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ENGINEERING SOCIETY

APPROVED METHOD: SPECTRORADIOMETRIC MEASUREMENT METHODS FOR LIGHT SOURCES

AN AMERICAN NATIONAL STANDARD

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Foreword

This guide is a revision of *IES LM-58-15, IES Guide to Spectroradiometric Measurements* with editorial changes only.

1.0 Introduction and Scope

1.1 Introduction

In evaluating the color performance of light sources, there are two factors to be considered:

- The light source color appearance (hue and saturation)
- Its color rendering ability (the effect of the light source on the appearance of objects, compared to their appearance under a reference source)

The perceived color of a light source is its appearance as a separate consideration from its luminance, geometry, and time variations. This in turn depends upon the relative spectral power distribution (SPD) of the radiant energy from the source and on observer adaptation. Two sources with entirely different spectral power distributions may produce the same color appearance when illuminating one surface (i.e., they produce a metameric match) but can look quite different when illuminating a surface with different spectral reflectance characteristics.

The SPD constitutes the basic data needed for the computation of chromaticity coordinates and the metrics that describe color rendering. These data are obtained by spectroradiometry, whereby the light from the source is dispersed into its component wavelengths and the power in each narrow band of wavelengths is measured. Spectroradiometry has been practiced since Newton discovered the dispersive properties of a prism on light. Spectroradiometry is now recognized as the most accurate, precise, and dependable method of determining the chromaticity of any light source.

Where visual phenomena such as color are involved, the SPD usually is determined between the wavelengths of 380 nm and 780 nm, and should be measured with sufficiently narrow bandpass to show the desired resolution. For more-complete coverage, the SPD should be determined between the wavelengths of 360 nm and 830 nm. The curves are often plotted at five-nanometer intervals and are based on a spectral bandpass of approximately five nanometers. Computer plotted spectral power distributions are common at intervals much smaller than five nanometers. For sources containing line spectra, it has been found necessary for accurate resolution of spectra to utilize a bandpass of approximately two nanometers.

All photometric, colorimetric, and radiometric values can be calculated using the SPDs measured by a spectroradiometer. Sufficient accuracy is attainable with modern spectroradiometric systems such that they can be used for defining standards for other methods of colorimetry (e.g., with tristimulus colorimeters). In general, a spectroradiometer consists of a monochromator (dispersing instrument), a detector to measure the power at the output of the monochromator, and a device for recording data. A standard light source of known spectral power distribution is used for calibration.

The spectroradiometric method is advantageous because once calibration has been carried out against one standard source (usually an incandescent filament lamp), the spectroradiometer can determine—with equal accuracy—the SPD of light sources of any color, providing only that the unknown SPD is within the range of calibration. This range can comfortably run from 380 nm to 780 nm—or preferably from 360 nm to 830 nm—and therefore covers the visible region of interest for determining chromaticity.

1.1.1 Safety Precautions. Since overexposure to bactericidal (and/or germicidal) and erythemal ultraviolet radiation may result in erythema (reddening of the skin) or keratoconjunctivitis (inflammation of the cornea and conjunctiva, the exposed eye membranes), it is imperative that suitable eye protection and clothing be used when conducting measurements in these spectral regions. Lamp manufacturers' recommendations for safety precautions should be followed.[1]