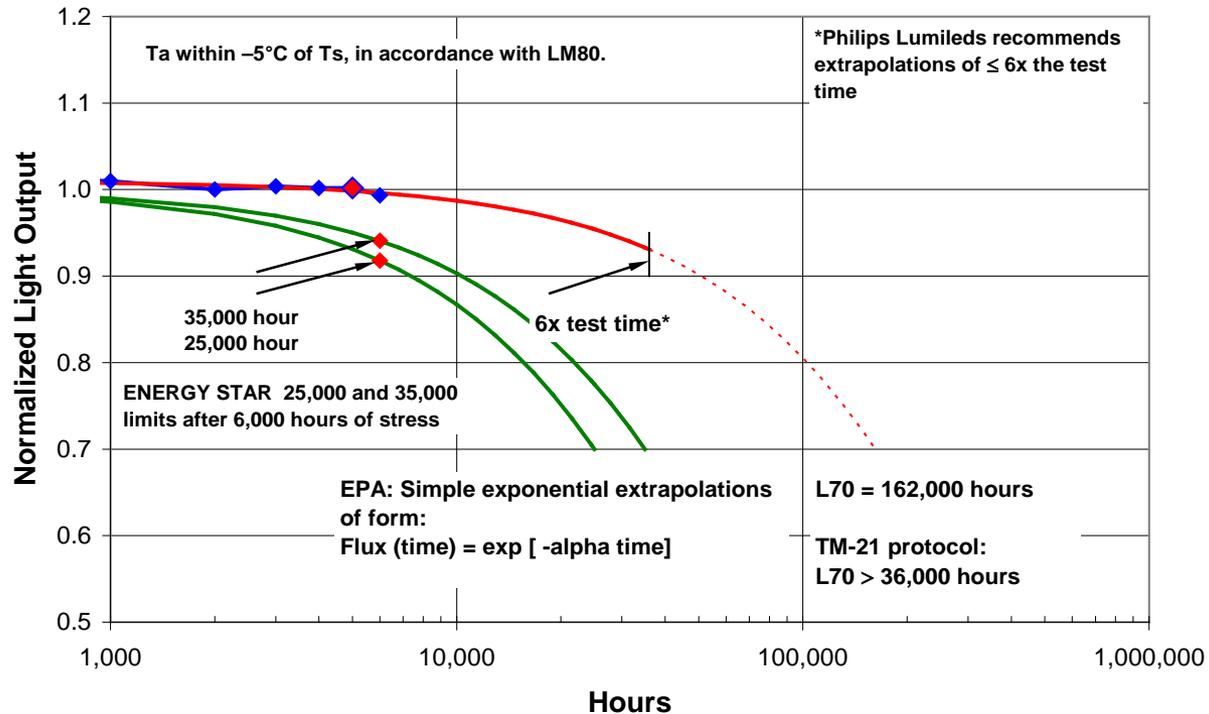
# Lumen maintenance and EPA

Lumen Maintenance Projection for White >3500°K LXML-PWx1  
LUXEON Rebel under these conditions  
85°C, 0.35A (T<sub>junction</sub> ≅ 98°C) Normalized to 1 at 0 hours



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# LM-80-08 Scope

Lumen maintenance test method written by IESNA (Illuminating Engineering Society of North America)

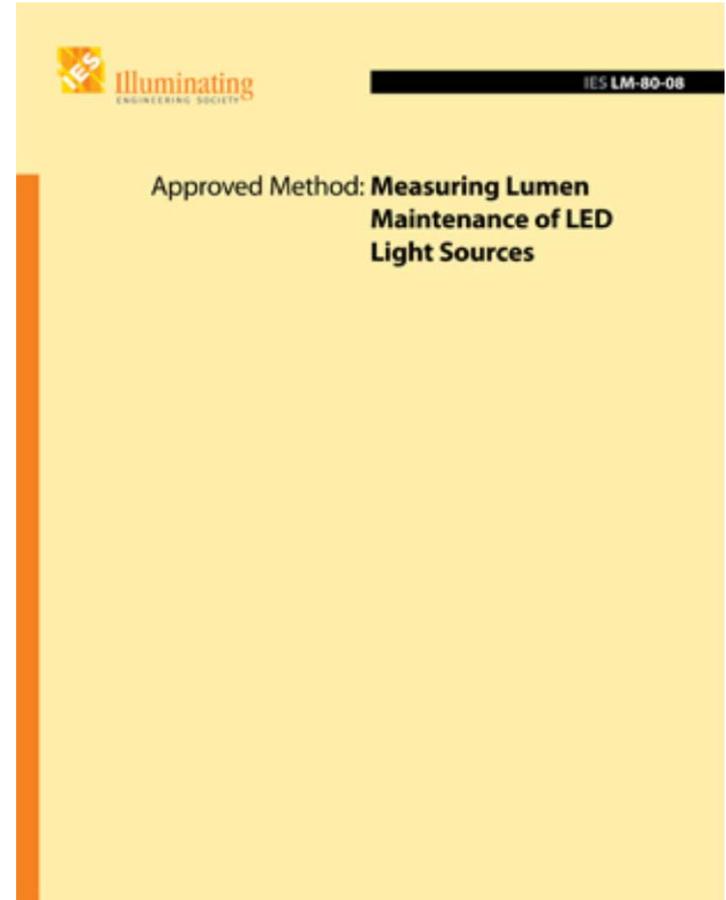
LED package, array or module driven by auxiliary driver

