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UNITED STATES DEPARTMENT OF LABOR  
BULLETIN OF THE WOMEN'S BUREAU, NO. 94

**STATE REQUIREMENTS FOR  
INDUSTRIAL LIGHTING**

A Handbook  
for the Protection of Women Workers, Showing  
Lighting Standards and Practices

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Pamphlet

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[PUBLIC—No. 259—66TH CONGRESS]

[H. R. 13229]

AN ACT To establish in the Department of Labor a bureau to be known as the Women's Bureau

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That there shall be established in the Department of Labor a bureau to be known as the Women's Bureau.

SEC. 2. That the said bureau shall be in charge of a director, a woman, to be appointed by the President, by and with the advice and consent of the Senate, who shall receive an annual compensation of \$5,000. It shall be the duty of said bureau to formulate standards and policies which shall promote the welfare of wage-earning women, improve their working conditions, increase their efficiency, and advance their opportunities for profitable employment. The said bureau shall have authority to investigate and report to the said department upon all matters pertaining to the welfare of women in industry. The director of said bureau may from time to time publish the results of these investigations in such a manner and to such extent as the Secretary of Labor may prescribe.

SEC. 3. That there shall be in said bureau an assistant director, to be appointed by the Secretary of Labor, who shall receive an annual compensation of \$3,500 and shall perform such duties as shall be prescribed by the director and approved by the Secretary of Labor.

SEC. 4. That there is hereby authorized to be employed by said bureau a chief clerk and such special agents, assistants, clerks, and other employees at such rates of compensation and in such numbers as Congress may from time to time provide by appropriations.

SEC. 5. That the Secretary of Labor is hereby directed to furnish sufficient quarters, office furniture, and equipment for the work of this bureau.

SEC. 6. That this act shall take effect and be in force from and after its passage.

Approved, June 5, 1920.

UNITED STATES DEPARTMENT OF LABOR  
W. N. DOAK, SECRETARY  
WOMEN'S BUREAU  
MARY ANDERSON, Director

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## STATE REQUIREMENTS FOR INDUSTRIAL LIGHTING

A Handbook  
for the Protection of Women Workers, Showing  
Lighting Standards and Practices

By  
MARIE CORRELL



UNITED STATES  
GOVERNMENT PRINTING OFFICE  
WASHINGTON: 1932

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UNITED STATES DEPARTMENT OF LABOR

WOMEN'S BUREAU

BULLETIN OF THE WOMEN'S BUREAU, No. 24

STATE REQUIREMENTS FOR INDUSTRIAL LIGHTING

A Handbook for the Protection of Women Workers, Showing Fighting Standards and Practices

MARIE CORRELL



UNITED STATES GOVERNMENT PRINTING OFFICE WASHINGTON, 1932

For sale by the Superintendent of Documents, Washington, D.C. - Price 15 cents

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LETTER OF TRANSMITTAL

UNITED STATES DEPARTMENT OF LABOR,  
WOMEN'S BUREAU,  
Washington, February 15, 1932.

SIR: I have the honor to submit a report on the lighting of work places and the importance of good lighting to the safety of working women.

There is apparent an increasing interest in lighting problems on the part of employers, due partly to the fact that good lighting pays for itself, but investigations of this bureau have shown that there are problems either of inadequacy or of glare in a large proportion of work places.

Since working conditions are improved both by employers voluntarily installing good equipment and by regulations of State departments of labor, this study presents detailed analyses of the recently adopted lighting code of the American Standards Association and of the State lighting codes and regulations.

I am grateful for the courteous cooperation of State officials in supplying information; of Dr. Janet Howell Clark in discussing the relationship of lighting and eye fatigue; of H. H. Magdsick, of the Illuminating Engineering Society, in writing the foreword of this report and in giving technical advice; of James D. Hackett, of the New York Department of Labor, in giving the report a critical reading; and of the American Standards Association and of the Illuminating Engineering Society in permitting the summarizing of the revised code and in expert assistance in many ways.

The report is the work of Marie Correll, of the division of research.

Respectfully submitted,

MARY ANDERSON, *Director.*

Hon. W. N. DOAK,  
*Secretary of Labor.*

To employers:

Decide that adequate light with protection from glare is essential for your plant and the health of your workers. The following suggestions may help you to do this. 1. Lighting is a technical problem. Consult a lighting expert in your community if possible. If not ask for aid from your State Department of Labor. (See Appendix, pp. 45 to 47.) 2. Determine whether your lighting meets the standards of the American Standard Code of Lighting, Factories, Mills, and Other Work Places. (A fairly complete summary and explanation of this code is given on pp. 11 to 22.) A copy may be secured from the American Standards Association and the Illuminating Engineering Society.

FOREWORD

The sense of sight dominates the activities of the industrial worker and is responsible for most of his usefulness. Its processes use up far more human energy than does any other sense. Yet eyes are constantly neglected; they are being worn out too soon in our homes, in schools, and in industry alike. We go through much of our working lives with efficiency impaired and opportunity limited because provisions for lighting have not developed fast enough to keep pace with the changes in man's mode of life and work. For the outdoor pursuits entailing relatively distant vision under a high order of illumination, under which our eyes evolved, we have substituted indoor activities which impose ever-increasing demands for concentrated near vision.

The effects of insufficient and improper lighting unfortunately do not at once make themselves apparent, for the visual process is a complicated one and the eye is able to adjust itself to render a partial service over a wide range of conditions. But the results are none the less definite and widespread: Accidents, eye strain that saps human energy, lowered accomplishment, visual defects, and even impaired health.

In issuing this publication on the lighting of work places, the Women's Bureau of the Department of Labor makes an important contribution to a more general understanding of lighting conditions and their effects in industry. It offers sound guidance toward safer and more effective illumination. In doing this the bureau is saving the lives and limbs and protecting the vision of workers. It is promoting the efficiency of industry, at the same time conserving human resources and adding to the well-being and happiness of our people.

H. H. MAGDSICK,  
Chairman of Committee on Industrial and School Lighting,  
Illuminating Engineering Society.

NELA PARK, CLEVELAND, OHIO, February, 1932.

Proper illumination is necessary for health and safety. There are standards for good lighting that have been tested by experience—experience is no longer necessary. 1. Several States have found lighting codes helpful guides and standards. (See pp. 14 to 17.) 2. The foot-candle meter is used by some State departments of labor to measure the lighting level usually in questionable cases. 3. While the entire field of lighting is highly technical and requires the experience of experts (some State departments of labor employ lighting experts), the basic requirements of good lighting, and the principles upon which these are based, are not difficult to understand. Inspectors with some information and training on this problem can improve lighting in places of employment.

LETTER OF TRANSMITTAL

UNITED STATES DEPARTMENT OF LABOR

WOMEN'S BUREAU

Washington, February 18, 1932.

Since I have the honor to submit a report on the lighting of work places and the importance of good lighting to the safety of working women.

There is apparent an increasing interest in lighting problems on the part of employers, due partly to the fact that good lighting pays for itself, but investigations of this Bureau have shown that there are problems either of inadequacy or of glare in a large proportion of work places.

Since working conditions are improved both by employers voluntarily installing good equipment and by regulations of State departments of labor, this study presents detailed analyses of the recently adopted lighting code of the American Standards Association and of the State lighting codes and regulations.

I am grateful for the courteous cooperation of State officials in supplying information; of Dr. Janet Howell Clark in discussing the relationship of lighting and eye fatigue; of H. H. Magdsick of the Illuminating Engineering Society in writing the foreword of this report and in giving technical advice; of James D. Hackett of the New York Department of Labor, in giving the report a critical reading; and of the American Standards Association and of the Illuminating Engineering Society in permitting the summarizing of the revised code and in expert assistance in many ways.

The report is the work of Marie Cornell, of the division of research.

Respectfully submitted,

MARY ANNORSON, Director

Hon. W. N. DORR,

Secretary of Labor.

## SUGGESTIONS FOR EMPLOYERS, EMPLOYEES, AND STATE DEPARTMENTS OF LABOR

### To employers:

Decide that adequate light with protection from glare is essential for your plants and then secure it. The following suggestions may help you to do so:

1. Lighting is a technical problem. Consult a lighting expert in your community if possible. If not, ask for aid from your State department of labor. (See Appendix, pp. 49 to 62, for a summary of the law in your State.)

2. Determine whether your plant illumination meets the standards of the American Standard Code of Lighting Factories, Mills, and Other Work Places. (A fairly complete summary and outline of this code is given on pp. 11 to 23.) A copy may be secured from the American Standards Association and the Illuminating Engineering Society, both at 29 West Thirty-ninth Street, New York, N. Y., for 20 cents, or from the Bureau of Labor Statistics, United States Department of Labor, Bulletin No. 556.

3. A foot-candle meter to measure the illumination level should be used at frequent intervals. Its use is a check on maintenance as well as on installation. (See p. 16.)

Eyes adjust themselves to almost any light; visual estimates can not satisfactorily take the place of actual measurements.

4. Expert information and aid on lighting problems for both natural and artificial light can be secured from the following sources:

The Illuminating Engineering Society, 29 West Thirty-ninth Street, New York, N. Y.; General Electric Lighting Institute, at Nela Park, Cleveland, Ohio; Commercial Engineering Department, Westinghouse Lamp Co., Bloomfield, N. J.; New York Lighting Institute, Grand Central Palace, New York, N. Y.; Chicago Lighting Institute, 20 North Wacker Drive, Chicago, Ill.; the lighting service departments of many local light and power companies or electrical associations; the National Safety Council, Civic Opera Building, 20 North Wacker Drive, Chicago, Ill.

Bulletins on lighting problems for particular industries and the advice of lighting experts can be secured from these sources without charge. Some State departments of labor have exhibits of lighting equipment.

5. Use your lighting facilities wisely. Some one person who has been given instruction on lighting problems should be responsible for turning on the lights, adjusting window and lamp shades, watching the lighting in aisles, hallways, etc. Work places should be arranged to secure the most effective use of natural light.

6. After installing an adequate lighting system, plan to secure efficient maintenance. Cleaning windows, cleaning and repainting walls and ceilings, and replacing bulbs and broken reflectors are important phases of careful maintenance. This responsibility should be given to some person or persons in your plant.

### To employees:

Your eyes are a valuable asset—protect them.

1. If the light on your work seems inadequate, request that it be adjusted.  
2. If a light hurts your eyes, some condition of glare may exist; ask that it be corrected. It is bad to sit facing a glaring window. Light can be too bright as well as too dim.

3. The lighting facts given in this bulletin may help you.

### To State departments of labor:

Proper illumination is necessary for health and safety. There are standards for good lighting that have been tested by experience—guessing is no longer necessary.

1. Several States have found lighting codes helpful guides and standards. (See pp. 24 to 44.)

2. The foot-candle meter is used by some State departments of labor to measure the lighting level, usually in questionable cases.

3. While the entire field of lighting is highly technical and requires the experience of experts (some State departments of labor employ lighting experts), the basic requirements of good lighting, and the principles upon which these are based, are not difficult to understand. Inspectors with some information and training on this problem can improve lighting in places of employment.

## STATE REQUIREMENTS FOR INDUSTRIAL LIGHTING

### A Handbook for the Protection of Women Workers, Showing Lighting Standards and Practices

#### INTRODUCTION

The American Standards Association has adopted recently a revised lighting code for factories, mills, and other work places, sponsored by the Illuminating Engineering Society. Because many women are employed in the needle trades and at other close work and because the Women's Bureau has found that lighting is still a problem in many places of employment and that few States have adequate laws and lighting codes, the bureau, in accordance with its duty to formulate standards to improve the working conditions of wage-earning women, has made available in this report the lighting code of the American Standards Association; a discussion of the importance of good lighting from the standpoint of the prevention of eye fatigue, written by an expert; an analysis of the State lighting codes and the experience of the States in administering them; an analysis of State requirements for lighting other than the lighting codes; and suggestions on lighting for employers, employees, and State labor officials.

Women's Bureau observation of lighting conditions in almost 300 establishments indicates that lighting is unsatisfactory in one or more respects in the majority of work places.

Although lighting is an involved technical problem that varies under different conditions, the basic requirements for good lighting, which are few and can be easily understood, are always the same and can be secured with equipment not difficult to obtain.

The American Standard Code outlined and reprinted here is a helpful summary of information and suggestions on lighting. The adequacy of this code is attested to by Dr. Janet Howell Clark, of the School of Hygiene and Public Health of Johns Hopkins University, in her discussion of The Importance of Good Lighting from the Standpoint of Eye Fatigue, which is included in this report.

Since State departments of labor are an important influence in the improvement of lighting conditions, it is significant to find that 13 States have lighting codes. Although only six of these States are enforcing their lighting codes as law, their experience proves the practicability of employing definite standards to improve lighting. The analysis of these codes may be helpful to the 19 States that have neither law nor regulation for the lighting of manufacturing and

mercantile establishments, and to the States that have indefinite, inadequate regulations.

The Women's Bureau suggestions to employers, employees, and State departments of labor (see p. viii) are offered as a brief summary of sources of information and a guide for improving the installation, maintenance, and use of lighting systems.

A Handbook for the Protection of Women Workers, Showing Lighting Standards and Practices

INTRODUCTION

The American Standards Association has adopted recently a revised lighting code for factories, mills, and other work places sponsored by the Illuminating Engineering Society. Because many women are employed in the needle trades and in other close work and because the Women's Bureau has found that lighting is still a problem in many places of employment and that few States have adequate laws and lighting codes, the Bureau in accordance with its duty to formulate standards to improve the working conditions of wage-earning women, has made available in this report the findings of the American Standards Association, a discussion of the importance of good lighting from the standpoint of the prevention of eye fatigue, written by an expert; an analysis of the State lighting codes and the experience of the States in administering them; an analysis of State requirements for lighting other than the lighting codes; and suggestions on lighting for employers, employees, and State labor officials.

Women's Bureau observation of lighting conditions in one or two establishments indicates that lighting is unsatisfactory in one or more respects in the majority of work places.

Although lighting is an involved technical problem that varies under different conditions, the basic requirements for good lighting which are few and can be easily understood, are always the same and can be secured with equipment not difficult to obtain.

The American Standard Code outlined and required here is a brief summary of information and suggestions on lighting. The adequacy of this code is attested to by Dr. James Howell Clark of the School of Hygiene and Public Health of Johns Hopkins University in his discussion of The Importance of Good Lighting from the Standpoint of Eye Fatigue which is included in this report.

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CHAPTER I.—SOME BASIC CONSIDERATIONS

Satisfactory lighting is essential to the best interests of both employers and employees because it affects the workers' comfort and health, reduces accidents,<sup>1</sup> and improves the quality and amount of the work done.

Investigations of working conditions made by the Women's Bureau at intervals over a period of more than 10 years have shown that in large numbers of establishments the problem of securing good light has not been solved. From the point of view of enough light, places where rough work is done or where the light does not directly affect production, such as aisles and hallways, are likely to be insufficiently lighted; when the factor of a light causing discomfort from glare is considered, the light in places requiring high levels of illumination is often faulty. Lighting conditions are likely to be bad in lofts and in old buildings.

Of about 1,300 establishments in 13 States whose lighting has been appraised by investigators of the Women's Bureau, natural lighting was reported to be satisfactory throughout in 672. It was unsatisfactory in 252 cases because of inadequacy, in 172 cases because of glare, and in 195 cases because of conditions not specified. Artificial lighting was reported as satisfactory throughout in 538 establishments. It was unsatisfactory in 164 cases because of inadequacy, in 268 cases because of glare, and in 259 cases because of conditions not specified.

Women's Bureau findings on lighting of workrooms in Mississippi and Tennessee<sup>a</sup>

Industry group	Establishments reported	Natural lighting				Artificial lighting			
		Establishments in which lighting was—				Establishments in which lighting was—			
		Satisfactory throughout	Unsatisfactory due to— Inadequacy	Glare	Both inadequacy and glare	Satisfactory throughout	Unsatisfactory due to— Inadequacy	Glare	Both inadequacy and glare
NUMBER									
Total	295	<sup>b</sup> 159	84	38	14	126	<sup>c</sup> 21	<sup>d</sup> 85	63
Manufacturing	203	<sup>b</sup> 119	38	35	11	70	<sup>c</sup> 18	<sup>d</sup> 60	55
Mercantile	60	20	37	1	2	47		11	2
Laundries	32	20	9	2	1	9	3	<sup>d</sup> 14	6
PER CENT									
Total	100.0	53.9	28.5	12.9	4.7	42.7	7.1	28.8	21.4
Manufacturing	100.0	58.6	18.7	17.2	5.4	34.5	8.9	29.6	27.1
Mercantile	100.0	33.3	61.7	1.7	3.3	78.3		18.3	3.3
Laundries	(*)								

<sup>a</sup> Women's Bureau Bul. No. 55, Women in Mississippi Industries, p. 37, 1926, and No. 56, Women in Tennessee Industries, p. 63, 1927.  
<sup>b</sup> Includes 1 establishment in which natural light was adequate but for which there was no report on glare.  
<sup>c</sup> Includes 2 establishments in which no means of artificial lighting was provided.  
<sup>d</sup> For 13 factories and 5 laundries glare was reported but no note was made of adequacy.  
<sup>e</sup> Per cent not computed; base less than 50.

<sup>1</sup> For a good discussion of accidents due to poor lighting see Industrial Lighting as a Safety Measure, by John S. Spicer, chief, accident investigation section, Pennsylvania Department of Labor and Industry. The Annals of the American Academy of Political and Social Science, January, 1926. Vol. CXXIII, No. 212, pp. 175-187.

The accompanying summary of the details of lighting conditions as noted by the bureau's investigations in 295 establishments in two of these States gives some indication of average conditions. These findings were based on the judgment of the bureau's investigators, and no instruments were used to measure the intensity of the illumination nor to determine its adequacy. While such observation is far from exact, it serves to at least suggest the problems involved.<sup>2</sup> It will be noted that the natural light was considered satisfactory throughout in a little over one-half of the establishments, while the artificial light was satisfactory in slightly more than two-fifths of them—proportions similar to those for the 1,300 establishments just referred to. The largest single cause of unsatisfactory natural light was inadequacy—there was not enough light in all parts of the work-rooms; in artificial lighting, glare was the chief defect.

Since entirely satisfactory lighting requires that adequate artificial light be available, it is evident that in more than one-half of these establishments lighting conditions were unsatisfactory. Some condition of glare from artificial light was found in approximately one-half of the establishments and from natural light in about one-sixth of them. The faulty condition most commonly found was glare, through workers facing windows, working with direct sunlight on their work or in their eyes because shades or awnings were not provided, or working near unshaded light bulbs.<sup>3</sup>

The bureau has found also that dirty windows, dirty light fixtures, and neglect to use the artificial light available, often contribute to unsatisfactory lighting conditions.

Contact with these lighting problems in industry has made the bureau realize that their complete solution requires the advice of experts. Such advice may not be available in small or isolated communities, and even employers, builders, and electrical dealers who realize that they need information may not know how to secure it. This bulletin has been prepared to help those interested to get aid on their lighting problems. Fortunately much splendid work has been done on this subject, and many places of employment have excellent lighting systems. For factories, mills, and other work places the lighting code of the Illuminating Engineering Society contains important suggestions and recommendations. (A summary of this code is given on pp. 11 to 23 of this report.) Some States have laws on lighting or have lighting codes (discussed on pp. 24 to 48 and given in detail on pp. 49 to 62.) Because the development of these codes was sponsored by persons employed in the lighting industries, there may be some tendency to question their standards. The Women's Bureau, interested in whether or not the standards do protect the health of employees, consulted Dr. Janet Howell Clark, associate professor of physiological hygiene in the School of Hygiene and Public Health of Johns Hopkins University. Her opinion, given on pp. 7 to 9, is that the standards are helpful in securing adequate and satisfactory lighting.

<sup>2</sup> Light measurements were taken by means of a foot-candle meter in the study *Lost Time and Labor Turnover in Cotton Mills*, made by the Women's Bureau in 1925. See its *Bulletin* 52.

<sup>3</sup> R. E. Simpson, engineer of the Travelers Insurance Co., estimated in February, 1930, that "Approximately 50,000,000 lamps are now installed in our industrial plants, but less than 25 per cent are equipped with proper reflectors. The remainder either have no reflectors of any kind, or merely those of the obsolete shallow-disk type." *Lighting the Way to Fewer Accidents*, by R. E. Simpson, in *Industrial Engineering*, February, 1930, p. 82, vol. 88, No. 2.

The many varying factors that affect lighting in places of employment make any general discussion of lighting involved and, of course, prevent the formulation of simple and specific recommendations. The character of the work, the cleanliness and color of walls, the arrangement of machinery, the natural light available, and the height of ceilings are a few of the many things that vary from place to place and that must be considered in planning a lighting system. However, the basic requirements for good lighting are few, are always the same, and can be easily understood. Moreover, the necessary equipment for good lighting systems is now available.

