

Recommended Practice for Lighting Industrial Facilities

Publication of this Committee Report has been approved by the IESNA. Suggestions for revisions should be directed to the IESNA.

**Prepared by:
The IESNA Industrial Lighting Committee**

Copyright 2001 by the Illuminating Engineering Society of North America.

Approved by the IESNA Board of Directors, August 4, 2001, as a Transaction of the Illuminating Engineering Society of North America.

Approved July 26, 2001 by the American National Standards Institute, Inc.

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 IESNA.

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

IESNA Standards and Guides are developed through committee consensus and produced by the IESNA 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 Educational and Technical Development, at the above address for verification and correction. The IESNA welcomes and urges feedback and comments.

ISBN #0-87995-176-1

Printed in the United States of America.

ANSI/IESNA RP-7-01 Recommended Practice on Industrial Lighting

Prepared by the IESNA Industrial Lighting Committee

RP Task Force:

Diarmuid McSweeney, FIES Chair

C. Amick
D. DeGrazio
R. Knott
S. Mishky
D. Paulin
M. Rhodes
G. Schaefer

Industrial Lighting Committee

William Busch, Chair 1994-99

Diarmuid McSweeney, FIES Chair 2000 –

C. Amick, FIES	R. Knott*
P. Belding	W. Lane*
W. Busch	P. Lanphere*
K. Chen*	S. Mishky
D. DeGrazio	M. Packer*
F. Dickey	D. Paulin
D. Duzyk*	M. Rhodes
J. Engle*	G. Schaefer
J. Feters*	W. Smelser*
D. Finch	S. Thomas
J. Fischer	R. Topalova
J. Huebner	J. Vlah*
G. Irvine*	R. Weber*
V. Jones	

*Advisory

Special recognition to F. Dickey for his work on the first draft of the revision of this standard and to P. Boyce, FIES and R. Mistrick, FIES for their contributions.

DEDICATION

The IESNA Industrial lighting Committee would like it noted that Charles Amick contributed greatly to the development of this document. The committee, therefore, dedicates this recommended practice to the late Charles Amick.

CONTENTS

Forward	1
1.0 INTRODUCTION	1
2.0 LIGHTING THE INDUSTRIAL ENVIRONMENT	1
2.1 General Design Considerations for Lighting Industrial Areas	1
2.2 IESNA Lighting Design Guide	2
3.0 QUALITY OF LIGHTING IN INDUSTRIAL FACILITIES	2
3.1 Luminance and Luminance Ratios	2
3.2 Modeling of Objects	6
3.3 Glare and Visual Discomfort	6
3.4 Material Characteristics	7
3.5 Shadows	8
3.6 Source/Task/Eye Geometry	8
3.7 Task Visibility-Flicker and Strobe	9
3.8 Color Rendering (CRI)	10
3.8.1 Color Rendering Index	10
3.8.2 Safety Colors	10
3.9 Daylight Integration and Control	10
4.0 QUANTITY OF LIGHTING IN INDUSTRIAL FACILITIES	11
4.1 Illuminance – Horizontal, Vertical and Intermediate Planes	11
4.1.1 Horizontal Illuminance	11
4.1.2 Vertical Illuminance	12
4.2 Initial and Maintained Illuminance	12
4.3 Lighting System Maintenance	13
5.0 GENERAL LIGHTING EQUIPMENT	13
5.1 Fluorescent Systems	13
5.1.1 Source Characteristics	13
5.1.2 Fluorescent Luminaire Characteristics/Performance	15
5.2 High Intensity Discharge Lighting Systems	15
5.2.1 Metal Halide Lamps	15
5.2.1.1 Pulse-Start and Ceramic Metal-Halide Lamps	17
5.2.2 High Pressure Sodium (HPS) Lamps	17
5.2.3 Luminaire Selection	17
5.2.3.1 High-Bay Luminaires	18
5.2.3.2 Low-Bay Luminaires	18
5.2.3.3 Other Luminaire Types	18
6.0 BALLAST ISSUES-GENERAL	18
6.1 Fluorescent Ballast Issues	19
6.1.1 Ballast Circuitry	19
6.1.2 Electromagnetic Ballasts	20
6.1.3 Electronic Ballasts	20
6.1.4 Instant Start Ballasts	20
6.1.5 Rapid Start Ballasts	21
6.1.6 Compact Fluorescent Ballasts	21
6.1.7 Dimming and Two-Level Switching Ballasts	21
6.1.8 General Ballast Requirements	21

