

N I N T H E D I T I O N

T H E I E S N A

LIGHTING HANDBOOK

R E F E R E N C E
& A P P L I C A T I O N



The
LIGHTING
AUTHORITY

ILLUMINATING ENGINEERING
SOCIETY OF NORTH AMERICA

MARK S. REA, PH.D., FIES, EDITOR-IN-CHIEF

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IESNA

Illuminating Engineering Society of North America

The IESNA is the recognized technical authority on illumination. For over ninety years its objective has been to communicate information on all aspects of good lighting practice to its members, to the lighting community, and to consumers through a variety of programs, publications, and services. The strength of the IESNA is its diversified membership: engineers, architects, designers, educators, students, contractors, distributors, utility personnel, manufacturers, and scientists, all *contributing to* the mission of the Society: to advance knowledge and disseminate information for the improvement of the lighted environment to the benefit of society.

The IESNA is a forum for the exchange of ideas and information and a vehicle for its members' professional development and recognition. Through its technical committees, with hundreds of qualified members from the lighting and user communities, the IESNA correlates research, investigations, and discussions to guide lighting experts and laypersons via consensus-based lighting recommendations.

The Society publishes nearly 100 varied publications including recommended practices on a variety of applications, design guides, technical memoranda, and publications on energy management and lighting measurement. The Society, in addition, works cooperatively with related organizations on a variety of programs and in the production of jointly published documents and standards.

In addition, the Society publishes *Lighting Design + Application (LD+A)* and the *Journal of the Illuminating Engineering Society (JIES)*. *LD+A* is a popular application-oriented monthly magazine. Every issue contains special feature articles and news of practical and innovative lighting layouts, systems, equipment and economics, and news of the industry. The *Journal* contains technical papers, most of which are presented at the Society's Annual Conference. IESNA has a strong education program with basic and intermediate level courses and seminars offered through its Sections.

The Society has two types of membership: individual and sustaining. Applications and current dues schedules are available upon request from the Membership Department. IESNA local, regional, and international meetings, conferences, symposia, seminars, workshops, and lighting exhibitions (LIGHTFAIR INTERNATIONAL) provide current information on the latest developments in illumination.

For additional information on the IESNA, consult the Society's Web site: <www.iesna.org>.

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Preface

Many of us believe that the ninth edition of the *IESNA Lighting Handbook* represents a watershed in lighting practice. Over the past twenty years there has been a movement in lighting practice from illuminating engineering to lighting design, a movement from calculations of illuminance to judgments of aesthetics, a movement from quantity to quality. For the first time, the IESNA has, through this edition, formalized recommendations of lighting quality, reflecting this movement in lighting practice.

These formal recommendations are provided in a matrix entitled the IESNA Lighting Design Guide. The Guide includes recommendations on important lighting design criteria such as eye-source-task geometry, flicker, color, and glare. They are provided alongside the traditional recommendations of illuminance for a wide variety of applications. The intent of the Guide is to broaden the perspective of lighting practitioners and to direct them to specify higher quality lighting.

The idea for the IESNA Lighting Design Guide was born beside Lake George in upstate New York at the retreat for editing the eighth edition of this *Handbook*. During a break in editing, some of the editing team took a walk along the edge of the lake. Feeling a bit tired, we lamented that most people would probably never read what we were editing because they would only consult the illuminance selection table. We repeated the standard joke: If the *Handbook* in most architectural-engineering offices is placed on its spine, it will fall open to the illuminance selection table because that is the only section ever consulted. We mused that it be nice if users *had* to consider the many other important lighting design criteria found throughout the text. Building on that idea, we sketched out the basic framework of the matrix. Through hard work and review by several committees, the IESNA Lighting Design Guide in Chapter 10 of this edition of the *Handbook* was produced. Of course we all still hope that users will read the entire text of the ninth edition of the *Handbook*, but if it must fall open to any one section, it will now fall open to a section that describes more than one lighting design criterion.

Actually the genesis of the IESNA Lighting Design Guide goes back several years before our walk along Lake George. One of the first lighting people I met as a graduate student at Ohio State University was Steve Squillace, engineer, teacher, past president of the IESNA, and recipient of its highest technical award. Steve's passion for lighting and life set him apart from his contemporaries. In every conversation I had with Steve he insisted that every lighting designer and illuminating engineer should *think* about lighting. As a passionate radical, he argued that the IESNA should do away with illuminance recommendations altogether because they were substitutes for thinking. Many disagreed with Steve, believing that the majority of practitioners in the building industry were not lighting specialists. These people needed to quickly find practical guidance and then move on to other decisions. The problem had been that illuminance became the only criterion these practitioners considered before moving on. In this edition, the single focus on illuminance is no longer possible.