The following important considerations on lighting, simply and nontechnically stated, may help in the more effective use of the lighting codes.<sup>4</sup>

1. For any work, at all times, enough light that does not flicker should fall on the work without causing glare or discomfort to the worker. Extreme contrasts and shadows should be avoided.

2. For the most part, the light that helps one to see is light that falls on an object and is reflected to the eye. Light that comes to the eye directly from the light source, such as the sun or an unshaded bulb, is painful and hinders rather than helps sight.<sup>5</sup> Some surfaces and colors reflect—that is, send out from their surface—more of the light that strikes them than others do. This is true of light-colored as compared with dark-colored materials; therefore, work on dark materials requires more light than does work on light materials.

3. The eye can adapt itself so that some sight is possible either with very little light or with a great deal of light, but the eye sees more quickly and clearly and with less effort under certain conditions than under others. The amount of light required for the best results depends partly on what is to be seen and partly on how clearly it needs to be seen. Seeing is not an instantaneous process. It takes time to see, and the amount of time needed depends in part on the light available.

The remarkable adaptability of the eye helps of itself to cause a lighting problem; partial darkness is taken for granted; people get along with unsatisfactory light; and some work gets done. But eyestrain, fatigue, accidents, slower and poorer work result.

4. Natural lighting, that is, the use of sunlight, is very desirable. It is a good light and the windows allowing it to enter also provide ventilation. However, in most places of employment artificial light is necessary to supplement the natural light available, and it always should be provided.

5. There are three systems of artificial lighting, referred to as general, local, and local-general. Under general lighting, all the artificial light used is supplied by overhead lights that illuminate the entire room; in local lighting, individual light sources are provided at each work place; and in local-general lighting, light sources are provided that illuminate the entire room, and local light sources are used to supplement them at work places where additional light is required. (The last is the system recommended for many classes of work by experts in this field. (See p. 16.)

<sup>4</sup>A recently published book, *Seeing—A Partnership of Lighting and Vision*, by Matthew Luckiesh and Frank K. Moss, The Williams & Wilkins Co., Baltimore, 1931, discusses these problems and offers new data.

<sup>5</sup>In general it is agreed that a clear unshaded bulb should not be hung lower than 18 feet from the floor.



6. There are instruments that measure illumination. The one most generally used is the foot-candle meter (see p. 16 for details), which tells how much light is falling on the place being measured. The arbitrary unit of measurement used is the foot-candle, and the lighting codes suggest the number of foot-candles needed at the work. Any measurement under ordinary conditions is one of natural light or of natural and artificial light together. (See p. 13.) Since light bulbs are generally used for artificial light, it seems desirable at first to know how many foot-candles of illumination result from lamps of different watts under given conditions. Such estimates are available<sup>6</sup> but, as watts are of no help in estimating the illumination coming from natural-light sources, a foot-candle measurement must be made in order to be certain of the level of lighting.

7. Glare may be a problem of both natural and artificial light. There is no satisfactory way to measure it except with the individual eye, and the term is loosely defined as "any brightness within the field of vision of such a character as to cause discomfort, annoyance, interference with vision, or eye fatigue."<sup>7</sup> Unshaded windows and unshaded light bulbs are the chief sources of glare, and reflection of light from polished surfaces is another important cause. Equipment to eliminate glare is easily available, and since glare means wasted energy it should be prevented.

With these considerations in mind, it is easy to interpret and to use the lighting codes in determining whether a particular lighting system is adequate, although it may take the advice of lighting experts to improve existing installations or to plan satisfactory new ones.

<sup>6</sup> The Franklin Specifications for Good Lighting. Society of Electrical Development, 420 Lexington Avenue, New York, N. Y.; and Industrial Shop Lighting. Safe Practices Pamphlet No. 22, National Safety Council, 20 North Wacker Drive, Chicago, Ill. It is sometimes estimated that under reasonably clean conditions lamps of from 150 to 300 watts with 1-watt per square foot, will give an illumination of approximately 5 foot-candles.

<sup>7</sup> See p. 17.

## CHAPTER II.—THE IMPORTANCE OF GOOD LIGHTING FROM THE STANDPOINT OF EYE FATIGUE

By JANET HOWELL CLARK, Ph.D.

*Associate Professor of Physiological Hygiene in the School of Hygiene and Public Health of Johns Hopkins University, and author of Lighting in Relation to Public Health, Williams & Wilkins Co., Baltimore, 1924*

Good lighting in places of work is an advantage to both employer and employee. There is ample evidence to show that the installation of a satisfactory lighting system saves time, improves the accuracy of work, safeguards the sight of the workers, and reduces accident hazard.

The Travelers Insurance Company, in analyzing the causes of industrial accidents, has come to the conclusion that 18 per cent are due in part to defective vision and poor lighting;<sup>1</sup> either insufficient illumination or misapplication of the illumination that results in glare, momentarily blinding the worker and obscuring the source of danger.

A relatively low illumination may be sufficient to prevent accidents, but a higher degree is necessary to prevent undue eye fatigue and safeguard eyesight, for continued use of the eyes under insufficient illumination may result in an increase in errors of refraction. Studies of the vision of school children have shown that close eye work, especially under conditions of poor illumination, increases myopia and astigmatism. This is especially noticeable in growing children, but even in adults close eye work under poor illumination will increase the number of eye defects and aggravate those already present.

There have been very few investigations made on which to base such assertions, but in a study made by the United States Public Health Service of the lighting of post offices, the grade of illumination and the eye defects of the workers were examined in two New York post offices.<sup>2</sup> The conclusions of the study state that in both buildings the intensity of illumination was low and its distribution was unsatisfactory. The number of eye defects and the number of cases of defective vision were found to vary in a general way with the intensity of eye work, the largest number of defects and the poorest vision being found in the group of workers doing the most intensive eye work. Furthermore, there seemed to be a definite relation between certain diseases of the eye and defects of vision and the amount of illumination under which the workers were occupied. In this respect it was found that the employees at the old post office, the majority of whom were working under an average artificial illumination of 2 to 3 foot-candles, had a smaller percent-

<sup>1</sup> Illuminating Engineering Society. Code of Lighting: Factories, Mills, and Other Work Places. Approved Aug. 18, 1930, by American Standards Association, 1930, 42 pp. Also published in Transactions of the Illuminating Engineering Society, vol. 25, No. 7, September, 1930, pp. 607-636.

<sup>2</sup> United States Public Health Service. The Hygienic Condition of Illumination in Certain Post Offices, Especially Relating to Visual Defects and Efficiency. Public Health Bul. No. 140, July, 1924. 118 pp.

age of normal vision and a greater percentage of certain eye defects than had the employees at the new post office, the great majority of whom were working under all or part-time daylight.

It is stated by Weston, in a report of the Industrial Fatigue Research Board,<sup>3</sup> that a special examination of the history of 480 myopic subjects revealed this fact: Of those who had not been engaged on fine processes 9.4 per cent had failed owing to visual troubles at some time during their occupations, and of these 7 per cent sustained definite damage to their eyes, while of those who had been engaged in occupations involving habitual close eye work the corresponding figures rose to 53 per cent and 15 per cent. The perception of fine detail depends upon the size of the retinal image and the illumination on the object viewed. When the illumination is too low, then the only resource available is to increase the size of the retinal image by diminishing the distance between the eye and the object, with the result that continuous strain is imposed to a greater or less extent on the muscles of accommodation and convergence.

Although few data are available by which to set the level of illumination necessary to prevent the development of eye defects, obviously this must vary with the fineness of the work and must be related to the eye strain and fatigue resulting from the use of the eye under improper conditions. Many attempts have been made to measure eye fatigue but the results are complicated by the fact that they may be affected by fatigue of any kind.

Ferree and Rand<sup>4</sup> have used as a measure of fatigue the power to sustain clear seeing. The ratio of the time the object was seen clearly to the time it was seen blurred was taken as a measure of the power to sustain clear seeing, and the difference in the power to sustain clear seeing before and after the performance of a given task was taken as a measure of ocular fatigue. By this method was studied the fatigue of the eye produced by different systems of lighting, and it was found that the eye fatigues least under indirect and most under direct systems of lighting, the degree of fatigue increasing with the number of lighting units in the field of view.

Cobb and Moss<sup>5</sup> used the change in the muscular balance of the eyes before and after a given task, performed under varying degrees of illumination, and came to the conclusion that the eye did not fatigue any more rapidly under 100 millilamberts than under 5 millilamberts provided the illumination was well diffused, and that high illuminations are not in themselves fatiguing to the eye provided glare is eliminated.

These results are of a general nature and do not give the conditions of illumination under which eye fatigue can be minimized

<sup>3</sup> Great Britain. Industrial Fatigue Research Board. Report No. 40. The Effect of Eyestrain on the Output of Linkers in the Hosiery Industry, by H. C. Weston and S. Adams. London, 1927. 20 pp.

<sup>4</sup> Ferree, C. E., and Rand, G. Lighting in Its Relation to the Eye. In Proceedings of the American Philosophical Society, Vol. LVII, No. 5, 1918, pp. 440-478; The Efficiency of the Eye Under Different Conditions of Lighting: The Effect of Varying the Distribution Factors and Intensity. In Transactions of the Illuminating Engineering Society, Vol. X, No. 6, Aug. 30, 1915, pp. 407-447; Further Experiments on the Efficiency of the Eye Under Different Conditions of Lighting. In Transactions of the Illuminating Engineering Society, Vol. X, No. 6, Aug. 30, 1915, pp. 448-501; Some Experience on the Eye with Inverted Reflectors of Different Densities. In Transactions of the Illuminating Engineering Society, Vol. X, No. 9, Dec. 30, 1915, pp. 1097-1170; and Some Experiments on the Eye with Pendant Reflectors of Different Densities. In Transactions of the Illuminating Engineering Society, Vol. XI, No. 9, Dec. 30, 1916, pp. 1111-1136.

<sup>5</sup> Cobb, Percy W., and Frank K. Moss. Eye Fatigue and Its Relation to Light and Work. In Journal of the Franklin Institute, vol. 200, No. 2, August 1925, pp. 239-247.

in specific industrial occupations. However, as eye fatigue results in low production in general, and in particular contributes to the lower rate of production in the afternoon compared with the morning, it should be possible to arrive at some idea of the illumination necessary to reduce eye fatigue to a minimum from a study of production data in various industries.

A very detailed study of output and errors in typesetting under different types and grades of illumination has been made by Weston and Taylor.<sup>6</sup> They found that maximum fatigue is experienced when the minimum illumination is provided, and that the quality of work, as judged by the ratio of errors to output, suffers until the illumination is raised to 24.5 foot-candles.

A study of the relationship of illumination to ocular efficiency and fatigue among the letter separators in post offices<sup>7</sup> led to the conclusion that speed of performance reaches a maximum and ocular fatigue a minimum, for work of this type, at an illumination of 8 to 10 foot-candles.

Research of this kind in the future will provide specific values for the level of illumination best suited to different types of industrial work. In the meantime the information that can be had along this line has been summarized in the various codes of factory lighting published and revised from time to time by the Illuminating Engineering Society.<sup>8</sup> In spite of the fact that these codes come largely from the illuminating engineering profession and might be regarded with some suspicion as an attempt on the part of the engineers to sell more light to the public, their genuineness is unquestioned. Great care has been exercised in appointing the committees and soliciting criticism from both scientists and practical constructors, so that many points of view are represented. It may be said fairly that these codes, far from being biased on the side of the illuminating engineer, have used his technical knowledge to give an honest and intelligent summary of the principles of good lighting for the use of the public. Further development of the codes along their present lines and their adoption, in part or in whole, by the various States certainly should be encouraged. By their help it is possible to pass upon factory lighting, while without them this is a matter of individual judgment and the opinion of the investigator may be unscientific and difficult to appraise.

Careful investigations of ocular efficiency and fatigue in specific occupations, such as those already carried out by the United States Public Health Service and the Industrial Fatigue Research Board, will provide definite information concerning the optimum illumination in certain types of work, and when incorporated into future revisions of the industrial lighting codes will furnish a more definite and useful guide for judging the conditions of illumination in industry.

<sup>6</sup> Weston, H. C., and A. K. Taylor. The Relation Between Illumination and Efficiency in Fine Work. (Typesetting by Hand.) Joint report of the Industrial Fatigue Board and the Illumination Research Committee. London, 1926. 11 pp.

<sup>7</sup> U. S. Public Health Service. Relationship of Illumination to Ocular Efficiency and Ocular Fatigue Among the Letter Separators in the Chicago Post Office. Public Health Bul. No. 181, December, 1928. 58 pp.

<sup>8</sup> Illuminating Engineering Society. Code of Lighting: Factories, Mills, and Other Work Places. Approved Aug. 18, 1930, by American Standards Association, 1930, 42 pp. Also published in Transactions of Illuminating Engineering Society, vol. 25, No. 7, September, 1930, pp. 607-636.

### CHAPTER III.—CODE OF THE AMERICAN STANDARDS ASSOCIATION FOR LIGHTING FACTORIES, MILLS, AND OTHER WORK PLACES

Lighting problems are so technical and are affected by so many varying factors that their solution requires trained persons. Fortunately, many discussions of lighting problems may be secured easily and a code of standard lighting practice for places of employment is available as a guide.<sup>1</sup>

The Illuminating Engineering Society, organized in 1906, has a membership representing the following groups of persons: The public utilities, that is, companies supplying electricity; manufacturers of natural and artificial lighting equipment; consulting engineers, architects; general manufacturing industries; government agencies; college professors, physicists, physiologists, and oculists. Since its first lighting code was published in 1915,<sup>2</sup> the society has sponsored several codes and code revisions, the latest being a code of lighting factories, mills, and other work places, approved as an American standard on August 18, 1930, by the American Standards Association. This is a revision of the code of lighting factories, mills, and other work places approved as an American standard on December 31, 1921, by the American Engineering Standards Committee.<sup>3</sup>

This code, which is based on lighting practice and has been approved by representatives of the following societies and agencies, is accepted as a guide for good lighting: American Gas Association, American Institute of Architects, American Institute of Electrical Engineers, American Society of Mechanical Engineers, Association of Edison Illuminating Companies, Association of Governmental Officials in Industry, Illuminating Engineering Society, International Association of Industrial Accident Boards and Commissions, National Association of Building Owners and Managers, National Association of Cotton Manufacturers, National Bureau of Casualty and Surety Underwriters, National Electric Light Association, National Electrical Manufacturers Association, National Safety Council, United States Bureau of Standards, United States Department of Labor, United States Navy Department, United States Public Health Service, United States War Department, and members at large.

Anyone interested in lighting problems should secure a complete copy of the code.<sup>4</sup> An outline and a fairly complete reprint of the code, with some rearrangement, is given in the pages following.

<sup>1</sup> For brief list of suggestions to persons most concerned, see page viii.

<sup>2</sup> Clark, Janet Howell. *Lighting in Relation to Public Health*, p. 106. Williams & Wilkins Co., Baltimore, 1924.

<sup>3</sup> Reprinted by the U. S. Bureau of Labor Statistics as Bul. No. 331 of its Safety Code Series.

<sup>4</sup> From either the American Standards Association or the Illuminating Engineering Society, at 29 West Thirty-ninth Street, New York, N. Y. American Standard Code of Lighting: Factories, Mills, and Other Work Places. Approved Aug. 18, 1930. Price, 20 cents.

The three main divisions of the code are these: Advantages of good illumination; essentials of good illumination and its measurements; and suggested minimum regulations to be established by State authorities.

### AMERICAN STANDARD OF LIGHTING: FACTORIES, MILLS, AND OTHER WORK PLACES

#### Part I.—ADVANTAGES OF GOOD ILLUMINATION

[Reprinted with some rearrangement and slight omissions, by permission of the Illuminating Engineering Society]

The advisability of good natural and artificial illumination is so evident that a list of its effects may seem commonplace, but these effects are of such importance in their relation to management that they are worthy of careful attention. The effects of good illumination, both natural and artificial, and of bright and cheerful interior surroundings, include the following:

1. Reduction of accidents.
2. Greater accuracy in workmanship, resulting in improved quality of goods.
3. Increased production.
4. Less eyestrain.
5. Greater contentment of the workers.
6. Greater cleanliness.
7. More order and neatness in the plant.
8. Supervision of the employees made easier.

The cost of accidents, due to poor illumination, greatly exceeds the cost of providing adequate illumination. [Based on comparison of cost of good and of poor lighting with the cost of accidents, not given here.]

While it is difficult to appraise the savings effected in increased production and improved quality by good illumination, it by no means follows that such savings are insignificant or unsubstantial. The factory owner who ignores them neglects his own interests. Other items in the foregoing list, even more difficult to value definitely, are none the less real; taken together, they constitute a powerful argument in favor of the best available illumination in the factory.

If an operator, because of the good illumination, saves—in more production or better quality of product—the equivalent of only 3 minutes per day for 300 days, he will offset the annual cost of the illumination. Good illumination is, relatively speaking, inexpensive, and its introduction and maintenance are good investments on the part of the factory owner.

The figures illustrating the low cost of good lighting compared with the cost of labor also illustrate how large may be the losses unconsciously sustained by the factory owner from the use of a poor lighting system. An operator losing, say, 30 minutes per day, loses more than \$60 per year, or about 10 times the cost of giving him good illumination.

## Part II.—ESSENTIALS OF GOOD ILLUMINATION AND ITS MEASUREMENT

### Natural lighting.

It is of interest to note that the range of illumination under which the eye can function with some degree of success is extremely wide, varying from a few hundredths of a foot-candle in the moonlight up to as much as 10,000 foot-candles out in the sunlight on a clear day. In planning a new factory building or other work place, the design should be such that the foot-candle values for daylight should be at least twice those stated in Table I. (See p. 14.) The natural lighting is frequently many times these figures; in fact, illuminations of a hundred foot-candles or more can be measured near the window in almost any shop. However, wide extremes in illumination are not conducive to best vision.

Factory owners in most industries are particularly interested in making the best possible use of their daylight facilities so as to render useful and valuable all parts of the floor space; and also to shorten the period when artificial lighting is needed. The saw-tooth, monitor, or skylight windows of modern factory construction permit of an adequate and more uniform daylight illumination of the entire floor area and are desirable when practicable. When rooms are illuminated through side windows, it is often difficult or impossible satisfactorily to light all parts of the floor space, furnishing adequate illumination to the workers without subjecting some of them to objectionable glare. In some cases the use of refracting or diffusing glass which redirects the rays of light so as to improve the distribution of daylight in the room, especially in the part of the room remote from the windows, is desirable.

If only one side wall contains windows, the width of the room perpendicular to this wall should be less than twice the height of the top of the windows above the floor; if windows are in two parallel side walls, the width of the room between these walls should not exceed six times this window height. A monitor gives best results when its width is about half the width of the building, and the height of the windows in the monitor is one-half of the monitor width. The height of the windows in saw-tooth construction should be at least one-third of the span. In general, single-story industrial buildings should have a window area of at least 30 per cent of the floor area.

Reflection of daylight from surfaces outside a building has an important effect upon the lighting of a room. Faces of structures, walls of courts, and roofs of saw-tooth buildings should be finished in the lightest practicable colors and so maintained. The possibility of glare from such surfaces should, however, be considered.

Windows should be equipped with adjustable devices so that the illumination may be accommodated to changing exterior conditions. Window shades of light tones should be used, for at night they will reflect artificial light back into the room; shades transmitting diffusely a large part of the natural light they receive will generally improve the daylight illumination. When practicable, shades should be mounted so as to permit of covering any desired parts of the windows. Venetian type blinds are effective means to control the distribution of natural illumination as well as the glare from windows,

if properly finished and adjusted. Any devices for adjustment of natural lighting should be controlled by some specified individual.

Rapid changes in illumination levels result in dangerous, even though temporary, inability to see, due to the time required for adaptation of the eyes. An example of this is when one steps from bright sunlight into a dimly lighted interior. A passageway adjacent to a highly illuminated area, therefore, needs relatively high and graduated illumination. Again, where the eye has been afforded the advantages of a high level of illumination throughout the day and artificial light is turned on to reinforce the failing natural light, a higher total illumination is ordinarily needed than at night under artificial lighting alone.

### Measurement of illumination.

The foot-candle is the unit of illumination, in terms of which lighting requirements are specified. A general idea of the amount of illumination represented by foot-candle values can be obtained by holding a newspaper at different distances from a bare 25-watt tungsten filament lamp, so that the light rays fall perpendicularly upon the surface. For 16 foot-candles the distance should be 15 inches; for 8 foot-candles, 21 inches; for 4 foot-candles, 2½ feet; for 1 foot-candle, 5 feet; for one-fourth foot-candle, 10 feet.

In this connection it should be realized that the brightness of the surface will depend not only upon the foot-candles of incident illumination, but also upon the nature of the surface. That is, with equal illumination, white paper will be much brighter than cast iron.

