Illuminating
ENGINEERING SOCIETY

IES LM-77-09

Approved Method: **Intensity Distribution of Luminaires and Lamps Using Digital Screen Imaging Photography**

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IES Approved Method for Intensity Distribution Measurement of Luminaires and Lamps Using Digital Screen Imaging Photometry

Publication of this report
has been approved by IES.
Suggestions for revisions
should be directed to IES

Prepared by:
The Digital Photometry Task Force
of the IES Testing Procedures Committee

Approved by the IES Board of Directors, November 15, 2009, as a Transaction of the Illuminating Engineering Society of North America.

Published by the Illuminating Engineering Society of North America, 120 Wall Street, New York, New York 10005.

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ISBN # 978-0-87995-237-2

Printed in the United States of America.

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1.0 FOREWORD

The intent of this IES document is to describe measurement procedures for the determination of the luminous intensity distribution of certain lamps and luminaires using a digital camera to capture the projected light distribution from a luminaire on a screen. Because this is a relatively new technique, considerable detail is provided to assist the reader in understanding the principles, requirements and limitations involved. As more experience is gained and as digital cameras increase in their capabilities, further requirements are likely to be developed. At this stage of development, digital photometry offers very high speed data collection versus a traditional goniophotometer, although typically over a restricted angular range. Many factors must be taken into account to achieve accurate digital photometry; this report addresses the most significant of these factors.

Other uses of cameras to perform digital photometry, such as capturing the distribution of a luminaire by aiming the camera at the luminaire, close field photometry techniques and methods using integrating spheres, are outside the scope of this report.

2.0 BACKGROUND AND BASIC PRINCIPLES

The measurement of luminaire intensity distributions and associated quantities has traditionally been performed using some form of goniophotometer. Such instruments may use a rotating mirror, a moving photodetector, or a single fixed photodetector with a biaxial goniometer.[1] Each of these systems collects an individual reading and then rotates to the next angular setting, and so on. Systems using multiple photodetectors have been developed, which increase test speed as several readings are taken almost simultaneously.[2]

In the 1960's it was shown that photographic techniques could be used to make photometric measurements of the luminance pattern in a space.[3] A high quality film camera was used with strictly controlled conditions of exposure and film development. The density at any point on the resultant negative image then could be numerically related to the luminance at the corresponding point in the scene, if calibration details were properly addressed. The technique required extensive work to obtain accurate data, as well as sophisticated equipment for the measurement of film density. Even so, it demonstrated the feasibility of a rapid method for the capture of a large amount of photometric data by photographic means.

In the 1980's with the advent of digital cameras, many of the disadvantages of the film technique were eliminated. Photometric methods for the measurement of scene luminance distribution,[4] and lamp intensity distribution,[5] were developed using cameras incorporating CCD (Charge Coupled Device) arrays that replaced the traditional film. Good accuracy was demonstrated despite the relative simplicity of the digital cameras of that time.

Through the 1990's, such cameras grew in their sophistication, as did associated hardware and software, allowing accuracy approaching that of traditional photometry.[6, 7]

This IES approved method addresses the use of digital cameras incorporating a CCD array. However it should be noted that other types of digital camera sensors such as CID (Charge Injection Device) arrays, CMOS (Complementary Metal Oxide Semiconductor) arrays and scanned photodiode arrays could be acceptable for photometry. Requirements for accuracy and the special conditions for this form of light measurement are covered. The numerous factors to be taken into account for hardware selection and software development are described. Calibration requirements are specified, as are data reduction techniques.

Requirements that are identical to those for conventional goniophotometry of luminaires and not described specifically in this document include:

- Lamp Selection and Seasoning
- Selection and Preparation of the Test Luminaire
- Luminaire Positioning
- Electrical Supply
- Electrical Instrumentation
- Thermal Environment (other than that for the camera)
- Luminaire Stabilization
- Special Considerations for Particular Lamp Types