American National Standard Practice on Lighting for Educational Facilities
ANSI/IES RP-3-13

American National Standard Practice on Lighting for Educational Facilities

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

Prepared by:
The Educational Facilities Committee of the Illuminating Engineering Society of North America
Copyright 2013 by the Illuminating Engineering Society of North America.

Approved by the IES Board of Directors, July 16, 2013 as a Transaction of the Illuminating Engineering Society of North America.

Approved January 17, 2014 by the American National Standards Institute

All rights reserved. No part of this publication may be reproduced in any form, in any electronic retrieval system or otherwise, without prior written permission of the IES.

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

IES Standards and Guides are developed through committee consensus and produced by the IES Office in New York. Careful attention is given to style and accuracy. If any errors are noted in this document, please forward them to Rita Harrold, Director of Technology, at the above address for verification and correction. The IES welcomes and urges feedback and comments.

ISBN# 978-0-87995-283-9

Printed in the United States of America.

DISCLAIMER

IES publications are developed through the consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on lighting recommendations. While the IES administers the process and establishes policies and procedures to promote fairness in the development of consensus, it makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

The IES disclaims liability for any injury to persons or property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this document.

In issuing and making this document available, the IES is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the IES undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

The IES has no power, nor does it undertake, to police or enforce compliance with the contents of this document. Nor does the IES list, certify, test or inspect products, designs, or installations for compliance with this document. Any certification or statement of compliance with the requirements of this document shall not be attributable to the IES and is solely the responsibility of the certifier or maker of the statement.
Prepared by the IES School and College Lighting Committee

Chad Loomis, PE, Chair

R. Altman, LC
R. Burk
N. De La Rosa, LC*
T. Hill, PE
C. Kohring
S. Padios*
T. Shaw
J. Yon, LC

* Advisory

ACKNOWLEDGMENTS

Special thanks to Craig DiLouie, LC, ZING Communications, Inc. for his editing and writing contributions to this document
AMERICAN NATIONAL STANDARD

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether that person has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation to any American National Standard. Moreover, no person shall have the right or authority to issue and interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

CAUTION NOTICE: This American National Standard may be revised at any time. The procedures of the American National Standards Institute require that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of approval. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.
Contents

Introduction ................................................................................. 1

PART I
1.0 General Considerations Affecting Lighting in Educational Facilities ........................................... 2
  1.1 The Learning Environment ................................................................. 2
    1.1.1 Education Level .................................................................... 2
    1.1.2 Multi-use Spaces .................................................................. 2
    1.1.3 Visual Comfort ..................................................................... 2
  1.2 Lighting for Safety ........................................................................ 3
  1.3 Task Locations ............................................................................ 3
  1.4 Color Appearance (and Color Contrast) .............................................. 3
  1.5 Light Distribution on Surfaces ........................................................ 4
    1.5.1 Surface Characteristics .......................................................... 4
    1.5.2 Luminances of Room Surfaces .............................................. 4
    1.5.3 Points of Interest ................................................................... 4
    1.5.4 Sparkle/Desirable Reflected Highlights ................................... 5
  1.6 Daylight Integration and Control .................................................... 5
  1.7 System Integration and Flexibility ................................................... 5
  1.8 Lighting Maintenance .................................................................... 5

2.0 Lighting Measurement ..................................................................... 5
  2.1 Illuminance .................................................................................. 6
  2.2 Illuminance Target Value System ................................................... 6
    2.2.1 Recommended Illuminances at Design Time ................................ 6
    2.2.2 Recommended Illuminances at Occupancy Time ....................... 6
  2.3 Known Task Locations .................................................................. 6
    2.3.1 Tasks within Large Areas ....................................................... 6
    2.3.2 Tasks at Uncertain locations within a Large Area ....................... 7
    2.3.3 Multiple Tasks ...................................................................... 7
  2.4 Visual Age of Occupants ............................................................... 7
    2.4.1 Lighting Levels by Age ......................................................... 7
  2.5 Uniformity .................................................................................... 7
  2.6 Luminance .................................................................................. 17
  2.7 Brightness and Adaptation ............................................................ 17
  2.8 Room Surface Luminances ............................................................ 17
  2.9 Luminance-Ratio Limits ................................................................ 17
    2.9.1 Luminance Variability ........................................................... 18
  2.10 Directing Attention .................................................................... 18