It is impractical and frequently misleading to attempt to estimate foot-candle values simply by viewing an illuminated surface. The simplest instrument for measuring these values is a foot-candle meter with which foot-candles can, with a little practice, be read accurately enough for ordinary purposes.<sup>5</sup>

*Points at which measurements should be taken.*—In checking recommended or required intensities of illumination with an instrument such as the foot-candle meter, it is extremely important that the measurement be made at the point and in the plane where the given illumination is needed. Thus, for any operation the illumination should be measured on the plane on which the work or operation is performed, whether it be horizontal, vertical, or at some intermediate angle. The illumination over an area such as a hallway or aisle refers ordinarily to the floor level and is measured in the horizontal plane.

### Recommended levels of illumination.

Table I gives the range of illumination values that are considered desirable for different classes of work. These values are based upon practice established through years of experience. Persons of advanced years or with defective eyesight require more light than do those having perfect vision. A range of foot-candle values is given

<sup>5</sup> Can only be purchased from the Nela Park Engineering Department, General Electric Co., Cleveland, Ohio, or the Westinghouse Lamp Co., 150 Broadway, New York, N. Y., price, \$21.50. A book of directions given with each meter clearly states the way to use it. Local light and power companies often have such instruments that may be borrowed. A new instrument, the Weston Photronic-Cell Illuminometer, can be purchased from the Weston Electrical Instrument Corporation, Waverly Park, Newark, N. J. Price, \$95. This instrument has many practical advantages for the layman.



Where the higher levels are specified for particular processes, such illumination need not be supplied in all parts of a room, nor on all parts of a machine, but only at locations where work of the type indicated is likely to be performed. Thus, in a workroom, a general illumination providing the value specified for aisles and passageways or storage spaces might be supplemented at proper locations by higher illumination, specified for work of different degrees of fineness in the table. The high illumination may be required over small areas only, as in watchmaking and machine sewing, or over wide areas, as in automobile assembly and finishing. In practice, the lower values required in the room will often be considerably exceeded in order to conveniently provide for the higher values. The latter is fortunate, since it avoids the possibility of having extreme contrasts between the actual working area and the surroundings.

#### Maintaining the level of illumination—cleaning and painting.<sup>7</sup>

The proper and adequate maintenance of equipment for both natural and artificial lighting is essential. Systems which are adequate when first installed will soon deteriorate unless properly maintained. The factory owner should establish a regular, definite system of maintenance so as to insure that sky windows, side windows, lamps, and accessories are at all times kept clean, in proper adjustment, and in good repair. Means should be provided for easy access to all lighting units by the employee in charge of their maintenance. Walls and ceilings should be repainted, preferably in light tones, at regular intervals, particularly where, as in indirect systems of lighting, a large part of the illumination comes from the ceiling. It should be kept in mind that the illumination requirements given in the tables apply to the lighting equipment under adverse operating conditions, not simply new and clean as when first installed.

#### Initial installation.

To insure that a given level of illumination will be maintained even where conditions are favorable, it is necessary to design the system to give initially at least 25 per cent more light than the required minimum. In locations where the dirt will collect rapidly and where adequate maintenance is not provided, the initial value should be at least 50 per cent above the minimum requirement, and \* \* \* even this allowance may prove insufficient.

#### Use of foot-candle meter.

Especially in connection with the maintenance of lighting systems attention is called to the desirability of having available in the factory an instrument with which the foot-candles of illumination received at any point can be measured. One instrument, the foot-candle meter, while not designed for precise measurements, has a wide field of usefulness because, with a little practice, determinations are easily made with it and are accurate enough for most practical purposes. The foot-candle meter is small, light in weight, and entirely self-contained. Illumination is read directly from the scale

<sup>7</sup>The American Standards Association Safety Code for Window Washing should be secured and followed to protect window washers from accidents. Address: Illuminating Engineering Society, 29 West Thirty-ninth Street, New York, N. Y.

without computation or manipulation. In one large establishment where the superintendent uses a foot-candle meter systematically as a check on his maintenance department, readings of illumination are taken at regular intervals at fixed stations throughout the plant. These readings are recorded in such a way that the successive readings are readily comparable. When any inconsistency appears in the records an investigation is made and the remedy applied. The illumination in that establishment is never allowed to fall below 6 foot-candles without immediate correction. By measuring light actually delivered to the work the foot-candle meter automatically reveals the combined effect of all possible causes of depreciation. Ignorance of the magnitude of depreciation has often been the cause of inadequate maintenance. Soap and water cost less than electrical energy.

#### Avoidance of glare.

It is not a particularly difficult problem to supply a factory or office with the amount of light specified in Table I, and reflectors are available which provide these levels economically. There are many installations, however, where poor conditions for vision exist in spite of an adequate foot-candle level. This is usually because precautions were not taken to provide illumination without glare.

Glare may be defined as any brightness within the field of vision of such a character as to cause discomfort, annoyance, interference with vision, or eye fatigue. Always a hindrance to vision, it often, like smoke from a chimney, represents a positive waste of energy as well. It is one of the most common and serious faults of lighting installations; the code properly requires the shading of lamps in industrial plants to guard against glare.

Glare is objectionable because (1) when continued it tends to injure the eye and to disturb the nervous system; (2) it causes discomfort and fatigue and thus reduces the efficiency of the worker; and (3) it interferes with clear vision, and thus reduces the efficiency and in many cases increases the risk of accident or injury to the worker. From both a humanitarian and a business viewpoint the owner or operator of a factory should be interested in avoiding glare, whether caused by daylight or by artificial light.

*Factors affecting glare.*—In order that the various factors affecting glare may be better understood, the principal causes are outlined below:

1. Brightness of source: The light source may be too bright; that is, it may have too high a candlepower per square inch of area.

A glance at the sun proves that an extremely bright light source within the field of vision is capable of producing acute discomfort.

2. Total volume of light: The light source may be too powerful for comfort; that is, it may have too great a total candlepower in the direction of the eye.

Experience has shown that a 500-watt lamp in a 10-inch opal globe, or a mercury-vapor lamp of an equivalent light output, hung seven or eight feet above the floor and a similar distance in front of the observer will prove quite as glaring as the exposed filament of a 50-watt incandescent lamp in the same location. An unshaded window often causes glare, due, of course, to the large volume of light rather than to the high brightness of the sky.

3. Location in the field of view: A given light source may be located at too short a distance from the eye or it may lie too near the center of the field of vision for comfort; that is, within too small an angle from the ordinary line of sight. The natural position of the eye during intervals of rest from any kind of work is generally in the horizontal direction, and it is desirable that during such periods the worker should be freed from the annoyance caused by glare. Glare is the more objectionable the more nearly the light source approaches the direct line of sight. While at work the eye is usually directed either horizontally or at an angle below the horizontal. Glaring objects at or below the horizontal should especially be prohibited. The best way to remove light sources out of the direct line of vision is to locate them well up toward the ceiling. Local lamps—that is, lamps placed close to the work—if used must be particularly well screened.

4. Contrast with background: The contrast may be too great between the light source and its darker surroundings. It is a common experience that a lamp viewed against a dark wall is far more trying to the eyes than when its surroundings appear relatively light. In order to provide a light background (usually ceiling or side walls) which will minimize contrasts, the surfaces should be painted a light color and the system of illumination employed should be such as to direct some light upon the background. In general, a light tone for ceilings and high side walls and a paint of medium reflecting power for the lower side walls will ordinarily be found most satisfactory under both artificial and natural lighting.

Where strictly local lighting systems are employed—that is, where individual lamps are supplied for all benches and machines—and no overhead lighting is added, the resulting contrasts in illumination will usually be found so harsh as to be objectionable even though the lamps themselves are well shielded. The eyes of the workman looking up from his brightly lighted machine or bench are not adapted for vision at low illuminations; hence, if adjacent objects and aisles are only dimly lighted, he will be compelled either to grope about, losing time and risking accident, or to wait until his eyes have become adapted to the low illumination. Glancing back at his work, he again loses time while his eyes adjust themselves to the increased amount of light which reaches them. If long continued, this condition leads to fatigue as well as to interference with vision and to accidents. In other words, where local lamps are employed, there should also be a system of overhead lighting which will provide a sufficient illumination of all surrounding areas to avoid such undesirable contrasts.

5. Time of exposure: The time of exposure may be too great—that is, the eye may be subjected to the strain caused by a light source of given strength within the field of vision for too long a time.

Where an operator is seated and his field of vision is fixed for several hours at a time, light sources of lower brightness and lower candlepower are required than where the operator stands at his work and shifts his position and direction of view from time to time. Those who are forced to work all day at desks facing the windows are particularly likely to suffer from this form of glare.

*Glare by reflection.*—Another way in which glare is produced is by the reflection of light from polished surfaces in the field of vision. The difficulty experienced in protecting the eyes from this kind of glare is sometimes very great. The brightness of the image on the working surface is, of course, proportional to the brightness of the light source above it, and hence, one way in which to minimize this effect is to diffuse the downward light; that is, to use a bowl-frosted or bowl-enameled lamp, or an inclosing fixture, or to employ semi-indirect or totally indirect lighting fixtures. In some cases the light source can be so located that its reflection is directed away from, rather than toward, the eyes of the workers. The avoidance of highly polished surfaces in the line of vision is another good way to minimize reflected glare.

There are some instances, on the other hand, where sharp shadows and specular reflection from the materials worked upon actually assist vision. For example, in sewing on dark goods the thread is much more easily distinguished when illumination is secured from a concentrated light source, such as a brilliant lamp filament, which casts sharp shadows and gives rise to a distinct glint from each thread. However, in these cases the light source must be particularly well shielded from the eyes of the worker.

*Determining glare.*—The eye has the quality of estimating, with a fair agreement among different observers, which of two light sources is the more glaring, taking into account both brightness and candlepower when the two sources are located side by side and viewed against the same background. This quality of the eye has been used as the basis of a relatively simple system of glare rating.

[WOMEN'S BUREAU COMMENT.—According to this system glare is classified in various grades on the basis of tungsten filament lamps of certain watts. Each of the 11 grades is designated by a letter (A to K), the first representing a 10-watt lamp, the last, one of 1,000 watts. The complete list is given in Table II. The extent of glare produced by various sources of light may be measured according to the standard designated by these letters, corresponding, of course, to the extent of glare produced by the lamp with given watt strength. See Table III. Finally, experiments have been made to determine the degree of glare—measured by the same letter standard—that should not be exceeded under conditions specified. The resulting recommendations are shown in Table IV.]

This classification follows:

TABLE II.—Scale used to classify glare of light sources

Glare grade	Standard for grade
A	10-watt tungsten filament lamp in 6-inch frosted ball globe.
B	15-watt tungsten filament lamp in 6-inch frosted ball globe.
C	25-watt tungsten filament lamp in 6-inch frosted ball globe.
D	40-watt tungsten filament lamp in 6-inch frosted ball globe.
E	50-watt tungsten filament lamp in 6-inch frosted ball globe.
F	60-watt tungsten filament lamp in 6-inch frosted ball globe.
G	100-watt tungsten filament lamp in 6-inch frosted ball globe.
H	150-watt tungsten filament lamp in 6-inch frosted ball globe.
I	300-watt frosted lamp.
J	500-watt frosted lamp.
K	1,000-watt frosted lamp.

Common light sources compared with the standards in Table II are rated as follows:

TABLE III.—Specific classification of common light sources from the standpoint of glare as derived from Table II

Light sources	Glare grade					
	40 watts	60 watts	100 watts	150-200 watts	300 watts	500-1,000 watts
Natural light (as seen through windows):						
Sun.....						K
Bright southern sky.....						G
Dull or northern sky.....						C
Sun shining on prism glass.....						J
Mercury vapor tubes.....						G
Carbon incandescent lamps:						
16-candlepower.....						F
32-candlepower.....						G
Tungsten filament lamps						
Bare lamps.....	G	H	I	J	J	K
Frosted lamps or frosted globes.....	D	F	G	H	I	J-K
8-inch opal globes.....	C	E	F			
12-inch opal globes.....			E	G	H	I
16-inch opal globes.....				F	G	H
With flat reflectors—filament position visible.....	G	H	I	J	J	K
With dome reflectors—steel or dense glass:						
Filament position visible from working position.....	G	H	I	J	J	K
Filament position not visible.....	B	B	D	D	E	G
Dome reflectors—white bowl lamps.....				F	G	G
With bowl reflectors—steel or dense glass:						
Filament position visible.....	G	H	I	J	J	K
Filament position not visible.....	C	C	D	E	G	H
Totally indirect lighting <sup>1</sup> .....			B	B-C	C	D
Semi-indirect bowl <sup>1</sup> .....			B-D	C-D	C-E	D-G

<sup>1</sup> Where a range is given, the best grade (that is, the lowest) applies to bowls that are of dense glass, and the poorest to bowls that have a decidedly bright spot in the center.

Finally, the experiments by which these glare grades were applied to various places according to height of light above the floor resulted in the following findings:

TABLE IV.—Grades of light-source glare that should not be exceeded for good conditions of vision<sup>1</sup>

Height of light source above floor	Glare grade that should not be exceeded <sup>2</sup> in—			
	Roadways and yard thoroughfares	Storage spaces	Ordinary manufacturing operations	Offices and drafting work and certain manufacturing operations <sup>3</sup>
Under 6.5 feet.....		D	C	A
6.5-7.5 feet.....		D	C	A
7.5-9 feet.....	F	E	D	C
9-11 feet.....	G	G	E	D
11-13 feet.....	H	G	G	E
13-16 feet.....	H	H	H	F
16-20 feet.....	I	I	I	G
20 feet and up.....	J	J	J	H

<sup>1</sup> That these standards are moderate is indicated by the fact that in each case a grade only 1 or 2 points harsher, is considered the lowest permissible. Its flexibility also is apparent.

<sup>2</sup> Where backgrounds are very dark in tone, a light source 1 grade softer than specified is recommended for interiors.

<sup>3</sup> Those operations in which workers are seated facing in one direction for long periods of time.

It will be observed that Grade K is representative of light sources that are extremely bright and glaring, whereas Grade A (a 10-watt lamp in a 6-inch frosted ball) can be placed almost anywhere in the field of view without causing discomfort. (See Table II.)

Where lamps are located at considerable heights above the eye level, relatively bright light sources can be tolerated, and this is particularly true in locations such as out-of-doors at night, where little close discrimination of detail is required of the eye. On the other hand, where light sources are hung low and are constantly in the field of view of a worker seated at a table or workbench, then the light source should be of Grade A or B, that is, very soft and free from glare. Again, the effect of glare is cumulative; therefore, in a long room where a considerable number of light sources are in one's field of vision it is necessary to have better diffused sources than in a room of limited area where only one or two units are visible to a man seated at his desk.

[Women's Bureau note: The following illustrates the way in which this glare classification may be used. A manufacturer of paper boxes is considering installing, 10 feet from the floor, a 300-watt lamp in a flat reflector with the filament position visible. By consulting Table IV he finds that for ordinary manufacturing operations lights 10 feet from the floor should not be harsher than glare Grade E. By consulting Table III he finds that a 300-watt lamp, in the type of reflector he is considering, is in Grade J, too harsh to allow good conditions of vision—in fact, much harsher than is considered permissible. (See Table IV, footnote 1.) However, both tables suggest solutions of his problem. Table IV shows that lights in Grade J may be used if they are placed 20 or more feet from the floor, and Table III shows that a 300-watt lamp will not exceed Grade E (the desirable maximum in this case) if placed in a dome reflector with the filament position not visible. The tables show that other types of reflectors, lamps of different wattage, and different elevations of the light source above the floor can be combined to give the employer illumination that is satisfactory from the standpoint of glare.]

**Adequate electrical wiring.**

In specifying electrical wiring for a new building or the revision of old wiring, it is important to observe the following points:

1. The National Electrical Code regulations are intended to insure protection from fire hazard, but do not necessarily provide a wire size sufficient to permit of the most efficient use of lamps and equipment, nor do they make provision for future increases of illumination. To take them as a criterion of adequate capacity of a wiring system, therefore, in the interests of low first cost, is not good economy in the long run.

2. Wiring should provide for economical distribution of electrical energy.

Electrical wiring of inadequate size introduces a source of energy loss between the meter and the outlet, and at the same time causes a reduction in the voltage at the lamp socket, so that lamps (unless specially ordered for lower voltage) are operated at a voltage below that for which they were designed. Operation of lamps at reduced voltage means that the efficiency of light generation is lower, and the



overall cost of light is higher, than when they are operated at rated voltage.

When wiring is inadequate, as more lamps are turned on the voltage at each socket decreases. Thus as daylight fails and more artificial light sources are required, the illumination secured from each lamp decreases, producing an annoying variation in illumination at different times and places.

3. Wiring should be of sufficient capacity to provide for future requirements, as the trend of lighting intensities is ever upward.

Recommended lighting practice and the appreciation on the part of factory owners and managers for the value of good lighting has a distinct forward trend, and an installation considered up-to-date when made may be found quite inadequate at a later date. The cost of rewiring finished buildings is many times greater than the additional cost of providing capacity for future requirements in the original installation.

The paragraphs following are abstracted from a specification prepared by the National Electric Light Association to express the quantitative requirements which good illumination practice imposes upon the wiring.

This specification is in conformity with the regulations of the National Electrical Code, as regards current-carrying capacity, and, in addition, makes reasonable provision for economical distribution of energy and the probable lighting requirements of the near future.

In this specification, it is assumed that each branch circuit will be fused for 15 amperes.

*Branch circuits.*—A single branch circuit should not be required to supply the general lighting for a work space greater than 400 square feet or a bay approximately 20 by 20 feet, nor should it be required to supply the overhead lighting for more than 800 square feet of hall or passageway or other nonproductive area.

Based on the wattage of outlets specified on the plans, branch circuits should be so arranged that the initial load on a single circuit will not exceed 1,000 watts, except in the case of a single lamp of larger size.

The smallest size wire that should be used is No. 12 gage, and for runs from a panel board to the first outlet of from 50 to 100 feet, No. 10 gage wire is the smallest that should be used, with No. 12 between outlets.

Runs exceeding 100 feet from panel board to the first outlet should be avoided by addition or relocation of panel boards. Where such runs can not be avoided, the lamp load should be limited to 600 watts for each branch circuit.

Convenience outlets should be placed on a circuit separate from that supplying general lighting. Such outlets should be of the duplex type, with not more than six grouped on one circuit. For runs from the panel board to first outlet under 100 feet, wire not smaller than No. 12 gage should be used, and No. 10 gage where the runs must be longer.

*Panel boards.*—Panel boards should contain at least one spare circuit position for each five active circuits or fraction thereof. It is generally desirable to supply each circuit position with a switch.

There should be provided at least one panel board on each floor of the building. Wherever possible, panel boards should be so located that branch circuit runs exceeding 100 feet to the first outlet can be avoided.

*Feeders.*—The current-carrying capacity of a feeder should be sufficient to supply 7.5 amperes (115 volts) to every 15-ampere circuit position provided for on the panel board or boards which it feeds.

The feeders should be of such size that the voltage drop from the service switch to the panel board will not exceed 1½ per cent, with a load of 7.5 amperes (115 volts) on every branch circuit provided for.

Conduits for inclosing feeders should be of sufficient size to permit replacing the original feeders with wires two standard-gauge sizes greater in capacity.

#### Locating switches and arrangement of lights.

The switches which turn on and off the light in entrances and halls of buildings should be located near the point of entrance. Likewise a switch which controls at least one circuit of lamps in a room should be located near each principal point of entrance to that room.

In locating switches or control devices in factory and mill aisles, care should be exercised to arrange them systematically; that is, on columns situated on the same side of the aisle and on the same relative side of each column. This plan materially simplifies the finding of switches or control devices by those responsible for turning the light on and off.

For control purposes, groups of lamps may constitute a square, a row parallel to the windows, or a row perpendicular to the windows. The arrangement on a square has the most to recommend it, as any worker within the area gets the benefit of several near-by lighting units. A row parallel to the windows is occasionally desirable since, when daylight fails, those workers farthest from the windows can have one or two rows lighted to supplement the natural light. If two rows are used, the merits of the square arrangement are to a great extent retained. Control of rows perpendicular to the windows is usually to be avoided, as grouping in a square can almost always be applied to better advantage.

*NOTE.*—The next section of the code, containing suggested minimum regulations that State authorities may establish, is discussed in another place in this study (see pp. 28 to 33), where the recommendations of the American Standard Code are used as the basis of comparison for the State lighting codes.

#### CHAPTER IV.—STATE LIGHTING CODES

The American Standard Code suggests that certain regulations of lighting should be established by State authorities as minimum requirements for the safety of employees. These suggestions are given in three rules: The first covers the minimum foot-candles of illumination to be required; the second requires the avoidance of glare; and the third requires special arrangements for exit and emergency lighting.

