DRAFT

BSR E1.41 – 202x

Recommendations for Measuring and Reporting Photometric Performance Data for Entertainment Luminaires Utilizing Solid State Light Sources.

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Approved as an American National Standard by the ANSI Board of Standards Review on xx xxx 2021.

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The Photometrics Working Group, which authored this standard, consists of a cross section of entertainment industry professionals representing a diversity of interests. ESTA is committed to developing consensus-based standards in an open setting. Future Photometrics Working Group projects will include updating this publication as changes in technology and experience warrant, as well as developing new standards and recommended practices for the benefit of the entertainment industry.

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The Photometrics Working Group was the consensus body for the development of this standard. The working group's members with company affiliations and interest categories at the time the working group approved this standard on 26 July 2016 are listed below:

Voting Members

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Observer Members (Non-voting)

XXXXX

Interest category codes

CP	Custom-market producer	U	User
MP	Mass-market producer	G	General interest
DR	Dealer or rental company	DE	Designer

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1 Scope and Purpose

Most conventional methodology in the entertainment industry for the measurement of the photometric parameters of luminaires is based around an assumption of the use of broad band or full spectrum emitters. The introduction of solid state narrow band emitters, particularly LEDs, has posed a problem for the industry in characterizing luminaires utilizing such emitters. In particular the industry needs methods for measurement which are defined, repeatable, and defensible to allow the manufacturer to produce marketing material and for the user to be able to use the published data for product comparison. This standard is intended to be used for the presentation of photometric data for luminaires employing solid state light sources used in the entertainment and performance industries. This standard defines photometric data that may be presented on documents purporting to accurately describe the photometric performance of these luminaires when producing both white and colored light.

This standard does not supersede or replace, and should be read in conjunction with, ANSI E1.9 – 2007 (R2012), Reporting Photometric Performance Data for Luminaires Used in Entertainment Lighting.

2 Definitions

For the purposes of this standard the following terms shall be defined as:

2.1 Correlated Color Temperature: The temperature of a Planckian black body radiator at which the hue of it, and the target illumination source appear to match, expressed in Kelvin (K)

2.2 luminaire efficacy: The ratio of a luminaire's total lumen output divided by the power consumed, expressed in units of "lumens per watt."

2.3 luminaire: A complete lighting unit, consisting of a lamp or lamps, together with all the parts that are needed to position and protect the lamp or lamps, distribute the light, and connect the lamp or lamps to the power supply.

3 Requirements for White Light Measurement

In addition to the requirements stated in ANSI E1.9 – 2007 (2012), photometric data reports for entertainment luminaires utilizing solid state light sources shall include the following additional information for white light measurement. If the luminaire utilizes more than three color primaries then all measurements should be taken at the mix of those primaries that produces the highest lumen output at the specified white.

3.1 Generic Requirements

The following generic items must be included as part of any reported data detailed in Specific Requirements 3.2.

3.1.1 Correlated Color Temperature

The correlated color temperature (CCT) in Kelvin shall be reported. If a luminaire has variable CCT, then the measured CCT may be reported at multiple CCT values. CCT values used for measurement should be selected from the following list: 2700 K, 3200 K, 4500 K, 5600 K, and 6500 K. The preferred reporting values are 3200 K and 5600 K. The target value chosen from the list of preferred reporting values, the actual value as measured, and the tolerance if available shall be reported.

Informative notes to 3.1.1:

***Examples of CCT reporting**:*
3225 K +/- 15K when set to 3200 K target
5700 K +/- 50K when set to 5600 K target

3.1.2 D_{uv}

For each CCT value a D_{uv} value shall be reported showing the deviation of the measured color coordinates from the black body or Planckian locus. D_{uv} should be reported conventionally as a distance on the u,v chromaticity chart, and should be reported as a positive value for points above the Planckian locus and as a negative value for those below.

3.1.3 Ambient Temperature

The ambient temperature in degrees Celsius while the photometric measurements were made shall be reported. The luminaire shall be operated at its maximum lumen output for 15 minutes in this ambient temperature environment before the photometric measurements are made.

3.2 Specific Requirements

3.2.1 Lumen Output

The lumen output as specified in ANSI E1.9 -2007 (R2012) Clause 3.1.6, when producing white light of a reported CCT, shall be reported.

3.2.2 Luminaire Efficacy

The luminaire efficacy when producing white light of a reported CCT shall be reported. Luminaire efficacy is calculated as the total lumen output of the luminaire in lumens divided by the power consumption of the luminaire in watts and is reported in lm/W. This figure is sometimes called the "wall-plug efficacy."

The point in the electrical system where the power consumption was measured, and whether the supplied voltage was AC or DC shall be reported.

If the luminaire being characterized is an automated luminaire, then measurement should be taken with all functions of the luminaire stationary, except for fans and other moving devices required to provide essential cooling for the luminaire.

