Illuminating ENGINEERING SOCIETY

IES TM-30-15

IES Method for **Evaluating Light Source Color Rendition**

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1.0 INTRODUCTION

Accurately quantifying the color rendition characteristics of a light source is a complex problem. Many aspects of color rendition, such as color fidelity, color discrimination, or color preference, should be simultaneously considered during the design and specification process. There is no one metric or measure that can accurately quantify all aspects of color rendition and/or identify the most desirable light source for every application. However, a precise and robust method for characterizing color rendition is critical to specifying appropriate light sources and optimizing spectral characteristics of light sources.

This Technical Memorandum describes a method for evaluating light source color rendition that takes an objective and statistical approach, quantifying the fidelity (closeness to a reference) and gamut (increase or decrease in chroma) of a light source. Importantly, it does not attempt to evaluate human color preference or provide a single number that captures the combined color rendition qualities. However, using the two-dimensional characterization provided by the Fidelity Index (R_f) and Gamut Index (R_g), a user is expected to be able to rely on experience and/or design guidelines to determine what is most appropriate for the specific application in consideration.[1,2] The method also generates a color vector graphic that indicates average hue and chroma shifts, and which helps with interpreting the values of R_f and R_g.

IES TM-30-15 Method for Evaluating Light Source Color Rendition is based on comparisons of colors as rendered by a given test source and a reference illuminant at the same correlated color temperature (CCT), with the reference illuminant being Planckian radiation up to and including 4500 K, a proportional blend of Planckian radiation and a CIE D Series Illuminant between 4501 K and 5499 K, or a CIE D Series Illuminant at or above 5500 K. This familiar reference-based approach is compatible with a typical lighting design process, where color temperature is decided before color rendition is considered.

This method utilizes 99 color evaluation samples (CES)—each represented by a spectral reflectance factor function—to quantify the difference in color rendition between the test source and reference illuminant. These samples were statistically down-selected from an initial collection of more than 100,000 measured objects, which were considered to be representative of the world of possible colors.[3] All of the included color samples are real objects from the database, and the set includes natural objects, paints, fabrics, plastics, and skin tones. This new set of purposefully selected color samples, as well the use of the most recent and most uniform color space (CAM02-UCS), are two key features that, combined, distinguish this method from others.

This Technical Memorandum provides equations and direction for calculating R_f and R_g, including the spectral reflectance functions for the 99 CES. It is accompanied by a software tool (avalable at http://www.ies.org/redirect/tm-30/) to aid in calculation and display of the results. It does not establish performance thresholds, nor does it provide guidance on how to do so. The *IES TM-30-15* color rendition method consolidates and synthesizes numerous research efforts that have been ongoing for several years, and was developed by representatives of the manufacturing, specification, and research segments of the lighting industry. Additional detail regarding the development of the metrics and their benefits is available in “Development of the IES method for evaluating the color rendition of light sources”.[3]

The familiar Color Rendering Index (CRI)[4] is a color fidelity metric that is in widespread use throughout the lighting industry.* The *IES TM-30-15* fidelity measure (R_f) accounts for many of the limitations of CRI that have been well documented.[3,5,6,7,8] While CRI R_a and R_f have similar scales, they should not be directly compared and performance thresholds for one should not be applied to the other. The relationship is explored further in “Development of the IES method for evaluating the color rendition of light sources”.[3]

R_f was developed specifically to be part of the broader *IES TM-30-15* measurement system. Importantly, R_f and R_g share a common set of color samples and uniform color space; thus, the tradeoff between fidelity and gamut can be explicitly demonstrated, and more knowledgeable design decisions that account for multiple aspects of color rendition can be made, compared to using other existing metrics.[7]

**The CIE method for evaluating color rendering is widely referred to as the Color Rendering Index, abbreviated CRI. The CIE method employs 14 test color samples and each test color has its own CIE Special Color Rendering Index (note the use of the word Special). Each index is abbreviated as R_i where i is an integer from 1 to 14. The first 8 values of R_i are averaged to compute the CIE General Color Rendering Index (note the word General), which is abbreviated a R_a. One way to remember this is*