Although more States have some law on lighting, only the 13 following States had lighting codes in April, 1931: California, Idaho, Kentucky, Maryland, Massachusetts, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Washington, and Wisconsin.<sup>1</sup> All these codes are based on the suggestions of the Illuminating Engineering Society codes. In fact, Idaho, Kentucky, Maryland, and New Jersey use the American Standard Code without any changes. These States having lighting codes are the only States that specify the amount of light required. Their regulations are discussed in greater detail than are the laws and regulations of other States because their example and experience may be helpful to other States interested in improving lighting.

Most of the State codes were adopted as safety measures in the period from 1918 to 1922. Important reasons for their adoption—similar for all States—are summarized in the following statement from the director of the division of industrial safety of the Massachusetts Department of Labor and Industries.

Reasons for adopting the lighting code \* \* \* were founded upon the belief that such action would reduce the large number of tripping accidents in work spaces, aisles, passageways, and exits, investigation of which showed clearly in some cases that objects had been left in these places and, because of poor lighting, were not noticed by the injured employee. In some instances, it was found that sharp contrasts of light and shadows constituted a factor in work accidents, and that causation in some cases was due in part to insufficient light intensity. Another contributing cause was believed to be the prevalence of eyestrain. \* \* \* Another important agency which brought about the adopting of lighting rules and regulations was the promiscuous use of modern high-efficiency lighting units without any thought of proper shading for the purpose of eliminating glare.

The methods used in developing and adopting the State codes vary. In six States—California, Massachusetts, New York, Ohio, Oregon, and Wisconsin—they were developed by committees of representatives of employers, employees, lighting experts, the State department of labor, and in some cases oculists and other persons interested in illumination, and adopted by the department of labor. In other States the codes were adopted by the State department of labor without this procedure of development by representative committees.

<sup>1</sup> Some other States suggest the code and code standards, but evidently do not consider that they recommend them.

Chart I.—Status of State lighting codes  
 [Based on State laws and codes and correspondence with State officials]

State	Date effective and revisions	Legal status of latest code		Establishments covered	Enforcing agency	Penalty
		Regulation	Inspection standard <sup>1</sup>			
California.....	Dec. 1, 1919.....	General Lighting Safety Orders of Industrial Accident Commission. Issued under authority workmen's compensation law.—Codes and General Laws, Deering. Supplement 1917. Act 2143c, secs. 39, 41; Consolidated Supplement 1925-1927. Political code, sec. 364b.	-----	Every employment and place of employment. <sup>2</sup> —Codes and General Laws, Deering. Supplement 1917. Act 2143c, sec. 41.	Department of Industrial Relations, Divisions of Industrial Accidents and Safety, Labor Statistics and Law Enforcement, and Industrial Welfare.	Misdemeanor. Each day separate offense.—Codes and General Laws, Deering. Supplement 1917. Act 2143c, secs. 49, 50.
Maryland.....	Jan. 1, 1927; revised Jan. 15, 1930.	Safety code approved by Industrial Accident Commission. Issued under authority workmen's compensation law.—Annotated Code. 1929 Supplement. (Bagby.) Art. 101, secs. 55, 55b.	-----	Extrahazardous industries. <sup>3</sup> —Annotated Code. 1929. Supplement. (Bagby.) Art. 101, sec. 35.	State Industrial Accident Commission.	Misdemeanor. Fine \$50 to \$500.—Annotated Code. 1929 Supplement. (Bagby.) Art. 101, sec. 55a.
Massachusetts.....	Jan. 1, 1924.....	Lighting code of the Department of Labor and Industries. March, 1923. Issued under authority of law creating Department of Labor and Industries.—General Laws, 1921, ch. 149, secs. 6, 113.	-----	Factories, workshops, manufacturing, mechanical, and mercantile establishments. <sup>2</sup> —General Laws, 1921, ch. 149, sec. 113.	Department of Labor and Industries, Division of Industrial Safety.	Fine not more than \$100.—General Laws, 1921, ch. 149, sec. 180.
New Jersey.....	1918; revised 1924 and 1930.	-----	Department of Labor, Bureau of Electrical Equipment, issues code of lighting factories, mills, and other work places, American Standard approved Aug. 18, 1930, prepared under direction of Illuminating Engineering Society.	Factories, mills, other productive industries. Does not cover mercantile establishments. <sup>2</sup>	Department of Labor, Bureau of Inspection.	-----

<sup>1</sup> Standard used to interpret general lighting requirements. The Idaho State Chamber of Commerce has a division of Ail-Idaho Safety Council that suggests the use of the code of Lighting Factories, Mills, and Other Work Places—American Standard approved August 18, 1930, and the Kentucky Department of Agriculture, Labor, and Statistics recommends that lighting equal the intensities of the American Standard Code.

<sup>2</sup> Agriculture and domestic service are not included.

<sup>3</sup> In practice includes all employments except country blacksmiths, wheelwrights, agriculture, and domestic service.

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STATE LIGHTING CODES

Chart 1.—Status of State lighting codes—Continued.

State	Date effective and revisions	Legal status of latest code		Establishments covered	Enforcing agency	Penalty
		Regulation	Inspection standard <sup>1</sup>			
New York	July 1, 1918; revised July 1, 1919, May 1, 1922.	Industrial Code Bulletin No. 18, Rules of the Department of Labor. Issued under authority of law creating Department of Labor.—Labor Laws, secs. 27-29 in Cahill's Consolidated Laws, 1930, ch. 32.		Factories and mercantile establishments. <sup>2</sup> —See Industrial Code Bulletin No. 18. Rule relating to Lighting of Factories and Mercantile Establishments.	Department of Labor, Bureau of Inspection.	Misdemeanor. First offense, fine \$20 to \$50; second offense, fine \$50 to \$250 or imprisonment not more than 30 days, or both; third offense, fine not less than \$250, or imprisonment not more than 60 days, or both.—Penal law, sec. 1, 275 in Cahill's Consolidated Laws, 1930, ch. 41.
Ohio	May 6, 1920		Industrial Commission, Industrial Lighting Code.	Factories, mills, and other work places including mercantile establishments. <sup>3</sup>	Department of Industrial Relations, Division of Factory Inspection.	
Oklahoma	July 1, 1922		Department of Labor, Industrial Code Rules Relating to Lighting [etc.].	Factories, mercantile establishments, and other work places. <sup>2</sup>	Department of Labor, Bureau of Factory Inspection.	
Oregon	1919	Industrial lighting code issued by Bureau of Labor under authority of a law requiring a lighting code.—General Laws 1919, ch. 181, sec. 8.		Factories, mills, offices, and other work places, including mercantile establishments. <sup>2</sup> —General Laws, 1919, ch. 181, sec. 1 (a).	Bureau of Labor	Misdemeanor. Fine not more than \$50, each day a separate offense.—General Laws 1919, ch. 181, sec. 9.
Pennsylvania	June 1, 1916; revised Feb. 13, 1918, Sept. 23, 1926.	Safety standard on lighting recommended by Industrial Board adopted by the Department of Labor and Industry under the authority of law creating Department of Labor and Industry.—Pennsylvania Statutes complete to 1920, sec. 13, 495.		All places where labor is employed.—Pennsylvania Statutes complete to 1920, sec. 13, 495.	Department of Labor and Industry, Bureau of Inspection.	Misdemeanor.—Fine of not more than \$100, or by imprisonment not exceeding one month, or both.—Pennsylvania Statutes complete to 1920, sec. 13, 497.

Washington	June 1919; revised Jan. 1, 1924.	Safety standards Nos. 14 to 20 on lighting issued by Department of Labor and Industries under authority of workmen's compensation law.—Remington Compiled Statutes, 1922, secs. 7, 675, 7, 730, 7, 734, 7, 774.		Where places of work or nature of operation causes a hazard due to insufficient illumination. In practice includes manufacturing and mercantile establishments. <sup>2</sup> —Remington Compiled Statutes, 1922, secs. 7, 674, 7, 628.	Department of Labor and Industries, Division of Safety and Industrial Welfare Commission.	Fine not more than \$1,000.—Session Laws 1923, ch. 136, sec. 14, amends Remington Compiled Statutes, 1922, sec. 7, 775.
Wisconsin	July 1, 1918; <sup>4</sup> revised Nov. 24, 1919, Dec. 20, 1920.	Lighting code adopted by Industrial Commission under authority of 1911 law creating Industrial Commission. Wisconsin Statutes, 1929, 101.10 (4).		All factories, mills, offices, and other work places, including mercantile establishments. <sup>2</sup> —Wisconsin Statutes, 1929, 101.01 (1).	Industrial Commission, Safety and Sanitation Department.	Fine \$10 to \$100 for each offense. Each day a separate offense.—Wisconsin Statutes, 1929, 101.18, 101.28.

<sup>1</sup> Standard used to interpret general lighting requirements. The Idaho State Chamber of Commerce has a division of All-Idaho Safety Council that suggests the use of the code of Lighting Factories, Mills, and Other Work Places—American Standard approved August 18, 1930, and the Kentucky Department of Agriculture, Labor, and Statistics recommends that lighting equal the intensities of the American Standard Code.

<sup>2</sup> Agriculture and domestic service are not included.

<sup>4</sup> Additions to existing lights and equipment to be completed by July 1, 1920.

Chart I gives the status of these State codes. It will be noted that in some States they are recommendations, in others they are regulations with the force of law, and in others they are inspection standards. Examination of the codes shows that there is some variation in their requirements; and the statements of the departments enforcing them reveal that there are wide differences in the way the codes are actually used. These important phases of the State lighting codes and their administration are discussed in the following sections: A, the contents of the State lighting codes are analyzed and their requirements are compared with the American Standard Code suggestions; B, the legal status and enforcement of the State lighting codes are discussed.

#### A.—CONTENTS OF THE STATE LIGHTING CODES AND THE AMERICAN STANDARD CODE

Parts I and II of the American Standard Code have been given in some detail in Chapter III; its third part, Suggested Minimum Regulation to be Established by State Authorities, is reprinted here to give some idea of the form of the State codes that have been based on codes similar to this.

#### AMERICAN STANDARD CODE. PART III

##### Purpose.

The purpose of this code is to make reasonable provisions for the safety of workers by requiring such illumination as may be necessary to conserve vision and to facilitate the utilization of eyesight for the prevention of accident.

##### Exceptions.

In cases of practical difficulty or unnecessary hardships the enforcing authority may grant exceptions from the literal requirements of this code or permit the use of other methods, but only when it is clearly evident that safety is thereby reasonably assured. There are occasional operations which need to be performed practically without light, such as photographic and photometric processes in dark rooms. Again, there are some operations which are best observed by their own light, as in certain parts of the process of working with glass. In all cases in which work must be performed under very low illumination, special precaution should be taken to safeguard the workers from accident.

##### Scope.

This code applies to all factories, mills, offices, storage buildings, yards, power houses, and other industrial and mercantile establishments and work places.

#### RULES

##### General requirement.

Illumination, daylight or artificial light, in accordance with the following rules, shall be supplied for—

1. Traversed spaces such as hallways, roadways, etc., during working hours, and
2. Work when attended by operators.

NOTE.—It should be recognized that the foot-candles specified represent minimum limits, and that tolerance for depreciation must

be made in the design of the installation. The values are established to meet the needs of safety and are not to be interpreted as providing for effective and economical operation of processes. Higher levels representing good lighting practice are recommended in Table I, and general suggestions for design will be found on pages 12 to 35. (See pp. 12 to 23 of this report.) Information on the measurement of illumination values will be found on page 12. (See p. 13 of this report.)

##### Rule 1. Illumination required.

The illumination maintained shall be not less than given in Table V.

TABLE V.—Minimum illumination requirements

	Foot-candles
1. MINIMUM FOOT-CANDLES ON TRAVERSED SPACES	
Roadways, yard thoroughfares.....	0.02
Storage spaces, aisles and passageways in workrooms, excepting exits and passages leading thereto.....	.50
Spaces such as hallways, stairways, exits, and passages leading thereto.....	.75
Spaces such as stairways, locker rooms, wash rooms, toilet rooms, and passageways where there are exposed moving machines, hot pipes, or live electrical parts, also elevator cars, and landings.....	1.00
2. MINIMUM FOOT-CANDLES AT THE WORK	
Where discrimination of detail is not essential.....	.50
Work such as handling material of a coarse nature; grinding clay products; rough sorting; coal and ash handling; foundry charging.	
Where slight discrimination of detail is essential.....	1.00
Work such as rough machining, rough assembling, rough bench work, rough forging, grain milling.	
Where moderate discrimination of detail is essential.....	2.00
Work such as machining, assembly work, bench work, fine core making in foundries.	
Where close discrimination of detail is essential.....	4.00
Work such as fine lathe work, patternmaking, toolmaking, weaving or sewing light-colored silk or woolen textiles, office work, accounting, typewriting.	
Where discrimination of minute detail is essential.....	8.00
Work such as drafting, weaving or sewing dark-colored material, very fine inspection or inspection of very dark goods.	

##### Rule 2. Avoidance of glare: Diffusion and distribution of light.

Lighting, whether natural or artificial, shall be such as to avoid glare, objectionable shadows, and extreme contrasts, and to provide a good distribution of light; in artificial lighting systems, lamps shall be so installed in regard to height, location, spacing, and reflectors, shades, or other suitable accessories as to accomplish these objects.

Bare light sources, such as exposed lamp filaments, located within the ordinary field of the worker's vision, are presumptive evidence of glare.

For a specification of definite requirements under this rule, reference should be had to Tables II, III, and VI.

##### Rule 3. Exit and emergency lighting.

The lighting to be provided under rule 1 in all important stairways and all exits of work places and in the passageways appurtenant thereto shall be supplied so as not to be subject to failure because of the failure of the room or work space lighting from internal causes. In the case of artificial illumination, the services should be preferably from an independent connection or connections extending back to the main service entrance for the building. In cases of unusual danger which may exist on account of the type of building or nature of the work, crowded conditions, or lack of suitable

exit space, an independent service shall be insured by connecting to a separate source of supply without or within the building. During the hours of occupancy, when daylight of the value given in rule 1 is lacking, this separate source of supply shall be connected so as to function continually or to come on automatically upon failure of the regular lighting service.

#### Notes on rule 1. Illumination required.

In Table V the lower values, up to one foot-candle, are required principally to enable employees to see well enough to avoid accident, while the higher values have the additional purpose of preventing eyestrain and so conserving vision. The values have been assigned on the basis of engineering experience and assume the average conditions found in practice. There are no sharp lines of demarcation. A specified process is carried on in different establishments with varying degrees of fineness. Where especially close attention to the fine detail is required, it is obvious that more illumination is needed than where the process is made more automatic or operated on a coarser scale. Where such special conditions exist, the next higher or lower classification may be found the reasonable requirement.

#### Notes on rule 2. Avoidance of glare.

It is assumed that in interpreting the enforcing of the regulation against glare, the enforcing officer will not insist upon what he might consider as pleasing or desirable practice in any given case. It is the intention of the rule merely to prevent conditions which are prejudicial to the physical welfare of the worker.

Table VI shows the harshest grade of light source that may be used under any particular set of conditions. It is based on the system of glare rating described on pages 22 to 25 (see pp. 17 to 21 of this report), where an explanation of the symbols used will be found.

TABLE VI.—Limiting grades of light sources permissible for various conditions<sup>1</sup>

[The grades given in this table are limiting values; from 1 to 2 grades softer are recommended, see Table IV]

Height of light source above floor	Space or work to be lighted <sup>1</sup>					
	Roadways and yard thoroughfares	Storage spaces	Ordinary manufacturing operations <sup>2</sup>		Office and drafting work and certain manufacturing operations	
			Short rooms <sup>3</sup>	Long rooms <sup>3</sup>	Short rooms <sup>3</sup>	Long rooms <sup>3,4</sup>
Under 6.5 feet.....		F	D	D	C	C
6.5 to 7.5 feet.....		G	F	F	E	E
7.5 to 9 feet.....	H	H	H	G	G	F
9 to 11 feet.....	I	I	I	H	H	G
11 to 13 feet.....	J	J	J	I	I	H
13 to 16 feet.....	J	J	J	I	I	H
16 to 20 feet.....	K	K	K	J	J	I
20 feet and up.....	K	K	K	K	K	J

<sup>1</sup> Where backgrounds are very dark in tone, a light source of one grade softer than specified may be required in the case of all indoor classifications.

<sup>2</sup> For the present the limits set in this table can not be rigidly applied to portable lamps used for temporary work, such as setting up machines, repairing automobiles, etc.

<sup>3</sup> A "long" room is considered to be one in which the total length in feet is more than twice the height of the lamps above the floor; one having a length less than twice the height of the lamps above the floor is classified as "short."

<sup>4</sup> Those operations in which workers are seated facing in one direction for long periods of time.

#### Notes on rule 3. Exit and emergency lighting.

The employer is to be held responsible for the proper lighting of passageways, stairways, and exits, so far as his premises are concerned, which means such parts of buildings, floors, or rooms as are controlled by the employer, including entrances thereto, but excluding hallways, passageways, and stairways giving access to other floors, or to spaces on the same floor, and used in common by the tenants of the building. These latter should be lighted by the building owner.

Exit and emergency lighting are to be understood as those artificial illuminants which are necessary only to make clear to the occupants or employees the places of exit, or to enable them to pass to and along safe exits with reasonable speed and assurance of footing. Such lighting is not assumed as being necessarily sufficient for the proper performance of regular working operations.

The circuits for exit electric lamps should be separate branch circuits, including no other lamps, and containing no receptacles or convenience outlets for the attachment of portable or other devices. Being thus separately fused, trouble on other circuits which causes the blowing of fuses will be less likely to affect them.

The main service entrance may be interpreted to mean the entrance point (meter or distributing panel) of lighting feeders for the building, floor, loft, or particular space in question. In gas lighting it may be considered to be the main gas feeder for the building, or the main gas riser for the floor or loft in question. Where several factory spaces are grouped in the same building, each with its own exit or exits, the emergency electric circuits for any one space are not required to run to the main building panel board or main switch, nor are the emergency gas pipes expected to extend to the main gas meter nor to the building feeder from the street main, except as explained below.

Under specially dangerous conditions, where in the opinion of the recognized authorities the failure of the main and entire regular lighting supply would leave the employees without assured means of seeing the outgoing passageways, the exit and emergency lamps should be fed from an entirely separate source of energy, such as a storage battery, or, in case the regular lighting system is electric, from gas or other reasonably dependable illuminant. Service from an independent street main, where available, is regarded as a separate source of supply; or a separate service from an independent transformer fed from the same primary wires will usually be considered sufficient. Factories supplied by an isolated plant should feed exit circuits from an independent source or utilize a separate generating unit driven by a separate prime mover. Such an independent supply as discussed in this paragraph is not considered necessary for typical conditions, but only where the large number of persons concerned or other special condition calls for special precautions. Such a condition may be recognized by the management, but if doubt exists a decision should be asked from the inspection department having jurisdiction.

As indicated in the general requirements of this regulation, the exit and emergency lamps should be lighted whenever artificial lighting is required in the work spaces.

It is the obvious intent of rule 3 to insure reduction of accident hazard, and inasmuch as this end is as beneficial to the industrial operator or owner as to the State, the detailed interpretations of this order, for the various types and situations of working spaces, can only be reached through mutual cooperation of the owner and the State authorities.

#### STATE LIGHTING CODES

The State codes all have practically the same scope—they all apply to most manufacturing establishments and with one exception they apply to mercantile establishments in the State. (See Chart I.)

A general comparison of the form and content of the codes shows that the States may be arranged in three groups. In one group are those States that either have adopted the suggested American Standard Code or follow it very closely in both form and content. These are Idaho, Kentucky, Maryland, and New Jersey, which have adopted the American Standard Code, and Ohio and Washington, which follow it closely. In these States the codes have established only a few definite lighting rules, but except in the case of Washington these are supplemented by discussions, with illustrations, of lighting problems and recommendations for their solution. The rule covering illumination levels sets the minimum illumination for certain broad classifications of places and types of work and, again except in Washington, it is supplemented by a list of the recommended illumination levels for various places and industries. Washington, though an exception in some respects, is placed in this group because its lighting requirements are stated in a few rules that are similar to those of the American Standard Code.

The California, Oregon, and Wisconsin codes, while not exactly alike, are similar and form another group. Their codes have more lighting requirements stated as rules than is true of the first group; but, like the first group, the rule covering illumination levels sets the minimum levels required for broad classifications of places and types of work and is supplemented by recommended levels. As regards the illumination level for specific industries, the Wisconsin code contains no information, the California code makes recommendations, and the Oregon code interprets its general rule by stating certain requirements. Each of the three codes in this group contains also a discussion of lighting problems.

