ANSI/IES TM-21-21

Illuminating ENGINEERING SOCIETY

TECHNICAL MEMORANDUM:
PROJECTING LONG-TERM LUMINOUS, PHOTON, AND RADIANT FLUX MAINTENANCE OF LED LIGHT SOURCES

AN AMERICAN NATIONAL STANDARD

Approved American National Standard ANSI

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An accompanying online calculator for ANSI/IES TM-21-21 is available: www.ies.org/tools

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1.1 Introduction

One of the benefits that LED light sources can provide is very long usable life. Unlike other lighting technologies, LEDs typically do not fail catastrophically* during use. However, over time the light output will gradually depreciate. At some point in time the light emitted from an LED depreciates to a level where it is no longer considered adequate for a specific application. It is important in lighting design to understand when this "useful lifetime" of an LED source is reached.

ANSI/IES LM-80 defines the setup, conditions, and procedures for performing luminous flux maintenance testing of LED light sources and is the IES standard that is used widely to measure the lumen depreciation behavior of LEDs. LED device manufacturers routinely provide ANSI/IES LM-80 reports for their products, with data collected during testing for 6,000 hours or more. However, how the data collected from ANSI/IES LM-80 testing is used to best determine the useful lifetime of the tested product is not well defined.

The rated flux maintenance life of an LED is the elapsed operating time over which an LED light source maintains a given percentage of its initial light output. It is defined as τ_p, where τ is the lumen, photon or radiant flux, and p is the percentage value. For example, L_{70} is the time (in hours) when the luminous flux output from the LED has dropped to 70% of initial; Q_{90} is the time (in hours) when the photon flux output from the LED has dropped to 90% of initial; R_{80} is the time (in hours) when the radiant flux output from the LED has dropped to 80% of initial. The flux maintenance of an LED light source is dependent upon many variables, including the operating temperature, drive current, and technology and materials used to construct the product. As such, the flux maintenance of LEDs can vary not only from manufacturer to manufacturer, but also between different LED package types produced by a single manufacturer.

* Used in this sense, a "*catastrophic failure* is a sudden failure that results in a complete inability to perform all required functions of an item. (Laplante, Philip A. Dictionary of Computer Science, Engineering and Technology. CRC Press, 2017)

This Technical Memorandum recommends a method of projecting the flux maintenance of LED light sources from the data obtained by ANSI/IES LM-80 testing.

This document was developed by a dedicated TM-21 Working Group of LED industry professionals. The analyses of the ANSI/IES LM-80-15 (the 2015 publication of ANSI/IES LM-80) test data provided by major LED manufacturers are used to rationalize and support this document. Much of the ANSI/IES LM-80-15 data came from testing that extended to 9,000 hours, and in some cases beyond.

Two additional notes are relevant here:

- In 2018, IES issued *PS-10-18, IES Position on LED Product Lifetime Prediction.*[1]
- An accompanying online calculator for ANSI/IES TM-21-21 is available: www.ies.org/tools.

1.2 Scope

This document provides recommendations for projecting flux maintenance of LED light sources using data obtained when testing them per ANSI/IES LM-80.

This method shall not be used to project lumen, photon or radiant flux maintenance below 70%.

2.0 Normative Reference

Illuminating Engineering Society. *ANSI/IES LM-80-21, Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.* New York: IES; 2021.

3.0 Definitions

In addition to the terms define in this section, illuminating engineering terms are defined in ANSI/IES LS-1-20.[2]

3.1 DUT

The *device under testing* is the LED light source as defined in **Section 3.2.**