3.0 Luminaire Classifications ............................................................... 18
  3.1 Determining Quantity of Luminaires ............................................... 20
  3.2 Determining Orientation of Luminaires .......................................... 20
  3.3 Layered Lighting Techniques ........................................................... 21
    3.3.1 Task Lighting ...................................................................... 21
    3.3.2 Downlighting ...................................................................... 21
    3.3.3 Wall Washing and Grazing ..................................................... 21
    3.3.4 Accent Lighting .................................................................. 22
    3.3.5 Cove Lighting ..................................................................... 22
9.0 Energy Efficiency, Sustainability and Controls .................................................. 57
9.1 Energy Regulations and Legislation ................................................................. 57
9.2 The Cost of Energy .......................................................................................... 58
9.3 Efficient Sources and Systems ......................................................................... 58
9.4 Controls ........................................................................................................... 58
  9.4.1 Switching and Dimming .............................................................................. 58
  9.4.2 Manual Controls ........................................................................................ 58
    9.4.2.1 Preset Scene Controls ........................................................................ 58
  9.4.3 Automatic Controls .................................................................................... 59
    9.4.3.1 Time Clocks ....................................................................................... 59
    9.4.3.2 Occupancy Sensors ........................................................................... 59
    9.4.3.3 Daylight Harvesting .......................................................................... 59
    9.4.3.4 Demand Responsive Buildings ......................................................... 60
  9.4.4 Fluorescent and HID Lamp Switching ......................................................... 60
9.5 Product Selection for Recycling ....................................................................... 60
9.6 Safe Disposal ..................................................................................................... 60
9.7 Energy Management Checklist ........................................................................ 60
9.8 Emergency Lighting .......................................................................................... 62
  9.8.1 The Need for Emergency Lighting ............................................................. 62
  9.8.2 Systems in Use ........................................................................................... 62
  9.8.3 Emergency Egress Lighting ....................................................................... 62
  9.8.4 Exit Marking ............................................................................................... 63

References ............................................................................................................... 63

PART III
Informative Annex A – General Lighting Terms ...................................................... 65
Informative Annex B - Measurement of Lighting Performance ............................... 83
Informative Annex C – Lighting Calculation and Design Issues ............................. 84
Informative Annex D – Light Sources ..................................................................... 85
Informative Annex E – Common Application Illuminance Tables ........................... 89
INTRODUCTION

Lighting is a critical element in the school environment. Lighting can influence behavior\(^1,2\), satisfaction\(^3\), psychological responses to a space and task performance, communication and interest, visual comfort and safety and security, while defining space and architecture.

Learning environments have changed dramatically over the past several decades. Not only have teaching methods and technologies evolved, so has our understanding of what makes good lighting, which should be delivered within tightening code constraints.

Classroom lighting should support the educational experience by providing a comfortable, attractive environment for students and instructors. While target illuminance on task surfaces is important, it is now understood that how light is distributed to reduce glare and shadow is even more important for visual comfort and task visibility.

Educators are using new methods. According to American Digital Schools 2008\(^7\), education trends to watch include computerized classrooms and adoption of interactive whiteboards, which display projected media. All public K-12 schools now have Internet access, and the number of students per computer with Internet access dropped 75% percent from 12% in 1998 to 4% in 2005. Lighting originally designed for black chalkboards and a single horizontal task plane is clearly inadequate for hi-tech learning environments, which have particular lighting requirements.

The above lighting demands should be met on a leaner energy budget. Education buildings consume some 109 billion kilowatt-hours (kWh) of electric energy (per year), of which 33 billion kWh, or about 30 percent (30% of electricity, 14% of electricity + other fuels), is allocated to lighting. This lighting energy consumption translates to 11 kWh per square foot, or $0.82 per square foot at an average utility cost of $0.075 per square foot.

A significant number of schools are being built according to sustainable design principles as defined by green building rating systems, such as daylight and energy efficiency. Energy standards are restricting lighting power allowances and mandating a growing list of lighting controls in schools and universities.

This Recommended Practice was developed to enable school and college administrators to understand the importance of the role that lighting plays in educational environments, to be able to convey to architects and other designers the needs for appropriate provisioning of lighting, and enable architects, engineers, lighting designers, and other lighting decision-makers to ensure that their lighting criteria are consistent with good current practice. It addresses all levels of education, from preschool to continuing professional development.

The scope of this Recommended Practice is restricted to learning and study activities and associated circulation areas. The IES Lighting Handbook, 10th Edition and latest versions of other IES Recommended Practices (RPs) should be consulted for guidance on lighting for other related spaces such as administration and sports, and strategies for daylighting, commissioning, and maintenance practices.

- ANSI/IES RP-1-13 American National Standard Practice for Office Lighting\(^9\)
- ES RP-4-13 Recommended Practice for Library Lighting\(^10\)
- IES RP-6-01/R2009 Recommended Practice for Sports and Recreational Area Lighting\(^11\)
- IES RP-5-13 Recommended Practice for Daylighting Buildings\(^12\)
- IES RP-36-03 Planned Indoor Lighting Maintenance\(^13\)
- IES LM-83-12 Approved Method: IES Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE)\(^14\)
- IES DG-29-11 The Commissioning Process Applied to Lighting and Control Systems\(^15\)

Because of the diversity of educational activities, it is not possible to provide comprehensive recommendations for every learning and study situation. Among the many types of spaces in grade schools, high schools, and colleges are, in addition to classrooms and corridors, assembly halls, theaters, wet and dry labs, trade shops for woodworking or auto repair, and social spaces such as cafes and student and faculty lounges. While this Recommended Practice seeks to explain the principles of good lighting, it will always be necessary for the lighting designer to be cognizant of the educational process and individual facility needs.

This Recommended Practice is organized into three parts:

Part I – Lighting principles and recommendations for spaces in educational facilities – Section 1.0 – Section 5.0

Part II – The Lighting Design Process, Quantity and Quality Considerations, and Equipment Criteria – Section 6.0 – Section 9.0