The main differences of the final group, the codes of Massachusetts, New York, Oklahoma, and Pennsylvania, from the other two groups are that the rule for illumination levels, that of Massachusetts excepted,<sup>2</sup> gives the minimum levels required for specific industries as well as for certain places and types of work, and that supplementary information is entirely lacking or is very brief. The New York, Oklahoma, and Massachusetts codes, which in form are almost identical, recommend illumination levels for certain broad classifications, but the Pennsylvania code makes recommendations for specific industries.

<sup>2</sup> In Massachusetts this rule is only for certain broad classifications of places and types of work.

#### Illumination levels required.

One of the most important provisions of lighting codes is that the amount of light, called the illumination level, that is, intensity of illumination or light, must be equal to a certain specified number of foot-candles.

All the lighting codes require artificial light when natural light is less than certain minimum requirements. These statements are comparable to rule 1 of the American Standard Code. Statute law in Oregon (see p. 58), however, requires the installation of artificial light in every workroom; and New York requires that factory rooms shall be lighted by electricity whenever persons are employed in them between 6 p. m. and 6 a. m.<sup>3</sup> With the exception of the California, Oregon, Washington, and Wisconsin codes, the illumination levels required are the same for natural and for artificial lighting. The codes of these excepted States require that natural illumination must be twice that of the minimum level required in the code, or artificial lighting at least equal to these levels must be installed.

<sup>3</sup> New York. Cahill's Consolidated Laws, 1930, ch. 32, sec. 300. It should be noted that the use of artificial light at night is implied by the other codes.

TABLE VII.—Comparison of the illumination requirements of the State lighting codes with the American Standard Code <sup>1</sup>

Space or work to be lighted <sup>2</sup>	Minimum foot-candles of natural or artificial light required							
	American standard code (also Idaho, Kentucky, Maryland, New Jersey codes)	California code <sup>3</sup>	Massachusetts, New York, and Oklahoma codes	Ohio code	Oregon code <sup>3</sup>	Pennsylvania code	Washington code <sup>3</sup>	Wisconsin code <sup>3</sup>
Traversed spaces—								
1. Roadways, yard thoroughfares.....	0.02	0.02	0.02	0.02	0.02	0.10	0.02	0.02
2. Storage spaces, aisles and passageways in workrooms, excepting exits and passages leading thereto.....	.50	.25	.25	4.25	.25	.25	.25	.25
3. Spaces such as hallways, stairways, exits, and passages leading thereto.....	.75	.25	.50	4.25	.25	1.00	.50	.25
4. Spaces such as stairways, locker rooms, wash rooms, toilet rooms, and passageways where there are exposed moving machines, hot pipes, or live electrical parts, also elevator cars, and landings.....	1.00	.50	.50	4.25	1.00	1.00	.50	<sup>4</sup> 1.50
At work—								
5. Where discrimination of detail is not essential..... Work such as handling material of a coarse nature; grinding clay products; rough sorting; coal and ash handling; foundry charging.	.50	.50	.50	.50	2.00	.50	.50	1.25
6. Where slight discrimination of detail is essential..... Work such as rough machining, rough assembling; rough bench work; rough forging; grain milling.	1.00	1.00	1.00	1.00	2.00	1.00	1.00	2.00
7. Where moderate discrimination of detail is essential..... Work such as machining; assembly work, bench work; fine core making in foundries.	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
8. Where close discrimination of detail is essential..... Work such as fine lathe work; pattern making; tool making; weaving or sewing light-colored silk or woolen textiles; office work: accounting; typewriting.	4.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
9. Where discrimination of minute detail is essential..... Work such as drafting; weaving or sewing dark-colored material; very fine inspection or inspection of very dark goods.	8.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

<sup>1</sup> American Standard Code is code of lighting, factories, mills, and other work places. American Standard approved Aug. 18, 1930, by American Standards Association. Prepared by Illuminating Engineering Society. (See pp. 10 to 24 of this report.)

<sup>2</sup> These classifications are from the American Standard Code. The State codes vary in classifications and in phraseology, but with the exceptions noted comparable locations are covered.

<sup>3</sup> If natural light, under normal conditions, is not at least twice these amounts artificial lighting must be provided.

<sup>4</sup> Intermediate and auxiliary spaces in interiors.

<sup>5</sup> Toilets and wash rooms.



A comparison of the illumination levels required in the various State codes with the American Standard Code, given in Table VII, shows that the State codes are very similar and that most of them make lower requirements than does the American Standard Code. The only State codes that require illumination levels for all classifications as high as those of the American Standard Code are those of Idaho, Kentucky, Maryland, and New Jersey—States that use the American Standard Code. This is due not only to the problems involved in the practical application of desirable recommendation but also to the fact that the Illuminating Engineering Society raised some of the requirements in its 1930 code, while most of the States are still using unrevised codes based on the society's earlier recommendations. (See Chart I.)

The American Standard Code requirements for passageways and other auxiliary places (Nos. 2, 3, and 4 in Table VII) are higher than those of any of the State codes except certain requirements of Oregon and Pennsylvania, while for work where close discrimination of detail and where discrimination of minute detail is essential (Nos. 8 and 9 in Table VII) the code requirements of 4 and 8 foot-candles respectively are higher than those of any State not using the American Standard Code, their requirements being in all cases 3 and 5 foot-candles, respectively.

However, in a few cases the codes of Oregon, Pennsylvania, and Wisconsin require higher illumination levels than does the American Standard Code. Oregon requires 2 foot-candles for work both where discrimination of detail is not essential and where slight discrimination of detail is essential, while the American Standard Code requirements are 0.50 and 1 foot-candle, respectively. Wisconsin, like Oregon, requires higher illumination for these two locations, the requirements being 1.25 and 2 foot-candles, respectively. Pennsylvania requires more light for roadways and yard thoroughfares and for hallways, stairways, exits, and passages leading thereto than does the American Standard or any other State code.

Table VII, comparing the State codes and the American Standard Code, gives most of the requirements for the level of illumination that are contained in each code. There are, however, a few supplementary ones that should be mentioned in this connection. These relate to where and how illumination measurements shall be taken, occupations and conditions excepted, provisions for overhead lighting, and lists of specific industries and their light requirements. Most of the codes state where the illumination level should be measured, specifying at the work or at the floor level for certain spaces. In the Oregon, Washington, and Wisconsin codes the floor level measurement is not required for certain spaces, but lighting practice would imply its use. In all the codes but those of Ohio and Washington, which make no mention of the measuring instrument, a standardized photometer is specified as the instrument. The American Standard Code does not require but suggests the use of that type of photometer known as the foot-candle meter.

Certain occupations in which light is detrimental are excepted by the codes of all States, except those using the American Standard Code and Washington and Wisconsin. Undoubtedly this exception is made in practice in these States. In Washington at least one-half of the total light required for workrooms or at the work must be

supplied by general, that is, overhead lighting. In Oregon at least 0.50 and in California at least 0.25 foot-candles must be so supplied. The other codes have no regulation on this matter. Ohio allows for a variation of 15 per cent above and below the required levels and that unusual circumstances such as fog are to be excepted.

Finally, in addition to specifications of the lighting required for certain classes of places or types of work, given in Table VII, illumination levels for a long list of specific industries are given in all the codes except those of Massachusetts, Washington, and Wisconsin. In the American Standard Code group and California only the recommended foot-candles are given in such detail, but in the other State codes the required illumination levels are given for various industries. Three States—New York, Oklahoma, and Pennsylvania—include these requirements in their code rules; in the Ohio and Oregon codes they are given in the appendix. The recommended levels of illumination of the American Standard Code (pp. 14 to 15) will give an idea of desirable lighting for various industries. The minimum light requirements of the codes vary so little and are so low—in no case are they over 5 foot-candles—that they have not been analyzed for specific industries in this report. In general it is true that the industry classifications are the same in all the State codes, so that the differences in light requirements are slight and are suggested by Table VII.

#### **Illumination levels recommended.**

Since the illumination levels required by the codes are the amount of light only considered essential to protect the workers from accident and eyestrain, all the codes suggest higher levels as desirable both for the workers' health and comfort and for efficient production. These recommended levels, analyzed in Table VIII, indicate that the required levels are very low.

TABLE VIII.—Comparison of the recommended illumination levels of the State lighting codes with the American Standard Code <sup>1</sup>

Space or work to be lighted <sup>2</sup>	Foot-candles of natural or artificial light recommended by—							
	American Standard Code (also Idaho, Kentucky, Maryland, and New Jersey codes)	California code	Massachusetts, New York, and Oklahoma codes	Ohio code	Oregon code	Pennsylvania code	Washington code	Wisconsin code
<b>Traversed spaces—</b>								
1. Roadways, yard thoroughfares.....	( <sup>3</sup> )	0.25-0.05	0.25-0.05	0.25-0.05	0.25-0.05	2.00-0.25	1.00-0.50	0.25-0.05
2. Storage spaces, aisles and passageways in workrooms, excepting exits and passages leading thereto.....	3.00-2.00	1.00-0.50	1.00-0.50	<sup>4</sup> 2.00-0.50	<sup>5</sup> 1.00-0.50	5.00-2.00	2.00-0.70	<sup>5</sup> 1.00-0.50
3. Spaces such as hallways, stairways, exits, and passages leading thereto.....	( <sup>3</sup> )	2.00-1.00	2.00-1.00	<sup>4</sup> 2.00-0.50	<sup>6</sup> 2.00-0.75	5.00-2.00	2.00-0.10	<sup>6</sup> 2.00-0.75
4. Spaces such as stairways, locker rooms, wash rooms, toilet rooms, and passageways where there are exposed moving machines, hot pipes, or live electrical parts, also elevator cars, and landings.....	<sup>7</sup> 6.00-4.00 <sup>9</sup> 8.00-5.00	2.00-1.00	2.00-1.00	<sup>4</sup> 2.00-0.50	3.00-1.50	5.00-2.00	<sup>8</sup> 8.00-0.10	<sup>7</sup> 3.00-1.50
<b>At work—</b>								
5. Where discrimination of detail is not essential..... Work such as handling material of a coarse nature, grinding clay products, rough sorting, coal and ash handling, foundry charging.	5.00-3.00	2.00-1.00	2.00-1.00	3.00-1.00	6.00-3.00	5.00-2.00	<sup>8</sup> 5 and up -1.50	<sup>8</sup> 6.00-2.00
6. Where slight discrimination of detail is essential..... Work such as rough machining, rough assembling, rough bench work, rough forging, grain milling.	8.00-5.00	4.00-2.00	4.00-2.00	6.00-2.00	6.00-3.00	5.00-2.00	<sup>8</sup> 8 and up -2.50	<sup>8</sup> 10.00-3.00
7. Where moderate discrimination of detail is essential..... Work such as machining, assembly work, bench work, fine core making in foundries.	12.00-8.00	6.00-3.00	6.00-4.00	9.00-3.00	( <sup>3</sup> )	10.00-5.00	<sup>8</sup> 10 and up -4.00	<sup>8</sup> 10.00-3.00
8. Where close discrimination of detail is essential..... Work such as fine lathe work, pattern making, tool making, weaving or sewing light-colored silk or woolen textiles, office work, accounting, typewriting.	20.00-12.00	8.00-4.00	8.00-6.00	12.00-4.00	8.00-4.00	10.00-5.00	<sup>8</sup> 15 and up -6.00	<sup>8</sup> 15.00-4.00
9. Where discrimination of minute detail is essential..... Work such as drafting, weaving or sewing dark-colored material, very fine inspection or inspection of very dark goods.	100.00-25.00	15.00-7.00	15.00-8.00	Unlimited -8.00	15.00-10.00	20.00 and above -10.00	<sup>8</sup> 20 and up -7.00	<sup>8</sup> 25.00-10.00

<sup>1</sup> American Standard Code is code of lighting factories, mills, and other work places. American Standard approved Aug. 18, 1930, by American Standards Association. Prepared by Illuminating Engineering Society. (See pp. 10 to 24 of this report.)

<sup>2</sup> These classifications are from the American Standard Code. The State codes vary in classification and in phraseology but with the exceptions noted comparable locations are covered.

<sup>3</sup> Not given.

<sup>4</sup> Intermediate and auxiliary spaces in interiors.

<sup>5</sup> Storage spaces.

<sup>6</sup> All stairways, passageways, aisles.

<sup>7</sup> Toilets and wash rooms.

<sup>8</sup> Combining their recommended intensities of good practice and productive intensities.

<sup>9</sup> Elevators.

In every case the lowest recommended level is higher than the minimum requirement, while the highest levels recommended are often two or three times as high as the corresponding minimum. In fact, in the American Standard Code the maximum levels recommended are at least five or six times as high as those required.

In addition to the fact that all the minimum levels required are lower than good lighting demands, a consideration of Table VIII shows that the recommendations of most of the State codes are decidedly lower than the recommendations of the American Standard Code. For most of the classifications the highest level recommended by the State codes is lower than the lowest recommended level of the American Standard Code for the same classification. There are only seven cases where the highest recommended level in the States not using the American Standard Code is equal to or exceeds the highest level of the American Standard. This, of course, excludes the cases in Ohio, Pennsylvania, and Washington, where an unlimited maximum is suggested. Oregon and Wisconsin suggest 6 foot-candles as compared with 5 in the American Standard Code as the maximum for work where discrimination of detail is not essential. Wisconsin suggests 10 foot-candles as compared to 8 in the American Standard Code, for work where slight discrimination of detail is essential. Pennsylvania's maximum recommendation of 5 foot-candles for storage spaces, aisles, and passageways in work-rooms is higher than the 3 foot-candles of the American Standards Association.

#### Avoidance of glare: Diffusion and distribution of light.

Another important provision of lighting codes is that glare be avoided. The section of the American Standard Code dealing with the avoidance of glare and the diffusion and distribution of light, rule 2, does not offer definite standards for the prevention of glare. It states that—

Lighting, whether natural or artificial, shall be such as to avoid glare, objectionable shadows, and extreme contrasts, and to provide a good distribution of light; in artificial lighting systems, lamps shall be so installed in regard to height, location, spacing, and reflectors, shades, or other suitable accessories as to accomplish these objects.

Bare light sources, such as exposed lamp filaments, located within the ordinary fields of the worker's vision, are presumptive evidence of glare.

This section is supplemented by a discussion of glare and certain methods of preventing its occurrence.

All the State codes contain sections making general statements similar to the one just quoted of the American Standard Code, except that no code prepared by a State contains the statement that bare light sources in the ordinary field of vision are presumptive evidence of glare, and that no mention of the problem of glare from natural light is made in the Massachusetts, New York, and Oklahoma rules.

Several State codes contain other provisions on glare. In addition to requiring reflectors for artificial light, the codes of California, Oregon, Washington, and Wisconsin require suitable awnings, window shades, or diffusive or refractive window glass to prevent glare from natural light. The Massachusetts, New York, Oklahoma, and

Pennsylvania codes specify that the reflecting devices used must be of noninflammable material.

Another element in the problem of glare is the desirability of a certain amount of illumination from overhead sources, that is, general lighting. This requirement may be implied in the statement that glare is to be avoided; it is mentioned specifically in the codes of California, Oregon, Washington, and Wisconsin.

Limitations of the brightest square inch of visible light source are peculiar to the California, Oregon, Washington, and Wisconsin codes. For overhead lamps 20 or less feet from the floor and at elevations above eye level less than one-quarter the distance from any position at which work is performed, 75 candlepower is the maximum in California, Oregon, and Wisconsin; while in Washington, for overhead lights 20 or less feet from the floor, visible from a location at which work is performed and located within the angle of 15 degrees of the eye level, 15 candlepower is the maximum.

For local light sources the brightest square inch of visible light source is 3 candlepower in each of these four State codes.

#### Emergency lighting for exits.

The American Standard Code suggests the provision, for exits, stairways, and passageways, of a lighting system not subject to failure, because of failure of room or work-space lighting, and preferably from independent connections extending back to the main entrance point of lighting feeders. Where such places are unusually dangerous, a separate source of supply, and not merely independent connection, is recommended; and when daylight fails, this should function continuously or come on automatically.

With the exception of New York, Ohio, Oklahoma, and Washington, the State codes contain some requirement for emergency lighting other than that certain illumination levels shall be supplied. Pennsylvania's rule on this subject in its lighting code has been superseded by special regulations for protection from fire and panic.<sup>4</sup>

Work-space aisles, stairways, passageways, exits, and, in California, Oregon, and Wisconsin, fire escapes<sup>5</sup> are the places required, in all the codes having provisions for emergency lighting, to have lights independent of the regular lighting system. Pennsylvania's requirements apply to—

"Factories and workshops where twenty-five (25) or more persons (cleaners and watchmen excepted) are employed above the second floor more than fifty (50) nights in any one year, or if employed at any time in factories or workshops where the shutting down of power causes the building to be in darkness."

"In such establishments where employees receive special training for action in case of emergency (such as telephone exchanges) and where there is available other light which they may immediately use if the general lights go out, the above requirements for emergency lighting shall not apply unless at least one hundred (100) persons

<sup>4</sup> Regulations for protection from fire and panic. Issued by the Department of Labor and Industry, 1930.

<sup>5</sup> For Wisconsin only those of the "B" class (3 feet and 4 inches wide. See Building Code).

are employed above the second floor after 7 p. m. at any time"  
\* \* \* and to—

"Mercantile establishments more than two (2) stories in height which are open to the public more than fifty (50) nights in any one year."

The places covered are—

"All workrooms" in manufacturing establishments and "rooms where employees work and where the public is admitted" in mercantile establishments and in both halls, corridors, stairways, and similar means of egress; above landings of fire escapes; and rooms in which emergency lighting equipment is located.

That the emergency lighting must be used when other artificial lights are used is required in California, Oregon, and Wisconsin; the other States do not mention this.

Where there is a hazard or unusual danger the emergency light must be supplied from a source independent of the regular light source in the States that have adopted the American Standard Code and in California, Massachusetts, and Oregon. In Pennsylvania this is required by the Regulations for Protection from Fire and Panic for the places listed above.

#### Miscellaneous requirements of some State codes.

The code provisions that have been discussed, namely, the levels of illumination required and recommended, the avoidance of glare and provisions for the diffusion and distribution of light, and emergency lighting for exits, are all the requirements that the American Standard Code suggests, but some of the State codes contain a few other rules. California, Oregon, and Wisconsin require that switching or controlling apparatus be plainly labeled for identification and placed so that at least pilot or night lights may be turned on at one or more easily accessible points.<sup>6</sup> Cleaning and maintenance of both natural and artificial light equipment are required by the codes of Oregon, Pennsylvania, and Wisconsin. Pennsylvania's is the only lighting code that has a rule requiring that gas, vapor, and dust proof lighting fixtures be provided where explosive gas, vapor, or dust accumulates.

As has already been mentioned, all the lighting codes but Pennsylvania's and Washington's are supplemented by additional information and recommendations. In three, Massachusetts, New York, and Oklahoma, these additional notes are brief, but in California, Ohio, Oregon, and Wisconsin and in the States using the American Standard Code (Idaho, Kentucky, Maryland, and New Jersey) many phases of lighting problems are discussed to make the application of the code rules clearer. These sections are similar to the provisions of the American Standard Code discussed on pages 11 to 24 of this study.

#### Summary.

An analysis of the content of the 13 State lighting codes and a comparison with the American Standard Code shows the following:

(1) The requirements of all lighting codes are low compared to the light needed for good illumination;<sup>7</sup> (2) the required illumination

<sup>6</sup> The purpose of these orders is to secure safe illumination for night watchmen.

<sup>7</sup> This is largely because the basis of the codes is State authority to protect workers' health and safety, rather than to secure ideal lighting conditions. The fact that the code requirements are moderate need not be interpreted as indicating that they are unsatisfactory but as evidence of their practicability.

levels of most of the State codes are somewhat lower than the recently revised and adopted American Standard Code, and the recommended illumination levels of most of the State codes are decidedly lower than those suggested by the American Standard Code; (3) the State codes have provisions on glare similar to those in the American Standard Code and in several instances have additional requirements; (4) 4 State codes contain no special provision for emergency lighting; (5) 5 of the 13 State codes do not require independent light sources for exits and passageways in hazardous places.

#### B.—THE LEGAL STATUS AND ENFORCEMENT OF THE STATE LIGHTING CODES<sup>8</sup>

The content of the lighting codes has been found to be very similar for the different States. However, the force that the code has in a State, that is, its legal status and the methods used to enforce it, varies widely. The American Standard Code, like all American standards, is not a law or requirement—it is a summary of lighting practice and is offered as a guide for employers and State officials. In Idaho and Kentucky the lighting code of the Illuminating Engineering Society is considered simply as a source of information and the application of its suggestions is recommended. Neither of these States has an adequate legal provision making it possible for the recommended code to be very effectively used by factory inspectors as a guide to improve conditions. (See pp. 5 and 23, where State requirements are given by State.) New Jersey, Ohio, and Oklahoma use their lighting codes as inspection standards. Each of these States has some law requiring adequate lighting that the State department of labor or industrial commission has tried to make specific by the use of the lighting code. (See pp. 56, 57-58.) Under these conditions the codes can be used more or less effectively by factory inspectors.