LEDs are driven with external current sources during operation and lumen maintenance testing

LED Case temperature is controlled during operation

During lumen maintenance testing, LED is allowed to cool to room temperature and tested at air temperature of 25°C

LM-80-08 is being updated by the IESNA LM-80 committee



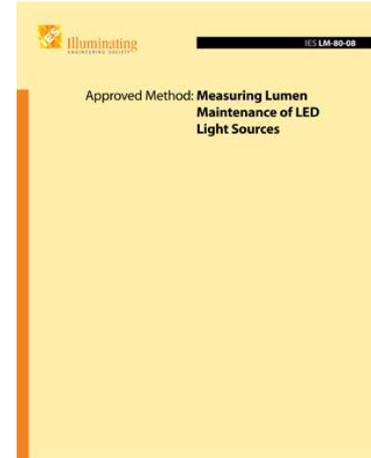
# LM-80-08 Test Method

## LM-80-08:

### IES “Approved Method”

### Specifies

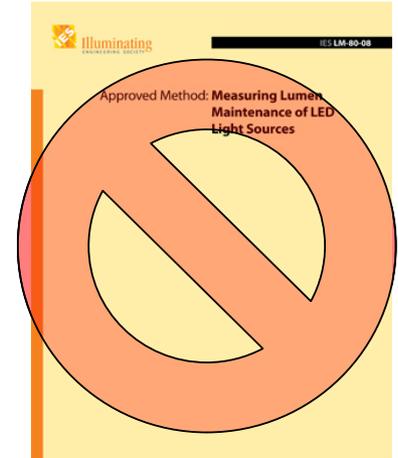
- Operation at three case temperatures (55°C, 85°C and one selected by manufacturer)
- Air Temperature to within +/- 5°C, Case Temperature to within +/- 2°C
- RH less than 65%
- Minimum 6,000 hours, data collected every 1,000 hours
- Data collection at 25°C
- Constant current, rated voltage
- Record Lumen Maintenance, Chromaticity, Catastrophic Failures
- Reporting Format



# What LM-80-08 Does Not Specify

## LM-80-08 does NOT specify:

- Pass/Fail Criteria
- Graphing of results
- Curve fitting methods
- Extrapolation and L70 prediction methods
- Sample Size
- How many drive currents
- What changes to an LED package require new testing



# Luminaire specifications

- **ENERGY STAR®**
  - **RESIDENTIAL**
    - Accent Lights
    - Cove Lights
    - Downlights: recessed, pendant, surface mount
    - Outdoor post mounted luminaires
    - Under cabinet luminaires
  - **COMMERCIAL**
    - Accent lights
    - Downlights
    - Under cabinet shelf-mounted task lighting
    - Portable desk task lights
- **DESIGNLIGHTS CONSORTIUM**
  - Outdoor area/roadway
  - Outdoor decorative
  - Outdoor wall mounted
  - Bollards
  - Wall-wash
  - Parking garage
  - Fuel pump canopy
  - Track or mono-point
  - Vertical refrigerated case
  - Horizontal refrigerated case
  - Display case
  - Linear panel (2x2, 1x2, 2x4 troffer)
  - High-bay and low-bay area
  - High-bay aisle
  - Outdoor roadway/area retrofit kit
  - Outdoor decorative retrofit kit
  - 4-foot linear lamp

## TM-21-11 What it is, and why it is important

- IESNA TM-21-11 (Technical Memorandum) specifies how to extrapolate the LM-80-08 lumen maintenance data to times beyond the LM-80 test time. For example: EPA ENERGY STAR® Luminaire Guide requires L70 of 25,000 or 35,000 hours.
- TM-21-11 is important because it is referenced in the EPA ENERGY STAR Guides and DESIGNLIGHTS CONSORTIUM Qualification Criteria, and customers generally are concerned about getting ENERGY STAR or DESIGNLIGHTS CONSORTIUM approvals for their products.
- It is also important as it creates a common playing field for LED competitors to specify lumen maintenance behavior for their white LED products intended for illumination applications.