Informative notes to 3.2.2:

Examples of luminaire efficacy reporting:
50 lm/W with power consumption measured at the 110 V AC input to the luminaire
15 lm/W with power consumption measured at the 24 V DC output from a remote power supply

3.2.3 Dimmer Efficiency

The dimmer efficiency when producing light of a reported CCT shall be reported. Dimmer efficiency is calculated as the ratio of the average of the luminaire efficacy values when the luminaire is dimmed to produce 50%, 25% and 12.5% output lumens to the efficacy at 100% output lumens. It is reported as a percentage.

$$\text{Dimmer Efficiency} = \frac{(\text{luminaire efficacy at 50\%}) + (\text{luminaire efficacy at 25\%}) + (\text{luminaire efficacy at 12.5\%})}{3 \times (\text{luminaire efficacy at 100\%})} \times 100$$

3.2.4 Quiescent Power Consumption

The power consumption of the luminaire in watts and the associated power factor when producing no light output shall be reported.

If the luminaire being characterized is an automated luminaire then measurement should be taken with all the functions of the luminaire stationary, except for fans and other moving devices required to provide essential cooling for the luminaire.

3.2.5 Color Rendering

3.2.5.1 Fidelity Index

The Fidelity Index (R_f) when producing white light of a reported CCT shall be reported. The Fidelity Index reported shall be as defined in IES TM-30-20, IES Method for Evaluating Light Source Color Rendition

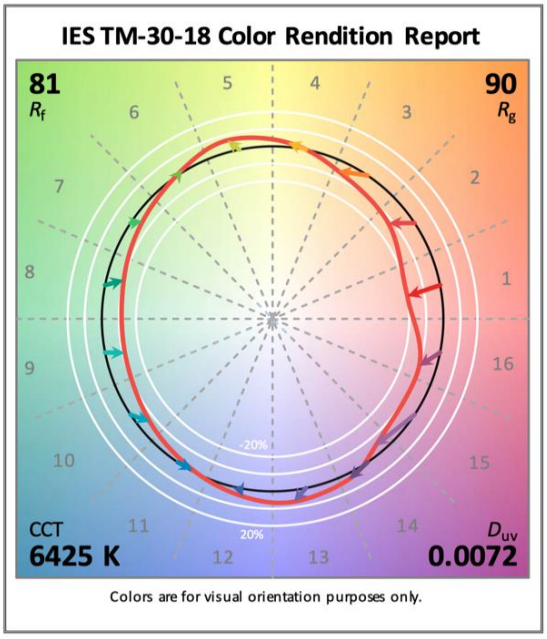
3.2.5.2 Gamut Index

The Gamut Index (R_g) when producing white light of a reported CCT shall be reported. The Gamut Index reported shall be as defined in IES TM-30-20, IES Method for Evaluating Light Source Color Rendition.

3.2.5.3 Color Rendition Report

The Simple Color Rendition Report produced by the IES TM-30-18 Calculation Tool shall be reported. (Alternatively including the IES TM-30-18 Intermediate or Full report shall meet this requirement. As of this standard's publication, the TM-30-18 calculator accompanies TM-30-20. Should the IES publish an updated calculation tool still under the TM-30-20 standard, reports generated by that tool shall also meet this requirement.)

Example graphic:



3.2.6 Modulation Frequency

The modulation frequency in Hz of the luminaire when measured at 100% output lumens and 50% output lumens shall be reported. *(Note: See Appendix A1. This is as generally described in IEEE 1789-2015)*

3.2.7 Stroboscopic Visibility Measure (SVM)

The stroboscopic visibility measure as defined in CIE TN 006:2016 of the luminaire when measured at 100% output lumens and 50% output lumens shall be reported.

3.2.8 Spectral Power Distribution (SPD)

The spectral power distribution of the luminaire when measured at 100% output lumens shall be reported. The SPD shall be reported at 5nm or smaller intervals over a range that includes 380nm to 780nm.

4 Requirements for Colored Light Measurement

In addition to the requirements stated in ANSI E1.9 – 2007 (R2017), photometric data reports for entertainment luminaires utilizing solid state light sources shall include the following additional information for colored light measurement. If the luminaire utilizes more than three color primaries, then the control settings and the levels of each emitter at which the test was carried out shall be reported.

4.1 Ambient Temperature

The ambient temperature in degrees Celsius while the photometric measurements were made shall be reported. The luminaire shall be operated at its maximum lumen output for 15 minutes in this ambient temperature environment before the photometric measurements are made.

4.2 Color Gamut

The color gamut area shall be reported as the area enclosed on the CIE 1976 (u',v') chromaticity diagram by a polygon whose vertices represent the individually controllable colors that the luminaire can produce. This chromaticity diagram is also known as the CIE 1976 UCS (uniform chromaticity scale) diagram.

Appendix A (informative, not normative)

A.1 Explanation of Modulation Frequency

This standard requires reporting of modulation frequency in section 3.2.6. It is understood that, for some SSL based luminaires, this may not always be possible or appropriate. Rather than having to use a single, prescribed, testing method, the reporter should make best efforts to report a modulation frequency appropriate to the technology being used. For example, a tester of an LED based luminaire using PWM to control the intensity of the LEDs should report that PWM frequency. If this frequency varies or a spread spectrum system is used then the range of variation should be reported. Other modulation or control methodologies may require reporting of other parameters. In all cases, it is the frequency of modulation of the output light intensity, not the electrical signals causing that variation, that is to be reported.