The codes of eight States—California, Maryland, Massachusetts, New York, Oregon, Pennsylvania, Washington, and Wisconsin—are rules with the force of law and can be so enforced.

Too much emphasis should not be placed on these differences among recommendations, inspection standards, and laws or rules. The effectiveness of improving working conditions by legislation dealing with the problems involved is sometimes questioned. It is argued that standards of good practice are accepted voluntarily by employers. From the point of view of a factory inspector, however, there would appear to be decided advantage in having the force of law behind the regulations he advocates. In cases where employers are cooperative, the inspector's methods in the enforcement of a law or rule may be the same as those of an inspector making a recommendation, but in the cases where the employer is not in sympathy with the inspector's recommendations, the power to issue an order that can be enforced is desirable. The lighting conditions in many plants

<sup>8</sup> This section is based on an analysis of the State laws and on correspondence with officials of State departments of labor or industrial commissions. A summary for each State is given in the Appendix. See also Chart I.

and the number of orders issued by some State departments of labor indicate that lighting problems can not be solved by recommendation alone.

The enforcement of State codes is even more significant than is their exact legal status. Moreover, it is much more difficult to determine and to evaluate, since the enforcement of any single law involves all the important facts about the purpose, appropriation, personnel, methods, standing in the State, etc., of the enforcing agency. For this study only a few facts definitely pertaining to the enforcement of the lighting code have been secured from the States. These are the following: Whether or not any attempts are made to enforce the code, and, if there are, how it is enforced; whether inspections are made of lighting in manufacturing and mercantile establishments, and, if made, how often and by whom; whether inspectors are given any training on lighting problems, and, if so, what the training is and by whom given; whether the foot-candle meter is used to measure illumination levels; and whether there is an electrical expert in the department. Regular inspections of lighting by persons with enough training and experience to understand and apply the code and with recourse to the use of a foot-candle meter to measure the illumination level, at least in debatable cases, seem essential in enforcing the lighting codes.

In no State but New Jersey is there much done in the way of enforcing the code where it has only the status of a recommendation or of an inspection standard. In Idaho, it will be noted (see p. 51), the code is only suggested by a committee of the chamber of commerce. The Kentucky Department of Agriculture, Labor, and Statistics, which recommends the lighting code, attempts to give its inspectors some general instructions on lighting problems, but there is no electrical expert in the department, the foot-candle meter is not used, and inspections are made at very irregular intervals. The only law on lighting that the department has any chance to enforce is a rule of the State board of health.<sup>9</sup>

The Oklahoma commissioner of labor writes that it is not possible for their three inspectors to inspect manufacturing and mercantile establishments once a year; that they have no funds to pay to have someone outside the State come to give them proper training and that without such training the application of the code is a mistake; and that they have had to abandon the use of the foot-candle meter or neglect too much of their other work.

Inspectors in Ohio, without any training on lighting problems or the aid of a foot-candle meter, make inspections for lighting at irregular intervals. They are instructed to enforce the building code and may refer to the suggested lighting code. (See p. 57.)

In New Jersey the lighting code has been an inspection standard since 1918 and attempts have been made to apply it in manufacturing establishments by frequent regular inspections. Mercantile establishments have not been inspected regularly. In cases where questions have arisen, an electrical expert in the department has used a foot-candle meter to check the illumination level. From time to

<sup>9</sup> The department is striving for a law on industrial safety.

time inspectors have been given some instruction on lighting problems. After the adoption of the new lighting code in 1930, they were given a series of lectures and demonstrations on lighting problems, on the code and its interpretation, and on the use of the foot-candle meter, at the General Electric Lighting Institute in Harrison, N. J.

California, Maryland, and Oregon, of the States where the lighting code has the force of law, are not enforcing it except in special cases. In Maryland this is due to the fact that until recently the State industrial accident commission has not had power to develop an inspection staff to enforce its safety standards.<sup>10</sup> In January, 1931, plans were made and a director of safety was appointed to enforce these standards. The Maryland Board of Labor and Statistics, an entirely separate agency, that makes factory inspections to enforce certain laws has no law on lighting.

The California Department of Industrial Relations does not make routine factory inspections. Their lighting code is enforced only in special cases by an electrical engineer in the department. This engineer uses a foot-candle meter. A letter under date of November 10, 1930, from the superintendent of safety of the department makes this statement:

When the general lighting safety orders were issued, it was soon found that they could not be enforced as a practical thing, and therefore they have been a dead letter for a number of years. We occasionally investigate lighting conditions, but these are, in all cases, considered as special investigations.

We are at this time studying the Code for Lighting Factories, Mills, and Other Work Places, recently published,<sup>11</sup> but can not at this time state whether the code as printed will be recommended to the commission for adoption.

Oregon, after passing a lighting law and adopting a code in 1919, has never had funds to adequately enforce it or to secure an electrical expert. The factory inspectors, using the foot-candle meter, do from time to time check the lighting in certain places in industrial plants.

The remaining code States, Massachusetts, New York, Pennsylvania, Washington, and Wisconsin, in addition to New Jersey, attempt to enforce their lighting codes. Inquiry shows that the enforcement methods used in these five States are practically the same. Inspectors who have been given some training on lighting problems check lighting in their regular inspections of manufacturing and mercantile establishments. Foot-candle meters may be secured from a supervisor and are used whenever any doubt of the illumination level arises. Each State has some person with training and experience on lighting problems who may be called an electrical expert. He considers any lighting case involving a special problem.

The penalties (see Chart I, pp. 25 to 27) for the violation of the lighting codes appear to be adequate. No lighting order in any State has been the basis of court action. The value of this enforcement of the lighting codes can not be judged wholly by the numbers of orders complied with but the fact that 3,494 lighting orders were complied with in one State<sup>12</sup> in a 6-year period indicates that

<sup>10</sup> Bagby. Annotated Code of Maryland. 1929 supplement. Art. 101, secs. 55, 55a, 55b.

<sup>11</sup> Refers to American Standard Code.

<sup>12</sup> Statement from the Massachusetts Department of Labor and Industries.

their enforcement has improved conditions in many plants in these States.

**Summary.**

A review of the legal status and enforcement of the State lighting codes shows that in 6 States—Massachusetts, New Jersey, New York, Pennsylvania, Washington, and Wisconsin—of the 13 States with lighting codes the code is really enforced as a law; 1 other State, Maryland, prepared in January, 1931, to enforce the code; while in the other six States it is either enforced only in special cases (California and Oregon) or used as a recommendation (Idaho, Kentucky, Ohio, and Oklahoma).

The following summary indicates that the lighting requirements of 23 States are largely inadequate in having no requirements and having very limited ones.

**CHAPTER V.—STATE LIGHTING REQUIREMENTS OTHER THAN LIGHTING CODES**

Lighting codes, which have been discussed, represent the most effective action that the States have taken in the matter of industrial lighting, but they are being observed in only 13 States. While the practices of the remaining States contribute little to a solution of lighting problems, they do suggest problems of labor law and its administration. The statement is made sometimes that the leading industrial States have adopted lighting codes, implying that the failure of other States to adopt such codes is of minor importance. However, the fact that the 13 States having lighting codes in 1920 employed less than one-half of the gainfully employed females 10 years of age and over in the United States shows that the majority of employed women are unaffected by the action of these States.

An analysis of the lighting requirements of the States shows that in 19 States the department of labor has no general law nor other requirement for lighting in manufacturing or mercantile establishments and no other agency is enforcing a law or rule on the subject.

In addition to the code States, 8 States and the District of Columbia have some general requirement for lighting in all parts of manufacturing and mercantile establishments, while the remaining 10 States have lighting requirements only for certain limited places. The 48 States may be classified in this respect as follows:

*Lighting requirements for manufacturing and mercantile establishments (not including food establishments), by State*

[For details about each State see Appendix]

States having no legal requirements	States having lighting codes (all but Idaho have some law on lighting also)	States not having codes but having some general requirements—	
		Applying to all parts of manufacturing and mercantile establishments	Applying to certain limited places only
Alabama. Arizona. Arkansas. Colorado. Florida. Georgia. Idaho. <sup>4</sup> Iowa. Louisiana. Mississippi. Montana. Nevada. New Mexico. North Carolina. North Dakota. South Carolina. South Dakota. Utah. Wyoming.	California. Idaho. Kentucky. Maryland. Massachusetts. New Jersey. New York. Ohio. Oklahoma. Oregon. Pennsylvania. Washington. Wisconsin.	District of Columbia. Delaware. <sup>2</sup> Kansas. Kentucky. <sup>4</sup> Maine. Missouri. New Hampshire. Tennessee. Vermont.	Connecticut. <sup>1</sup> Illinois. <sup>3</sup> Indiana. <sup>3</sup> Michigan. <sup>5</sup> Minnesota. <sup>3</sup> Nebraska. <sup>6</sup> Rhode Island. <sup>1</sup> Texas. <sup>3</sup> Virginia. <sup>1</sup> West Virginia. <sup>3</sup>

<sup>1</sup> Applies to manufacturing establishments. <sup>4</sup> Lighting code is recommended.  
<sup>2</sup> Where women are employed. <sup>5</sup> Basement rooms, tenements, and foundries.  
<sup>3</sup> In passageways or means of egress. <sup>6</sup> Certain hazardous industries.

The foregoing summary indicates that the lighting requirements of 29 States are largely inadequate, 19 having no requirements and 10 having very limited ones.

#### Lighting requirements of States without lighting codes.

Besides the code States, only eight States (including one that recommends the American Standard Code) and the District of Columbia have lighting requirements for workrooms in both manufacturing and mercantile establishments. Consideration of the contents of these laws and requirements as compared with the requirements of the American Standard Code shows more clearly how unsatisfactory they are. New Hampshire is the only State other than the code States that has a set of rules on lighting covering general lighting, avoidance of glare, diffusion and distribution of light, and exit and emergency lighting.

No State but the code States (and it must be remembered that in some of these the code is not enforced or is merely a recommendation) has any specific requirement for the illumination level for general lighting. The laws stipulate that sufficient or adequate light must be supplied, or that if the lighting is such as to be injurious or dangerous to the health of employees changes must be made. Such unstandardized and indefinite requirements are very difficult to enforce.

Though some of the general statements about adequate light, and so forth, might be interpreted as covering the condition of glare, Kansas and New Hampshire are the only States, other than the code States, that specifically mention its prevention.

No requirement for lighting passageways and means of exit under certain conditions is made or may be included by interpretation in the 19 States that have no legal requirements and in Ohio, Michigan, and Nebraska, a total of 22 States. Moreover, of the exit requirements in addition to the light codes only the building code in Indiana definitely specifies the illumination level to be supplied.

Ten States—Indiana, New Hampshire, California, Maryland, Massachusetts, New York, New Jersey, Oregon, Pennsylvania, and Wisconsin, all but the first two being code States—are the only ones that require an independent system of emergency lights in certain places. Idaho and Kentucky recommend lighting codes suggesting such emergency systems, and Virginia requires for some places that the lighting system for halls, stairways, etc., must be independent of the motive power of the plant.

There are no other significant requirements in the laws of the States without lighting codes, although the Ohio State building code contains provisions for natural lighting that are not found in other States. (See p. 57 of this report.)

#### Enforcement of lighting requirements in States without lighting codes.

Most of the States with any law on lighting give the problem some consideration in the inspections made in manufacturing and mercantile establishments, and a few States without any legal requirements—Alabama, Colorado, and Iowa—also investigate lighting and make recommendations concerning it. None of the States without

lighting codes use a foot-candle meter in their lighting inspections, and only Missouri, New Hampshire, and Texas have stated that their inspectors were given training on, or had experience with, lighting problems. Missouri has an electrical expert in its department of labor and industrial inspection.

Because of its bearing on effective enforcement there should be noted the fact that some of the State lighting requirements shown in the appendix are not requirements of the department of labor, and their enforcement is not directly charged to that department. In Kentucky<sup>1</sup> the Department of Fire Prevention and Rates of the Auditor's Office and in Illinois the Division of Fire Prevention of the Department of Trade and Commerce has rules pertaining to illumination in places of employment; in Massachusetts<sup>1</sup> the Department of Public Safety, entirely independent of the Department of Labor and Industries, has certain lighting regulations; a few States—the District of Columbia, Indiana, Ohio,<sup>1</sup> and Wisconsin<sup>1</sup>—have building codes with sections pertaining to lighting. But in all these cases the department of labor either is the body administering the code or is represented on such body.<sup>2</sup> Many requirements affecting lighting are made by local ordinances such as city building codes and city fire rules. Only a few State departments of labor require that wiring shall comply with the standards of the National Electrical Code or some State code covering this matter, but insurance standards, local building codes, fire rules and ordinances, and standards for general practice do make such requirements. In many places in the United States it is difficult to determine what all the regulations are that pertain to natural light, building, wiring, illuminating levels, and exit lighting. Under such conditions it is almost impossible to secure efficient enforcement. The present study, as stated before, attempts to cover only State requirements, for the most part requirements of the departments of labor.

Lighting problems are so technical that it is doubtful if the inspection in many of these States under the conditions too frequently existing, of incomplete and inadequate laws, lack of definite standards, an enforcing personnel untrained in lighting problems, does very effectively improve the lighting of places of employment. However, it probably helps to prevent the worst conditions.

#### Laws and other requirements in States having lighting codes.

The State lighting codes have been considered in detail (see pp. 24 to 44), but in a discussion of lighting requirements other than these codes it should be noted that several of the code States have such additional lighting requirements. Special regulations concerning the kind of artificial light to be used in certain places, the guarding of lights, and lighting at night, orders for lighting places where women are employed, provisions for windows and window cleaning may be found in some of these code States. Since few of these requirements modify the levels of illumination recommended by the codes, they have not been analyzed completely for every State. (See each code State summary in the appendix.)

<sup>1</sup>This State uses the lighting code in some way. (See pp. 54, 57, 61-62.)

<sup>2</sup>Building-code rules can not require adequate light at work places because the amount needed varies with the type of occupancy of the building.



### Conclusions.

State departments of labor have before them the opportunity to improve lighting conditions in places of employment. In a discussion of illumination, Mr. R. E. Simpson, of the engineering and inspection division of the Travelers Insurance Co., has made this statement:

There is probably no body of men who have greater opportunity for raising the standard of our industrial lighting than the Federal, State, and insurance inspectors. \* \* \* The consulting engineer and the lighting specialist of manufacturing and public-utility concerns must interest the executives before they can make any progress. Even then the executive is under no obligation to follow the expert recommendations. These experts must solicit admission to the work places, while the Federal, State, or insurance inspector has behind him either the power given by law, or certain contractual obligations, so that a mere presentation of his card gains him ready admission to a plant. The executive, moreover, will probably give favorable consideration to the inspector's report because he is aware that it is to his interest to comply with any recommendation that the inspector is likely to make. With these advantages, plus an understanding of the fundamentals of good lighting, an inspector can be a potent influence in bettering our industrial lighting with a resulting reduction in the number of our industrial accidents.<sup>3</sup>

The experience of some States with lighting codes shows that they are an important means of securing effective action on illumination problems. Dr. George M. Price, an authority on working conditions in places of employment and on factory inspection, urges the adoption of lighting codes. In an address at the 1928 annual conference of the National Society for the Prevention of Blindness, he said:

The State authorities may greatly help in improving lighting conditions. Scientific and practical lighting codes must be enacted by the State. It is imperative that bureaus of light and illumination, with experts in charge as well as expert inspectors, should be established in our labor departments. Inspectors should be trained to make necessary photometric tests in the workshops. \* \* \*

A more radical recommendation would be the enactment of a law licensing trades and requiring employers, before occupying the loft or shop, to submit their plans for illumination to the labor department. This would insure an efficient illumination according to the specific needs of the work to be done in each workshop.<sup>4</sup>

While it may not seem possible to adopt some of these suggestions, most departments of labor could become informed on lighting problems and could use a lighting code at least as a guide for good illumination. The lighting codes are not blanket legislation for all industries; they provide specific requirements for various industries and conditions. They are a definite standard which an inspector can use to secure interest in lighting, and they have the additional advantage of being relatively easy to revise and to adapt to particular situations.

<sup>3</sup> Simpson, R. E. *Illumination. Safety Fundamentals.* Lectures given by Safety Institute of America, February to June, 1919. New York, 1920, ch. 8, p. 165.

<sup>4</sup> Price, George M., M. D., director of the Joint Board of Sanitary Control in the Women's Garment Trades, and director of the Union Health Center, New York City. *Light and Illumination and Defective Vision in the Garment Industry.* Proceedings of the 1928 Annual Conference of the National Society for the Prevention of Blindness, National Society for the Prevention of Blindness (Inc.), 370 Seventh Avenue, New York, N. Y., p. 61.

## APPENDIX

### SUMMARY OF STATE REQUIREMENTS FOR LIGHTING IN PLACES OF EMPLOYMENT, WITH SPECIAL REFERENCE TO FACTORY AND MERCANTILE WORKROOMS, PASSAGEWAYS, AND EXITS,<sup>1</sup> BY STATE

[NOTE.—Based on analysis of State laws and replies from officials of State departments of labor or industrial commissions, 1930-31. For text discussion of these data see pp. 24 to 48.]

No attempt has been made to list every law or regulation on lighting in each State. The illumination requirements of the State departments of labor or industrial commissions are covered where they apply to general work places in most industries. Not all requirements for mines, tenement houses, foundries, hotels and other food establishments, toilets,<sup>2</sup> hazardous industries, and wiring are included. The requirements of State boards of health and State fire marshals have been included for certain States, but preliminary inquiries showed that most board of health regulations apply only to food establishments and that in most cases the State fire marshals' requirements have to do only with the marking of exits by red lights. The former provision is primarily for the benefit of the public; the latter, for fire protection rather than for the proper illumination of exits for safe egress. These regulations are not included here. A few States have building codes, and sections of these that apply to lighting are included.<sup>3</sup>

#### ALABAMA

*Legal requirements.*—None.

*Enforcement practice.*—When inspections are made in connection with employment of minors, the inspectors take note of the lighting arrangements in the establishment. If the lighting is adequate, they comment on this fact. If it is inadequate, they make suggestions as to how it might be improved. There are no rules or regulations. There is no definite follow-up to see whether or not suggestions are carried out. All comments on lighting are made in an informal manner.

*Enforcement agency.*—Child Welfare Department, Child Welfare Commission, Montgomery.

#### ARIZONA

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Industrial Commission, Phoenix.

#### ARKANSAS

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Bureau of Labor and Statistics, Little Rock.

<sup>1</sup> For a supplementary list of references to State requirements pertaining to industrial lighting, see National Safety Council's *Safe Practices Pamphlet No. 94 on State Safety Requirements in Industry*, in *National Safety News*, March, 1930, vol. 21, No. 3, pp. 19-26.

<sup>2</sup> Women's Bureau Bulletin No. 99 gives the State requirements regarding lighting in toilet rooms. California, Connecticut, Delaware, District of Columbia, Idaho, Illinois, Kentucky, Maine, Maryland, Massachusetts, Minnesota, Montana, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Tennessee, Texas, Washington, West Virginia, and Wisconsin have lighting laws or rules for these places.

<sup>3</sup> Details on enforcement received from State agencies. Except where some action is mentioned, States with no legal requirements do not inspect for lighting.

CALIFORNIA<sup>4</sup>

*Legal requirements.*—Has a lighting code. (See pp. 24 to 44 of this report.)—General Lighting Safety Orders issued by the Industrial Accident Commission.

Every workroom shall be supplied with adequate natural or artificial light during the working hours. The sources of illumination shall be of such a nature and so placed as to provide a reasonably constant and uniform illumination over the necessary area of work and avoid the casting of shadows on the work. They shall be so placed or shaded that light from them does not fall directly on the eyes of an operator when engaged on her work. Applies where women or minors are employed in laundry and manufacturing industries.—Industrial Welfare Commission's Order No. 4, amended—laundry and manufacturing industries. Effective March 8, 1919.

Every room in which women and minors are employed shall be supplied with adequate natural or artificial light, in accordance with the General Lighting Safety Orders of the Industrial Accident Commission.—Industrial Welfare Commission's Order No. 13—mercantile establishments. Effective February 17, 1920.

*Enforcement practice.*—Regular inspections are not made in manufacturing and mercantile establishments, but in special cases an electrical engineer does inspect for lighting, using a foot-candle meter to measure the amount of illumination.

Lighting code is considered out of date and is not enforced, though the department plans to prepare another code.

*Enforcement agency.*—Department of Industrial Relations, San Francisco.

## COLORADO

*Legal requirements.*—None.

*Enforcement practice.*—The chief factory inspector states that on their inspection blanks are three questions on lighting: Are red lights provided for all exits (above 2 stories)? Are premises sufficiently lighted? Is artificial light provided?