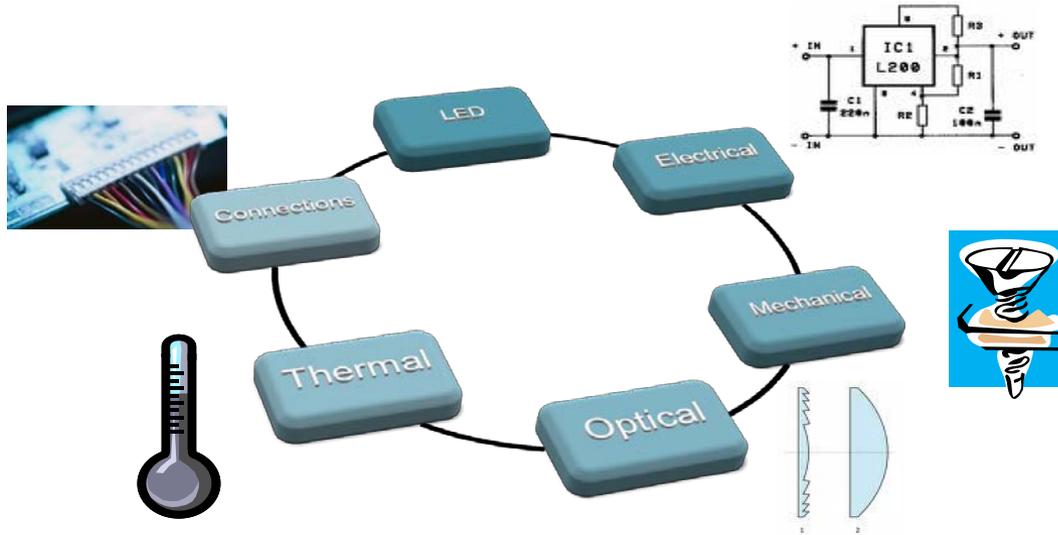
# TM-21-11 status

- **TM-21-11 was written by a panel of industry experts:**
  - 6 LED manufacturers (Philips Lumileds, Osram, Nichia, Illumitex, GE, and Cree).
  - 2 US Government Labs (PNNL, NIST)
- **Status: Final document was balloted within IESNA and approved for publication. Final artwork is still being generated.**

## Lumen maintenance is not the whole story

- LM-80-08 and TM-21-11 provide an industry standard for lumen maintenance testing and for lumen maintenance extrapolations for LED components. LM-79 is the lumen maintenance standard for SSL systems.
- Next Generation Industry Alliance and US Department of Energy 'LED Luminaire Lifetime: Recommendations for Testing and Reporting, 2<sup>nd</sup> edition', June 2011, discusses practical lifetime considerations for SSL luminaires.
- Lumen maintenance is not the dominant failure mode for most SSL products.

# System Reliability $\neq$ LED Reliability



$$R_{\text{system}} = R_{\text{electrical}} * R_{\text{connections}} * R_{\text{LEDs}} * R_{\text{optical}} * R_{\text{thermal}} * R_{\text{mechanical}}$$

Philips Lumileds has developed reliability and lumen maintenance models in order to predict long-term reliability performance of LUXEON Rebel products. See WP15 'Evaluating the Lifetime Behavior of LED systems' for more information.

# What good is LM-80 testing?

LM-80 testing and TM-21 extrapolations are intended to ensure that lumen maintenance meets expectations for LED lighting. LM-80 ensures consistent testing protocols for all LED manufacturers. TM-21 ensures consistent lumen maintenance extrapolation methods for all LED manufacturers.

TM-21 6x rule is intended to limit length of lumen maintenance predictions. Note that 6,000 hours of testing, allows lumen maintenance claims up to 36,000 hours.

TM-21  $L_p$  extrapolations are 'best-case' system lifetime estimates, and assume that no other failure mechanisms influence the life of the LED luminaire.

'Real-world' system lifetime predictions also need to consider other types of possible failures, such as drivers, electrical interconnections, and random wear-out failures.

# PHILIPS

sense **and** simplicity

Thank you for your valuable time!

Mark Hodapp  
Senior Applications Engineer  
Philips Lumileds  
[mark.hodapp@philips.com](mailto:mark.hodapp@philips.com)

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