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Illuminating ENGINEERING SOCIETY

TECHNICAL MEMORANDUM:
MEASUREMENT UNCERTAINTY FOR LIGHTING EQUIPMENT CALIBRATION USING INTEGRATING SPHERES

AN AMERICAN NATIONAL STANDARD

Approved American National Standard ANSI

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Prepared by
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1.1 Introduction

Uncertainty is inherent in every measurement. To truly understand the value of a measurement, the uncertainty of such should be analyzed. A critical step of this analysis is to know the uncertainty contributed by the instruments used to make the measurement. This Technical Memorandum provides a detailed and step-by-step method for determining uncertainty of certain calibration procedures common to instruments used in lumen measurement laboratories. This document uses the structure proposed in the *Guide to the Expression of Uncertainty in Measurement* (GUM) for its recommendations. For each calibration procedure presented in this document, a mathematical model is developed, estimates of each input quantity are discussed, and guidance is provided for the evaluation of the standard uncertainty of each input estimate. With this information, the combined standard uncertainty is calculated, effective degrees of freedom are calculated, and finally, the expanded uncertainty is reported.

The intent of this document is to provide a common approach to the uncertainty analysis for calibration of lumen measuring equipment (integrating spheres) with standard incandescent lamps, including halogen, that have been assigned values of total luminous flux and/or total spectral radiant flux. In addition, uncertainty budget templates are provided for calibration of incandescent (including halogen) working standard lamps that are virtually identical to the standard lamps they are compared against. These templates are starting points for uncertainty analysis. A laboratory applying these templates is expected to estimate each input quantity and the standard uncertainty of each input quantity, except where industry standard values are specifically noted in this document. Additional input quantities may be required based on specific situations that arise in the uniqueness of each laboratory measurement system. Future documents will cover topics such as uncertainty determination for colorimetric calibrations, and photometric and colorimetric measurements for testing general lighting products.

1.2 Scope

This document provides templates for the analysis of measurement uncertainty for the photometric calibration of integrating sphere systems using standard incandescent lamps, as well as the creation of working standard lamps using integrating sphere systems that are effectively identical to the primary standard lamps. It does not provide templates for the analysis of measurement uncertainty for colorimetric calibration of working standard lamps or for the testing of general lighting products.

2.0 Normative References

JCGM 100-2008, *Evaluation of Measurement Data – Guide to the Expression of Uncertainty in Measurement* (GUM). Bureau International des Poids et Mesures (BIPM); Sep 2008. Free download: www.bipm.org/en/publications/guides/gum.html.

ANSI/IES LS-1-20, *Nomenclature and Definitions for Illuminating Engineering*. New York: Illuminating Engineering Society; 2017. Free access from www.ies.org/standards/definitions/