When an inspector finds insufficient lighting he recommends changes. According to the correspondence from the chief factory inspector, the law seems to be made to protect the public against latent dangers, rather than the persons employed in the establishment.

*Enforcement agency.*—Bureau of Labor Statistics, Denver.

## CONNECTICUT

*Legal requirements.*—All factories and buildings where machinery is used shall be well lighted. There is no law applying to mercantile establishments.—General Statutes of Connecticut, revision of 1930, chapter 131, section 2355.

*Enforcement practice.*—Lighting inspections are made at least once a year in manufacturing and mercantile establishments. The inspector's observation and opinion determines what orders shall be issued.

*Enforcement agency.*—Department of Labor and Factory Inspection, Hartford.

## DELAWARE

*Legal requirements.*—All workrooms, halls, stairways, and toilets must be properly lighted where women are employed in mercantile, mechanical, transportation, or manufacturing, laundry, baking, printing, or dressmaking establishments, place of amusement, telephone or telegraph office or exchange, hotel, restaurant, or office.—Session Laws, 1917, chapter 231, sections 1, 5.

*Enforcement practice.*—No inspections are made for lighting.

*Enforcement agency.*—Labor Commission, Wilmington.

## DISTRICT OF COLUMBIA

*Legal requirements.*—Sufficient light is required in any store, factory, workshop, or other structure or place of employment where workmen or workwomen are employed for wages. Orders of Commissioners of the District of Columbia.—Laws and Regulations Relating to Public Health, in force July 1, 1930. Orders 1 and 3, pages 246, 247.

<sup>4</sup> Industrial Accident Commission's safety orders for certain specific industries not included.

Every stairway or other exit and the corridors and passageways appurtenant thereto shall be provided with an adequate system of lighting. At least one light at every floor landing, within the stair inclosure, and a red light over every door leading to an exit or from an exit to the street. This is required for office buildings, stores, factories, workshops, and all other buildings in the process of erection, alteration, or repair. There are supplemental requirements for certain conditions such as night occupancy, old and new buildings, etc. Orders of Commissioners of the District of Columbia.—The Building Code, July 1, 1930, pp. 55, 89, 110.

*Enforcement practice.*—Inspectors visit industrial establishments regularly about four times a year. They have no control over light in hallways.

*Enforcement agency.*—District Health Department, Washington, D. C.

## FLORIDA

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—State Labor Inspector, Jacksonville.

## GEORGIA

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Department of Commerce and Labor, Atlanta.

## IDAHO

*Legal requirements.*—None.<sup>5</sup>

*Enforcement practice.*—None.

*Enforcement agency.*—Industrial Accident Board, Boise.

## ILLINOIS

*Legal requirements.*—The following statute does not require lighting at the work place: In all factories, mercantile establishments, mills, or workshops, a proper light shall be kept burning by the owner or lessee in all main passageways, main hallways, at all main stairs, main stair landings, and shafts, and in front of all passenger or freight elevators, upon the entrance floors and upon other floors, on every workday of the year, from the time that the building is opened for use until the time when it is closed, except at times when the influx of natural light shall make artificial light unnecessary: *Provided*, That when two or more tenants occupy different floors in one building, such elevator shafts need be lighted only on the floors occupied and used by employees.—Smith-Hurd. Illinois Revised Statutes, 1929, chapter 48, section 119.

The Division of Fire Prevention of the Department of Trade and Commerce, Springfield, has additional requirements for certain hazardous industries.—Department of Trade and Commerce, Division of Fire Prevention.

*Enforcement practice.*—No inspections are made for lighting in manufacturing and mercantile establishments.

*Enforcement agency.*—Department of Labor, Springfield.

## INDIANA

*Legal requirements.*—By a written permit the chief inspector may allow persons to be employed in a room where there are less than 400 cubic feet but not less than 250 cubic feet of air space for each person employed between 6 o'clock in the evening and 6 o'clock in the morning: *Provided*, such room is lighted by electricity at all times during such hours while persons are employed therein.—Burns's Annotated Indiana Statutes, Watson's Revision 1926, ch. 72, sec. 9423.

<sup>5</sup> The Idaho State Chamber of Commerce states that there is an independent organization known as the All-Idaho Safety Council that has adopted and is suggesting the Code of Lighting Factories, Mills, and Other Work Places, approved by the American Standards Association Aug. 18, 1930. Although the council has no committee or individual appointed to compel compliance with its suggestions, it is receiving the heartiest cooperation on the part of builders in adopting the suggested code.

The chairman of the industrial board, the secretary of the State board of health, and the State fire marshal are the administrative committee of a State building council that is responsible for the enforcement of building laws and the making of regulations for buildings in the State. Their requirements for lighting are as follows:

6-2-219. All stairways and exits and the passageways appurtenant thereto except as otherwise provided shall be properly illuminated to facilitate egress. Such illumination shall be continuous during the time that the conditions of occupancy require that the exit ways be open or available. Artificial lighting shall be employed at such places and for such periods of time as required to maintain the illumination of the full intensities herein specified.

6-2-220. (a). The floors of exit ways of buildings used for public assembly or congregation, schools, department stores, factories, mills, and other occupancies as required shall be illuminated at all principal points such as angles and intersections of corridors and passageways, stairways, landings of stairs, and exit doorways to intensities of not less than 1 foot-candle and at other points to intensities of not less than 0.5 foot-candle.<sup>6</sup>

6-2-221. The lighting source shall be arranged to assure continued illumination of all exit ways in cases of emergency caused by the failure of the principal lighting of the building. Where electric current is the source of the lighting of buildings used for public assembly or congregation, the emergency lighting shall be from a source independent of that for the general lighting or shall be controlled by an automatic device which will operate reliably to switch the circuit to an independent secondary source in the event of failure of the primary source of current.

6-2-222. The lighting and all control apparatus shall be installed so as to be under the supervision of and controlled only by authorized persons.

Wiring, etc., must be in accordance with the Electrical Rules and Regulations of the Administrative Building Council.—Administrative Building Council of Indiana. Building Rules and Regulations, approved and promulgated October 15, 1928, pp. 82, 83, 192.

*Enforcement practice.*—None.

*Enforcement agency.*—Industrial Board, Indianapolis.

### IOWA

*Legal requirements.*—None.

*Enforcement practice.*—The deputy labor commissioner states that inspections are made in manufacturing and mercantile establishments, and that when conditions are noticeably poor, inspectors call attention to this fact and ask that lighting be improved with ventilation requests.

*Enforcement agency.*—Bureau of Labor, Des Moines.

### KANSAS

*Legal requirements.*—If the inspector finds that lighting is such as to be injurious to the health of persons employed or residing in any factory or mill, workshop, private works or State institution having shops or factories, mercantile establishment, laundry, or any other place of business, he shall notify, in writing, the owner, proprietor, agent, or lessee of such building, establishment, or place to make the changes deemed necessary for the safety and protection of the employees or other persons endangered by such conditions.—Revised Statutes of Kansas, annotated 1923, chapter 44, section 636.

All rooms shall be properly and adequately lighted during the working hours. Where the light is insufficient, artificial illumination in every workroom shall be installed, arranged, and used so that the light furnished will at all times be sufficient and adequate for the work carried on therein, and prevent unnecessary strain on the vision, or glare in the eyes of the workers. Applies to mercantile, laundries, dyeing, dry-cleaning and pressing establishments where women are employed.—Commission of Labor and Industry Orders affecting women workers, No. 1, Laundry; No. 3, Mercantile.

<sup>6</sup> Prescribes the minimum intensities of illumination; generally greater intensities should be provided. The additional illumination should be from lights placed alternately with the required emergency lights and supplied from the general lighting circuits or sources, or other sources similar to the required emergency lighting sources.

Ample lighting shall be provided and so arranged that direct rays do not shine into the worker's eyes. Applies where women are employed in any manufacturing occupation.—Commission of Labor and Industry; Order No. 2, Manufacturing.

*Enforcement practice.*—Manufacturing establishments are inspected yearly. Some inspections are made in mercantile establishments. An inspector uses his own judgment to determine when lighting is adequate and sees that stairways and exits are light and accessible.

*Enforcement agency.*—Commission of Labor and Industry, Topeka.

### KENTUCKY

*Legal requirements.*—1. A rule of the State Board of Health requires that the lighting of places of employment shall be adequate and shall be maintained with strict regard for the health, comfort, and safety of employees. This applies to every person, firm, or corporation operating a factory, mill, mine, quarry, store, office, workshop, or work place of any description, including building and construction work, employing one or more persons to labor. (Rules for food establishments do not make more definite requirements.)—Kentucky Laws and Rules of Interest and Pertaining to Children, Labor, Safety, Industry. Department of Labor, Bul. 32, pages 44-45, March, 1929.

2. The Department of Labor recommends the lighting code of the American Standards Association and the Illuminating Engineering Society, reprinting the 1922 edition, and also recommends certain daylighting suggestions of the United States Public Health Service.—Industrial Housekeeping (with suggestions). Department of Labor, Bul. 31, pages 51-90.

3. A safety standard of the Department of Fire Prevention and Rates requires that every inclosed stairway and exit shall be provided with an adequate system of lighting. Where the State fire marshal considers necessary, such lighting circuit shall be separate from that "indirectly" used throughout the building.—Standards of Safety, adopted and approved by Department of Fire Prevention and Rates, Section II, page 22, 1929.

*Enforcement practice.*—1. Department of Labor is required by law to report violations of health laws and rules to health officials.—Session Laws 1924, chapter 68, section 10.

2. Manufacturing and mercantile establishments are inspected irregularly. Inspectors are given some training on lighting problems by the engineers of the Actuarial Bureau and by the chief labor inspector.

3. No information.

*Enforcement agency.*—1. Bureau of Agriculture, Labor, and Statistics, Frankfort. State Board of Health.

2. Department of Labor of the Bureau of Agriculture, Labor, and Statistics.

3. Department of Fire Prevention and Rates.

### LOUISIANA

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Bureau of Labor and Industrial Statistics, New Orleans.

### MAINE

*Legal requirements.*—If the commissioner or any authorized agent of labor and industry finds that lighting is such as to be injurious to the health of the persons employed or residing in any factory or mill, workshop, private works or State institution that has shops or factories, he shall notify, in writing, the owner, proprietor, or agent of such workshops or factories to make, within 30 days, the alterations or additions by him deemed necessary for the safety and protection of the employees.—Revised Statutes of Maine, 1930, chapter 54, section 13.

*Enforcement practice.*—Inspectors make their own personal judgment of lighting when inspections, at irregular intervals, are made in manufacturing and mercantile establishments.

*Enforcement agency.*—Department of Labor and Industry, Augusta.

## MARYLAND

*Legal requirements.*—Industrial Accident Commission has adopted a lighting code. (See pp. 24 to 44 of this report.)—Code of Lighting Factories, Mills, and Other Work Places, sponsored by the Illuminating Engineering Society, approved as an American standard by the American Standards Association, August 18, 1930.

Has also adopted a building exits code that requires that exit lighting must not be less than that required by the American Standard Code of Lighting Factories, Mills, and Other Work Places.—Building Exits Code, sponsored by the National Fire Protection Association, approved as an American tentative standard by the American Standards Association, September 11, 1929, section 12, Orders 1201-1204; section 23, Order 2317a.

*Enforcement practice.*—A director of safety was appointed January, 1931, and plans were made to enforce the standards.

*Enforcement agency.*—State Industrial Accident Commission, Baltimore.

MASSACHUSETTS<sup>7</sup>

*Legal requirements.*—Has an industrial lighting code. (See pp. 24 to 44 of this report.)—Lighting Code for Factories, Workshops, Manufacturing, Mechanical, and Mercantile Establishments, Department of Labor and Industries, Division of Industrial Safety, Industrial Bul. No. 18.

The section of the law on which this code is based provides that every factory, workshop, manufacturing, mechanical, and mercantile establishment shall be well lighted, according to reasonable rules and regulations adopted by the department with reference thereto.

The industrial health inspectors shall, when obtaining information concerning the proper lighting of industrial establishments, make such investigation concerning the eye and vision in their relation to occupational diseases, including injuries to the eyes of the employees and to the pathological effects produced or promoted by the circumstances under which the various occupations are carried on, as in the opinion of the department is practicable, and it shall from time to time issue such printed matter containing suggestions to employers and employees for the protection of the eyes of the employees as it may deem advisable.—General Laws, 1921, ch. 149, secs. 113, 114.

*Enforcement practice.*—Lighting is inspected once each year, approximately, in most manufacturing and mercantile establishments by inspectors of the division of industrial safety. Hazardous industries are inspected three or four times a year. The inspectors are trained about lighting problems through lectures given by a lighting expert at the Massachusetts Institute of Technology. A foot-candle meter is used where it is necessary to determine the quantity of illumination. There is an electrical expert in the department.

*Enforcement agency.*—Department of Labor and Industries, Boston.

## MICHIGAN

*Legal requirements.*—Has no legal requirements for general or exit lighting in manufacturing and mercantile establishments, except that sufficient light is required in basement rooms where special processes are performed and in certain tenement manufacturing. Foundries must be reasonably well lighted.—Compiled Laws of Michigan, 1929, ch. 149, secs. 8337, 8346, 8341.

*Enforcement practice.*—Lighting is noted in annual inspections of manufacturing and mercantile establishments by factory and store inspectors, respectively, who use their own judgment of sufficient lighting.

*Enforcement agency.*—Department of Labor and Industry, Lansing.

## MINNESOTA

*Legal requirements.*—All stairways and inclined footways, and all points where there is a break or change in the floor level or in the character of the floor surface, where persons may have to walk or pass, and all dangerous places, all prime movers and all moving parts of machinery where, on, or about which persons work or pass, or may have to work or pass in emergencies,

<sup>7</sup> The department of labor and industries mentions lighting in some of its orders for special industries and the department of public safety (Boston) has special lighting requirements for fire prevention. These rules are not included.

shall be kept properly and sufficiently lighted during working hours. Applies to all work places except agriculture and domestic service.—Mason's Minnesota Statutes 1927, ch. 23, secs. 4147, 4171.

*Enforcement practice.*—None.

*Enforcement agency.*—Industrial Commission, St. Paul. Division of Accident Prevention and Division of Women and Children.

## MISSISSIPPI

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Bureau of Industrial Hygiene and Factory Inspection, Jackson.

## MISSOURI

*Legal requirements.*—When the inspector or one of his assistants finds that the lighting of any establishment where labor is employed is such as to be dangerous to the health or safety of employees therein or thereat, he shall at once, in writing, order the owner or owners, or the person or persons in charge of such establishment or place, to make the alterations or additions necessary within 10 days.—Revised Statutes of Missouri, 1929, ch. 95, sec. 13237.

*Enforcement practice.*—Inspectors use their own judgment to determine when lighting is adequate. Inspections are made every six months and upon complaint in manufacturing and mercantile establishments by State inspectors. There is an electrical expert in the department, and inspectors are given some training on lighting problems.

*Enforcement agency.*—Department of Labor and Industrial Inspection, Jefferson City.

## MONTANA

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Department of Agriculture, Labor and Industry, Helena.

## NEBRASKA

*Legal requirements.*—Has no general legal requirement. Safety codes adopted by the Department of Labor, August 26, 1930, require electric lights in certain hazardous industries: Construction and dry cleaning and dyeing.—Safety codes adopted by Department of Labor, August 26, 1930, pp. 10, 56.

*Enforcement practice.*—None.

*Enforcement agency.*—Department of Labor, Lincoln.

## NEVADA

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Labor Commissioner, Carson City.

## NEW HAMPSHIRE

*Legal requirements.*—(a) Lighting: All workrooms, passageways, and stairways and all basements or other places where workmen are employed or are obliged to go shall be at all times suitably lighted. Wherever natural illumination is not sufficient, artificial means of illumination shall be installed. To secure the best results from natural lighting, all windows should be kept clean and properly shaded to prevent glare. Walls and ceilings of all workrooms should be painted a light color and kept reasonably clean.

(b) Avoidance of glare; diffusion and distribution of light: Lighting, whether natural or artificial, shall be such as to avoid a glare, objectionable shadows, and extreme contrasts, and to provide a good distribution of light; in artificial lighting systems, lamps shall be so installed in regard to height, location, spacing, and reflectors, shades, or other suitable accessories as to accomplish these objects.

Bare-light sources, such as exposed lamp filaments located within the ordinary field of the worker's vision, are presumptive evidence of glare.

(c) Exit and emergency lighting: The lighting to be provided in all stairways and exits of factories and in the passageways appurtenant thereto shall be supplied so as not to be subject to failure because of the failure of the room or work space lighting from internal causes, and preferably from an independent connection extending back to the main service entrance for the building.

Applies to factories, mills, workshops, or other manufacturing or mercantile establishments in which three or more persons are regularly employed.—Bureau of Labor, Factory Inspection Standard No. 2, Lighting, supplemental to Session Laws, 1926, ch. 177, secs. 1, 7.

*Enforcement practice.*—Inspections are made of lighting in annual visits made in manufacturing establishments by factory inspector and in mercantile establishments by a woman factory inspector. The labor commissioner states that they always pay special attention to lighting in their general inspection work, and as all the members of his staff have been employed under all kinds of lighting conditions, they are very competent in making recommendations to improve lighting conditions.

*Enforcement agency.*—Bureau of Labor, Concord.

#### NEW JERSEY

*Legal requirements.*—Has a lighting code as an inspectors' standard. (See pp. 24 to 44 of this report.)—Code of Lighting Factories, Mills, and Other Work Places, sponsored by the Illuminating Engineering Society, approved as an American standard by the American Standards Association, August 18, 1930.

The law requires that, when in the opinion of the commissioner it is necessary, the halls or other portions of a building shall be provided with proper lighting facilities.—Cumulative Supplement to Compiled Statutes, 1911–1924, ch. 107, sec. 28.

*Enforcement practice.*—Lighting inspections are made in manufacturing establishments by the regular force of factory inspectors and in special cases by the electrical inspector as often as a building requires it. Mercantile establishments are not inspected. The electrical inspector uses a foot-candle meter to check the light in questionable cases. In 1930 and 1931 the inspectors were given training on lighting problems, the lighting code, and the use of the foot-candle meter in a series of lectures at the General Electric Lighting Institute, Harrison.

*Enforcement agency.*—Department of Labor, Trenton.

#### NEW MEXICO

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—State Inspector of Coal Mines,<sup>8</sup> Gallup.

#### NEW YORK<sup>9</sup>

*Legal requirements.*—Has lighting code for factories and mercantile establishments. (See pp. 24 to 44 of this report.)—Industrial Code Bul. No. 18, Rules Relating to Lighting of Factories and Mercantile Establishments. Code Rules Nos. 50, 51, 52, 53. Industrial Commission of the Department of Labor.

This code has the force of law and supplements sections of the labor law that specify certain lighting requirements in particular places. The basic lighting law is as follows:

1. In every factory proper lighting shall be provided during work hours for—
  - a. All places where persons work or pass, or may have to work or pass in emergencies;
  - b. All elevator cars and entrances;
  - c. All halls and stairs leading to workrooms;
  - d. All moving parts of machinery not required to be guarded by section 256 and the rules of the commission, and dangerous because of their location.
2. In every factory workroom the lighting shall be such as will not cause strain on the vision or glare in the eyes of workers.

<sup>8</sup> Only labor agent.

<sup>9</sup> Many rules of the industrial code applying to factories and mercantile establishments again mention lighting requirements for specific work places. A few modify the code. These are not included.

3. In the public hallway upon each floor of every factory building a proper light shall be kept burning near the stairs during each working day from the opening of the building until its closing, except when natural light suffices. Such lights shall be arranged to operate reliably when through accident or other cause other lights of the building are extinguished.

*Gas jets and other lights.*—All gas jets and other lights in factories shall be properly inclosed by globes or wire cages, or shall be otherwise properly protected in a manner approved in the city of New York by the fire commissioner of such city and elsewhere by the commissioner.—Labor Law in Cahill's Consolidated Laws, 1930, chapter 32, secs. 257, 255, 256, 316, 282.

*Enforcement practice.*—Annually and also upon complaint the factory inspectors inspect lighting in manufacturing and mercantile establishments. An illuminating engineer in the department gives factory inspectors training in the use of the foot-candle meter and in the law regarding lighting. Each supervisor of inspectors has a foot-candle meter, which is used to check the amount of illumination where there is any question about it. Before any prosecution is started the illuminating engineer makes an inspection.

*Enforcement agency.*—Department of Labor, New York.

#### NORTH CAROLINA

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Department of Labor and Printing, Raleigh.

#### NORTH DAKOTA

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Department of Agriculture and Labor, Bismarck.

#### OHIO

*Legal requirements.*—Has a lighting code as a recommendation. (See pp. 24 to 44 of this report.)—Industrial Lighting Code for Factories, Mills, and Other Work Places. The Industrial Commission of Ohio.

