Illuminating Engineering Society

ANSI/IES LS-6-20

LIGHTING SCIENCE: CALCULATION OF LIGHT AND ITS EFFECTS

AN AMERICAN NATIONAL STANDARD

Approved American National Standard

ANSI

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CONTENTS

The purpose of computing is insight, not numbers. 1961
The purpose of computing numbers is not yet in sight. 1997
— W. Hamming

1.0 Introduction and Scope

1.1 Introduction

Predicting the performance of a proposed lighting design is an integral part of the design process, allowing the designer to examine and compare alternatives, refine a promising idea, see whether applicable recommendations and codes will be met, evaluate energy conservation and lighting control opportunities, invoke standardized procedures to predict glare and visibility, and perhaps generate a rendering of how a space might appear. The ability to predict performance requires a computational infrastructure that consists of: standardized data that characterize lighting equipment; a knowledge of the properties of surface and other components of the environment involved; theoretical models of how light behaves; software that makes use of those models; and computer hardware on which the software operates. However elaborate this infrastructure, its output still requires careful interpretation.

1.2 Purpose and Scope

The purpose of this Lighting Science document is to provide the theoretical basis for lighting calculations, to describe how this theory is approximated and used, and to describe how it is embodied in most lighting analysis software. This can provide, from a user's perspective, an understanding of the power and limitations of calculations—however performed—and thus make clear their use in the lighting design process.

These purposes require the presentation of information in the following three general areas.

- The fundamental theories of light transport and interaction with architecture, what form—exact or approximate—the mathematical models of these theories take, and how the models are in turn used in lighting software.
- The geometric, photometric, and physical information that is commonly available as input into a lighting calculation process and how the nature, limits, and uncertainties of this information affect the results.
- The various ways of predicting lighting system performance by assessing and interpreting calculation results and their comparison with anticipated or actual measured results.

In addition, this document explains IES standard calculation procedures, including lumen method coefficients of utilization and glare assessment.

2.0 The Role and Use of Lighting Calculations

Like most technical disciplines in engineering and design, lighting had a long history of support and direction provided by hand calculation, nomograms, and mechanical calculators.[1] By the middle of the 20th century these were, to some extent, augmented with large analog and then digital electronic computers. But the eventual widespread availability and use of inexpensive computers running standardized operating systems has made general purpose lighting analysis software (hereafter simply "software") a commercially viable enterprise, and hand calculations, however augmented, now have virtually no role in modern illuminating engineering or lighting design.