6.2 High Intensity Discharge (HID) Ballast Issues	21
6.2.1 Ignitor	23
6.2.2 Metal-Halide Ballasts	23
6.2.3 High Pressure Sodium Ballasts	23
6.2.3.1 Magnetic Regulator or Constant-Wattage Autotransformer (CWA) Ballast.....	23
6.2.3.2 Lag or Reactor Ballast.....	23
6.2.3.3 Lead Circuit Ballast.....	24
6.2.4 Other HID Ballasts	24
7.0 DISTRIBUTION MODES	24
7.1 General Luminaire Characteristics and Performance	24
7.2 Operating Considerations	24
7.2.1 Electrical	24
7.3 Luminaire Classifications	24
8.0 BUILDING CONSTRUCTION FEATURES THAT INFLUENCE LUMINAIRE SELECTION AND LUMINAIRE PLACEMENT	26
9.0 LIGHTING SYSTEM ECONOMIC ANALYSIS	27
10.0 SPECIAL CONSIDERATION FACTORS	29
10.1 Lighting and Space Conditioning	29
10.2 Classified Areas	29
10.3 High Humidity or Corrosive Atmospheres	30
10.4 High Ambient Temperatures	30
10.5 Low Ambient Temperatures	30
10.6 Clean Rooms	30
10.7 Food and Drug Processing	31
11.0 GENERAL LIGHTING	31
12.0 SUPPLEMENTARY TASK LIGHTING	31
12.1 Luminaries for Supplementary Task Lighting	32
12.2 Portable Luminaries	32
12.3 Classification of Visual Tasks and Lighting Techniques	33
13.0 SPECIAL EFFECTS AND TECHNIQUES	33
13.1 Color Contrast	33
13.2 Inspection Techniques	33
14.0 EMERGENCY, SAFETY AND SECURITY LIGHTING	36
14.1 Emergency Lighting	36
14.2 Safety Lighting	37
14.3 Security Lighting	37
15.0 LIGHTING FOR SPECIFIC TASKS	37
15.1 Molding of Metal and Plastic Parts: Discussion of Lighting and Equipment Choices	38
15.1.1 Foundry Molding (Sand Casting).....	38
15.1.2 Molding Parts of Die-Cast Aluminum and Injection Molded Plastic	38
15.1.3 Inspection of Sand Castings	38
15.1.4 Inspection of Die-Castings and Opaque Injection Molded Plastic Parts.....	39
15.2 Parts Manufacturing and Assembly	39
15.3 Machining Metal Parts	40

16.0 LIGHTING FOR SPECIFIC VISUAL TASKS	40
16.1 Convex Surfaces	40
16.2 Flat Surfaces	40
16.3 Scribed Marks	40
16.4 Center-Punch Marks	41
16.5 Concave Specular Surfaces	41
16.6 Flat Specular Surfaces	41
16.7 Convex Specular Surfaces	41
16.8 Lighting and Visibility for Specific Sheet Metal Fabrication	42
16.8.1 Punch Press	42
16.8.2 Shear	42
16.9 Lighting for Large Component Sub- and Final Assembly	42
16.10 Control Rooms	43
16.11 Warehouse and Storage Area Lighting	44
16.11.1 Types of Warehouse Area and Storage Systems.....	44
16.11.2 Warehouse Illuminance	44
16.11.3 Warehouse Lighting Design Considerations	45
17.0 OUTDOOR AREA LIGHTING	46
17.1 Projected Lighting Systems	46
17.2 Distributed Lighting Systems	46
17.3 Outdoor Tower Platforms, Stairways and Ladders	46
17.4 Special Equipment	47
17.5 Low Illuminance and Visual Acuity Outdoors	47
References	47
Annex A1	
The Basis for Deviating from Recommended Illuminances	48
Annex A2	
Recommended Illuminance Values (target maintained) for Industrial Lighting Design	51
Annex B	
Predictive Methods for Determining Visual Comfort Probability (VCP) and Unified Glare Rating (UGR)	64
Annex C	
Average Illuminance Calculation: The Lumen Method	69

FOREWORD

(This Foreword is not part of the American National Standard and Practice ANSI/IESNA RP-7-01.)