Steve might argue that we are moving in the wrong direction, however. There are more formal recommendations in this edition of the *Handbook* than ever before. Perhaps people who are now doing good lighting will stop thinking, but we doubt that. Rather, we believe that thinking is required to follow these recommendations. The lighting practitioner who needs to hurry to the next decision can no longer rely upon an illuminance calculation and consider the lighting job completed. Often illuminance is not the primary lighting design criterion in the Guide. With the recommendations put forward in this edition, the practitioner must take some time to study the application and decide among several important lighting design criteria. The thinking time invested by the lighting practitioner is worthwhile because that investment will improve the quality of lighting throughout North America.

Many people deserve a great deal of credit in developing, writing, and producing this edition of the *IESNA Lighting Handbook*. I have tried to acknowledge everyone who contributed, but no acknowledgment can do justice to the long-standing commitment these people have made to lighting. Their contributions to this edition are only a small part of their life-long commitment to improving the quality of life through better lighting. It is my sincerest wish that the ninth edition of the *IESNA Lighting Handbook* does honor to these contributors and helps them continue to improve the quality of lighting throughout North America.

Mark S. Rea, Ph.D., FIES
Editor-in-chief

Foreword

The Illuminating Engineering Society was founded in 1906, but it was not until 1947 that the first edition of the *Handbook* appeared, thus representing the accumulation of 41 years of lighting progress since the Society's founding. In each subsequent edition, IESNA has provided information on an ever-broadening range of technologies, procedures, and design issues. In the ninth edition, the editorial team has continued the trend of securing knowledge on all phases of lighting from IESNA committees and individual experts to ensure that this *Handbook* is *the lighting reference source* for the beginning of the next century.

The emphasis in the ninth edition is on quality. Previous editions have discussed important criteria for assessing and designing the visual environment, but a formal system for considering these issues had not been developed. IESNA has, however, always recommended quantity of light for specific applications or visual tasks. As a result, many practitioners often mistook the IESNA system of recommended illuminances (quantity) as the primary, or even the sole criterion, for lighting design. This *Handbook* introduces a new, formal system of addressing quality issues in the Lighting Design Guide in Chapter 10, Quality of the Visual Environment.

There are changes, too, in the illuminance categories, reduced from nine to seven and organized into three sets of visual tasks (simple, common, and special). Every application in the Lighting Design Guide has a specific (single number) recommended illuminance representing best practice for a typical application.

Through the Lighting Design Guide and other information in Chapter 10, IESNA is recognizing and emphasizing that illuminance is not the sole lighting design criterion. Other criteria may be more important, and, given the complexity and diversity of design goals for a specific application, the designer now has the opportunity to evaluate among the quantity and quality choices. This approach has been described as "a bridge to the 21st century," when it is expected that the tenth edition of the *Handbook* will provide a more precise method of measuring quality factors and their impact on the visual environment.

Other chapters in the book are new, or have been rewritten or updated. There are new application chapters on outdoor lighting, security lighting, parking facilities, retail, shopping mall and industrial lighting, and significant revisions to chapters on measurement of light, vision and perception, photobiology, aviation, and transportation.

This *Handbook* could not have been produced without the IESNA committees and individual specialists, those willing volunteers who give countless hours to the process of sharing their expertise. The Society thanks each and every contributor.

The professional editorial team brought talent and discipline to the project. Dr. Mark Rea, Judith Block, John Bullough, and Mariana Figueiro of Rensselaer Polytechnic Institute together with four Topic Editors, Michael Ouellette, David DiLaura, Roger Knott, and Nancy Clanton, have earned our appreciation for their contributions in evaluating, editing and, when necessary, developing material.

The IESNA Lighting Handbook represents the most important reference document in the lighting profession. It is one means by which the Society accomplishes its mission: to advance knowledge and disseminate information for the improvement of the lighted environment to the benefit of society. We hope that, you, the reader, will find the ninth edition your principal reference source for lighting information.

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