While the objectives of this Recommended Practice are to give a comprehensive treatment of lighting in the industrial environment, there are many spaces in a modern industrial complex that are used for purposes other than manufacturing. These include offices, meeting, conference and reference spaces. It is suggested that the reader refer to the most recent version of these other IESNA Recommended Practices and Design Guides for the appropriate lighting recommendations for spaces not covered in this publication:

ANSI/IESNA RP-1, *Recommended Practice on Office Lighting*
 IESNA RP-5, *Recommended Practice of Daylighting*
 IESNA RP-20, *Recommended Practice on Lighting for Parking Facilities*
 ANSI/NECA/IESNA 502, *Recommended Practice for Installing Industrial Lighting Systems*
 IESNA DG-2, *Design Guide for Warehouse Lighting*

1.0 INTRODUCTION

A well-designed lighting system can make an important contribution to the success of an industrial facility. Unfortunately, too often the lighting is treated as an afterthought during the planning and construction of these facilities. Great attention is paid to the physical dimensions of the building, to the flow of the process and materials, and to production equipment.

It is common that only horizontal illuminance is considered in providing an environment in which to perform industrial tasks. However, many industrial tasks do not occur in a horizontal plane. There are many features of the lighting system, other than quantity of light, which make a significant contribution to the efficiency of the industrial worker. Placement of the luminaries is critical to providing light of the proper quality, as well as quantity and direction, to allow fast, easy recognition of operations, which may be taking place at high speeds in portions of production machinery where ambient light cannot easily penetrate. Selection of the luminaire distribution can be important to rendering the visual task properly when that task is multi-dimensional rather than flat, and when the task occurs in a plane other than horizontal. The operation of the light sources must be understood to ensure that the proper lamps are selected. Improper light source choice can result in difficult and potentially dangerous conditions caused by long

warm-up periods or stroboscopic effects created where rotating parts are present. The ability of the lamps to render colors accurately may have an effect on the recognition of colors or product components and safety colors used to protect the workers from dangerous conditions within the work place. Many industrial operations take place in hostile environments, and the hardware used in these locations must be designed and manufactured to survive these conditions. For these reasons, and many others, great care is required to provide an effective, efficient and readily maintainable lighting system to help modern industrial workers produce at the peak of their ability in a safe environment.

2.0 LIGHTING THE INDUSTRIAL ENVIRONMENT

Providing a successful lighting design for a modern industrial facility is a complex task. In the last three decades of the 20th century, much has been learned about lighting and its positive effects on the well being of people. The goal of providing an efficient, reliable and easily maintainable lighting system, making use of all of the knowledge available to the designer today, is a task that requires experience and considerable planning.

2.1 General Design Considerations for Lighting Industrial Areas

The designer of an industrial lighting system should carefully consider all of the following design criteria since any single issue, or combination of several, could be important in planning a successful industrial lighting installation. (These criteria are not necessarily arranged in order of importance since priorities will vary for different industries or different locations within an industrial complex.)

1. Determine the *quality* of illumination for the manufacturing processes involved. (See the Industrial Lighting Design Guide in **Figure 1 (a)** and **Section 3.0**.)
2. Determine the *quantity* of illumination for the manufacturing processes involved. (See the Industrial Lighting Design Guide in **Figure 1 (a)** and **(b)**, **Section 4.0** and **Annex C**.)
3. Determine the lighting required for safety and ensure all three conditions (quality, quantity and safety) are properly weighed and addressed in the final design.
4. Select listed or approved lighting equipment that will provide the requirements of quality and quantity, including photometric characteristics, as well as the mechanical performance required to meet installation and operating conditions.
5. Arrange equipment so that it will be safe, easy and