The Ohio State Building Code requires that in workshops, factories, mercantile and office buildings—

- (a) All rooms in buildings of this classification except storage or other rooms where the nature of the occupancy will not permit shall have adequate facilities for natural light and ventilation independent of the use of adjoining property unless the right to such use has been obtained by deed or instrument;
  - (b) Natural light and ventilation shall be obtained by means of windows placed in external walls, clerestory windows, or skylight;
  - (c) Windows shall have movable sash, and skylights shall be ventilated;
  - (d) All occupied areas in workshops and factories shall be provided with not less than one (1) square foot of glass area to eight (8) square feet of floor area;
  - (f) No required windows shall be placed nearer any building or adjoining lot line than four (4) feet;
- and that—

All occupied parts of buildings of this classification shall be adequately lighted at all times; and when not sufficiently lighted by windows, artificial light shall be provided during the day;

Gas, oil, or vapor lamps may be used for illumination only when electrical current is not available.—Department of Industrial Relations, Division of Factory and Building Inspection, Bul. No. 109, Ohio State Building Code, Workshops, Factories, Mercantile, and Office Buildings. November, 1929, sections 6, 22, pages 11, 17.

*Enforcement practice.*—At irregular intervals, inspectors of the Division of Factory Inspection inspect manufacturing and mercantile establishments for lighting, enforcing the provisions of the building code, and using the lighting code as a guide.

*Enforcement agency.*—Department of Industrial Relations, Columbus.

## OKLAHOMA

*Legal requirements.*—Has a lighting code that is used as a recommended standard for lighting. (See pp. 24 to 44 of this report.)—Department of Labor, Bul. No. 3, Industrial Code Rules Relating to Lighting of Factories and Mercantile Establishments.

The law states that, when in the opinion of the factory inspector it is necessary, the workrooms, halls, and stairs leading to the workrooms shall be properly lighted. Applies to factories, workshops, and machine shops, foundries, laundries, manufacturing establishments, and such other places where labor is employed as the commissioner of labor may designate.—Revised laws, 1910, sections 3748, 3743.

*Enforcement practice.*—The three inspectors can not inspect each manufacturing and mercantile establishment once a year as directed in the code, and they have had to abandon the use of the foot-candle meter because its use required so much time that other parts of their work were neglected.

*Enforcement agency.*—Department of Labor, Oklahoma City.

## OREGON

*Legal requirements.*—Has a lighting code. (See pp. 24 to 44 of this report.)—Code Governing Industrial Lighting in Places of Employment, 1919, Bureau of Labor.

This code is a regulation promulgated by the Bureau of Labor as directed by the following law: Applies to any place where any industry, trade, or business is carried on, or where any process or operation directly or indirectly relating to any industry, trade, or business is carried on, except private domestic service or agricultural pursuits which do not involve the use of mechanical power.

All passageways and other portions of places of employment and all moving parts of machinery which are not so guarded as to prevent accidents, where, on, or about which persons work or pass or may have to work or pass in emergencies, shall be kept properly and sufficiently lighted during working hours. The halls and stairs leading to the workrooms shall be properly and adequately lighted, and a proper and adequate light shall be kept burning by the owner or lessee in the public hallways near the stairs, upon the entrance floor, and upon the other floors on every work day in the year from the time when the building is open for use in the morning until the time it is closed in the evening, except in times when the influx of natural light shall make artificial light unnecessary. Such lights shall be so arranged as to insure their reliable operation when through accident or other cause the regular factory or workshop lighting is extinguished.

All workrooms in any place of employment shall be properly and adequately lighted during working hours. Artificial illuminants in every workroom shall be installed, arranged, and used so that the light furnished will at all times be sufficient and adequate for the work carried on therein, and so as to prevent unnecessary strain on the vision or glare in the eyes of the workers.

Working or traversed spaces in all places of employment as defined in this act shall be supplied during the time of use with artificial light in accordance with a schedule of minimum values which shall be determined as hereinafter specified; and when the natural light is less than the intensity so determined, the artificial light must be used.

Lamps must be so located or suitably shaded as to minimize glare.

All lamps and lighting appliances must be so installed in regard to height, spacing, reflectors, or other accessories as to secure a good distribution of light on the work, avoiding objectionable shadows and sharp contrasts of intensity. Emergency lamps shall be provided in the main aisles and in all stairways, passageways, and exits so as to afford sufficient guidance to provide the safe exit from said places of employment in case of emergency. Such lamps shall be in operation concurrently with the lighting and independent thereof.

The switching and controlling apparatus shall be so placed that at least pilot or night lights may be turned on at the main points of entrance.

The commissioner of labor and inspector of factories and workshops of the State of Oregon is hereby authorized to establish certain minimum values for lighting, which shall be deemed proper and adequate in accordance with the conditions set forth in this act. In arriving at what values shall be used in this schedule of minimum lighting, and such other rules as shall determine

definitely what shall constitute compliance with the provisions of this act, he shall be guided by the best engineering practice as set forth in the recommendations of "Illuminating Engineering Society." Before such schedule and rules, however, shall become effective, the Commissioner of Labor must, upon his own motion, appoint a commission of three persons, one to represent the manufacturing interests, one to represent the operating electrical workers, and one must be an electrical engineer. Notice of the public meetings of such commission shall be published in the leading newspapers of each county in the State, giving the time, place, and purpose of such meetings. The commission shall have power, after holding these public meetings, to establish, to rearrange, or to readjust the schedule of lighting values and rules as above set forth. These rulings or adjustments shall then become effective, 30 days after they have been made, and the commissioner of labor shall serve notice, in writing or by publication in the leading newspapers of each county in the State, of the rulings thus made and of the date upon which they become effective.

Any person, firm, or corporation who violates or does not comply with the provisions of this act or who shall fail or neglect to provide the necessary and proper illumination herein provided, within thirty (30) days after receiving written notice so to do by the commissioner of labor and inspector of factories and workshops, is guilty of a misdemeanor, and upon conviction shall be punished by a fine not exceeding the sum of fifty dollars (\$50), and that for the purposes of this act each day that such violation continues, or for each day such refusal continues, shall constitute a separate and distinct violation of this act.—Session Laws, 1919, ch. 181, secs. 1-9.

The Industrial Welfare Commission has an order applying to all occupations of women, requiring that: All rooms shall be properly and adequately lighted during working hours. Artificial illumination in every workroom shall be installed, arranged, and used so that the light furnished will be, at all times, sufficient and adequate for the work carried on therein, and prevent unnecessary strain on the vision or glare on the eyes of the worker.—Industrial Welfare Commission Order No. 22. Sanitary Code, sec. 3.

*Enforcement practice.*—There have been no funds available to provide for adequate enforcement of the lighting law and code, but the factory inspectors do check the lighting from time to time in certain places in industrial plants, using the foot-candle meter to determine the amount of illumination.

*Enforcement agency.*—Bureau of Labor, Salem.

PENNSYLVANIA<sup>10</sup>

*Legal requirements.*—Has a lighting code. (See pp. 24 to 44 of this report.)—Regulations for Industrial Lighting, Department of Labor and Industry.

The law requires that all workrooms, halls, and stairways be properly lighted. Applies to all manufacturing and mercantile establishments and other places of employment.—Pennsylvania Statutes, complete to 1920, sec. 13593.

Special rules for emergency lighting in certain factories and mercantile establishments where night work is performed more than 50 nights in any one year supplement the emergency lighting section of the lighting code.—Regulations for Protection from Fire and Panic, Construction, Installation, and Maintenance of Emergency Lighting Systems, Department of Labor and Industry.

*Enforcement practice.*—Lighting inspections are made in manufacturing and mercantile establishments by inspectors of the bureau of inspection in their regular inspections and in their special inspections where an accident has occurred. Foot-candle meters are available in each division office and some person in each division is trained to use them. They are used in such places as there appears to be reason to doubt that the lighting meets the requirements of the regulations. Two men in the main office, who are experts on lighting problems, give some instruction to the inspectors on lighting.

*Enforcement agency.*—Department of Labor and Industry, Harrisburg.

## RHODE ISLAND

*Legal requirements.*—To provide adequate lighting is the duty of the proprietor of any factory or workshop. This does not cover mercantile establishments.—Session Laws, 1926, ch. 761, sec. 9.

<sup>10</sup> In addition, lighting and the lighting code are referred to in many of the regulations for particular industries by the department of labor and industry. These are not included here.

*Enforcement practice.*—Inspections of lighting are made by the inspectors in their regular visits to factories and workshops. As they have 10,000 places under the factory inspectors' care, and only five inspectors, the inspector states that visits can not be made very often.

*Enforcement agency.*—Office of Factory Inspectors, Providence.

#### SOUTH CAROLINA

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Department of Agriculture, Commerce, and Industries, Columbia.

#### SOUTH DAKOTA

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Industrial Commissioner, Pierre.

#### TENNESSEE

*Legal requirements.*—Inspectors of factories and workshops are charged to carefully inspect for lighting.—Session Laws, 1915, ch. 170, sec. 9.

The Department of Labor has supplemented this requirement by a safety standard requiring that all work places, passageways, and storage spaces should be so well lighted that a person may easily see any dangers with which he might come in contact. Light that is sufficient is required in stairways, elevator cars, and on elevator landings.—Handbook of Industrial Safety Standards, Tennessee Department of Labor, Factory Inspection Division, pages 68, 5, 15, issued under authority of Session Laws, 1923, sec. 55, part 9.

*Enforcement practice.*—The factory inspectors inspect for lighting at least once a year in their inspection of manufacturing and mercantile establishments. Standards for proper lighting left to judgment of inspectors.

*Enforcement agency.*—Department of Labor, Nashville.

#### TEXAS

*Legal requirements.*—Lights shall be kept burning at all main stairs, stair landings, and elevator shafts in the absence of sufficient natural light in factories, mills, workshops, mercantile establishments (except those having seven or less female employees), laundries, or other establishments of a height of two stories or over.—Revised Civil Statutes, 1925, Art. 5176.

*Enforcement practice.*—Inspections are made for lighting once each year in manufacturing and mercantile establishments. The chief of the division of factory inspectors gives inspectors some training on lighting problems.

*Enforcement agency.*—Bureau of Labor Statistics, Austin.

#### UTAH

*Legal requirements.*—None.

*Enforcement practice.*—None.

*Enforcement agency.*—Industrial Commission, Salt Lake City.

#### VERMONT

*Legal requirements.*—If the Commissioner of Industries finds that the lighting is injurious to the health of the persons employed or residing in a factory, mill, workshop, private works, or State institution which has shops or factories, he shall give written notice to the owner, proprietor, or other person in charge of such workshop or factory to make, within 30 days, such alterations or additions for the safety and protection of employees as said commissioner deems necessary.—General Laws, 1917, sec. 5847.

*Enforcement practice.*—The factory inspector inspects for lighting in manufacturing and mercantile establishments at least once a year, using his own best judgment about lighting that is injurious to the health of the persons employed.

*Enforcement agency.*—Office of the Commissioner of Industries, Montpelier.

#### VIRGINIA

*Legal requirements.*—When in the opinion of the commissioner of labor it is necessary, the workrooms, halls and stairs leading to the workrooms shall be properly lighted; and in cities of the first class, if deemed necessary by the commissioner of labor, a proper light shall be kept burning by the owner or lessee in the public hallways, near the stairs upon the entrance floor and upon the other floors, on every workday in the year from the time when the building is opened for use in the morning until the time it is closed in the evening, except at such times when the influx of natural light shall make artificial light unnecessary. Such lights shall be independent of the motive power of such factory. This applies to factories, shops, and manufacturing establishments where machinery is used. It does not cover mercantile establishments.—Virginia Code of 1930, annotated, ch. 75, sec. 1830.

*Enforcement practice.*—Inspections are made of lighting in manufacturing establishments by the factory inspectors. Although the law does not cover mercantile establishments, the factory inspectors or the inspector of the women's and children's division of the Department of Labor and Industry do note lighting in their inspections of mercantile establishments.

*Enforcement agency.*—Department of Labor and Industry, Richmond.

#### WASHINGTON

*Legal requirements.*—Has a lighting code. (See pp. 24 to 44 of this report.)—Safety Standards, effective January 1, 1924, Nos. 14–20, Department of Labor and Industries.

Also an order of the Industrial Welfare Committee.

Every room in any manufacturing or mercantile establishment in which women are employed shall be supplied with adequate natural or artificial light. Sufficient illumination shall be provided for each woman irrespective of her position on the floor space. Individual lamps shall be placed close to the work where necessary, and in such cases the lamps shall be provided with suitable opaque reflectors.—Industrial Welfare Committee Order No. 30, Working Conditions for Female Employees, sec. 1.

*Enforcement practice.*—Inspections of lighting are made in manufacturing and mercantile establishments by inspectors of the Division of Safety and of the Industrial Welfare Commission. The inspectors are trained on lighting problems by the department and are under the supervision of an electrical engineer.

*Enforcement agency.*—Department of Labor and Industries, Olympia.

#### WEST VIRGINIA

*Legal requirements.*—No legal requirements for general workroom lighting, but a proper light shall be kept burning by the owner or lessee in all main passageways, main hallways, at all main stairs, main stair landing and shafts, and in front of all passenger or freight elevators, upon entrance floors, and upon other floors, on every workday of the year, from the time that the building is open for use until it is closed, except at times when the influx of natural light shall make artificial light unnecessary. Passageways must be of ample width, well lighted, and free from obstruction. This applies to all factories, mercantile establishments, mills, or workshops.—Official Code of West Virginia, 1931, ch. 21, art. 3, sec. 6.

*Enforcement practice.*—Inspectors may issue orders on lighting.

*Enforcement agency.*—Bureau of Labor, Charleston.

#### WISCONSIN<sup>11</sup>

*Legal requirements.*—Has a lighting code. (See pp. 24 to 44 of this report.)—Industrial Lighting Code for Factories, Mills, Offices and Other Work Places; Third edition revised. Industrial Commissioner's Orders 2100 to 2118.

<sup>11</sup> Several additional orders supplementing the basic lighting code are not included here.

The building code requires that in all places of employment all passageways and stairways when used at night shall have lights at the head and foot of each flight of stairs and at the intersections of all corridors and passageways. Where "B" fire escapes are required, such fire escapes shall be lighted whenever the stairways are required to be lighted. For red exit lights, see order 5132. All gas jets or gas lights in factories or workshops where combustible material is used shall be properly enclosed by globes or wire cages, or otherwise properly guarded.

Oil lamps shall not be used when gas or electricity is available.

Certain requirements are made for locating and protecting gas and oil lights. All electrical work shall conform to the Wisconsin State Electrical Code of the Industrial Commission.—Building Code, reprint, 1927, Industrial Commission of Wisconsin. Orders 5410, 5224, and 5225.

Enforcement practice.—Inspections of lighting are made in manufacturing and mercantile establishments by the factory inspectors. Foot-candle meters are used in any place in which there has been disagreement concerning lighting between the deputy and the owner or person in charge. The electrical engineer of the department is also called in if there is a decided difference of opinion. After inspectors have become familiar with the requirements of the lighting code, they are given instruction in its application by demonstrations and joint inspections with the electrical engineer.

Enforcement agency.—Industrial Commission, Madison.

WYOMING

Legal requirements.—None.

Enforcement practice.—None.

Enforcement agency.—Department of Labor and Statistics, Cheyenne.

PUBLICATIONS OF THE WOMEN'S BUREAU

[Any of these bulletins still available will be sent free of charge upon request]

- \*No. 1. Proposed Employment of Women During the War in the Industries of Niagara Falls, N. Y. 16 pp. 1918.
- \*No. 2. Labor Laws for Women in Industry in Indiana. 29 pp. 1919.
- No. 3. Standards for the Employment of Women in Industry. 8 pp. Fourth ed., 1928.
- No. 4. Wages of Candy Makers in Philadelphia in 1919. 46 pp. 1919.
- \*No. 5. The Eight-Hour Day in Federal and State Legislation. 19 pp. 1919.
- No. 6. The Employment of Women in Hazardous Industries in the United States. 8 pp. 1921.
- No. 7. Night-Work Laws in the United States. (1919.) 4 pp. 1920.
- \*No. 8. Women in the Government Service. 37 pp. 1920.
- \*No. 9. Home Work in Bridgeport, Conn. 35 pp. 1920.
- \*No. 10. Hours and Conditions of Work for Women in Industry in Virginia. 32 pp. 1920.
- No. 11. Women Street Car Conductors and Ticket Agents. 90 pp. 1921.
- \*No. 12. The New Position of Women in American Industry. 158 pp. 1920.
- \*No. 13. Industrial Opportunities and Training for Women and Girls. 48 pp. 1921.
- \*No. 14. A Physiological Basis for the Shorter Working Day for Women. 20 pp. 1921.
- No. 15. Some Effects of Legislation Limiting Hours of Work for Women. 26 pp. 1921.
- No. 16. (See Bulletin 98.)
- No. 17. Women's Wages in Kansas. 104 pp. 1921.
- No. 18. Health Problems of Women in Industry. 6 pp. Revised, 1931.
- No. 19. Iowa Women in Industry. 73 pp. 1922.
- \*No. 20. Negro Women in Industry. 65 pp. 1922.
- No. 21. Women in Rhode Island Industries. 73 pp. 1922.
- \*No. 22. Women in Georgia Industries. 89 pp. 1922.
- No. 23. The Family Status of Breadwinning Women. 43 pp. 1922.
- No. 24. Women in Maryland Industries. 96 pp. 1922.
- No. 25. Women in the Candy Industry in Chicago and St. Louis. 72 pp. 1923.
- No. 26. Women in Arkansas Industries. 86 pp. 1923.
- No. 27. The Occupational Progress of Women. 37 pp. 1922.
- No. 28. Women's Contributions in the Field of Invention. 51 pp. 1923.
- No. 29. Women in Kentucky Industries. 114 pp. 1923.
- No. 30. The Share of Wage-Earning Women in Family Support. 170 pp. 1923.
- No. 31. What Industry Means to Women Workers. 10 pp. 1923.
- No. 32. Women in South Carolina Industries. 128 pp. 1923.
- No. 33. Proceedings of the Women's Industrial Conference. 190 pp. 1923.
- No. 34. Women in Alabama Industries. 86 pp. 1924.
- No. 35. Women in Missouri Industries. 127 pp. 1924.
- No. 36. Radio Talks on Women in Industry. 34 pp. 1924.
- No. 37. Women in New Jersey Industries. 99 pp. 1924.
- No. 38. Married Women in Industry. 8 pp. 1924.
- No. 39. Domestic Workers and Their Employment Relations. 87 pp. 1924.
- No. 40. (See Bulletin 98.)
- No. 41. Family Status of Breadwinning Women in Four Selected Cities. 145 pp. 1925.
- No. 42. List of References on Minimum Wage for Women in the United States and Canada. 42 pp. 1925.
- No. 43. Standard and Scheduled Hours of Work for Women in Industry. 68 pp. 1925.

\* Supply exhausted.



- No. 44. Women in Ohio Industries. 137 pp. 1925.  
 No. 45. Home Environment and Employment Opportunities of Women in Coal-Mine Workers' Families. 61 pp. 1925.  
 No. 46. Facts About Working Women—A Graphic Presentation Based on Census Statistics. 64 pp. 1925.  
 No. 47. Women in the Fruit-Growing and Canning Industries in the State of Washington. 223 pp. 1926.  
 \*No. 48. Women in Oklahoma Industries. 118 pp. 1926.  
 No. 49. Women Workers and Family Support. 10 pp. 1925.  
 No. 50. Effects of Applied Research Upon the Employment Opportunities of American Women. 54 pp. 1926.  
 No. 51. Women in Illinois Industries. 108 pp. 1926.  
 No. 52. Lost Time and Labor Turnover in Cotton Mills. 203 pp. 1926.  
 No. 53. The Status of Women in the Government Service in 1925. 103 pp. 1926.  
 No. 54. Changing Jobs. 12 pp. 1926.  
 No. 55. Women in Mississippi Industries. 89 pp. 1926.  
 No. 56. Women in Tennessee Industries. 120 pp. 1927.  
 No. 57. Women Workers and Industrial Poisons. 5 pp. 1926.  
 No. 58. Women in Delaware Industries. 156 pp. 1927.  
 No. 59. Short Talks About Working Women. 24 pp. 1927.  
 No. 60. Industrial Accidents to Women in New Jersey, Ohio, and Wisconsin. 316 pp. 1927.  
 No. 61. The Development of Minimum Wage Laws in the United States, 1912 to 1927. 635 pp. 1928.  
 No. 62. Women's Employment in Vegetable Canneries in Delaware. 47 pp. 1927.  
 No. 63. (See Bulletin 98.)  
 No. 64. The Employment of Women at Night. 86 pp. 1928.  
 \*No. 65. The Effects of Labor Legislation on the Employment Opportunities of Women. 498 pp. 1928.  
 No. 66-I. History of Labor Legislation for Women in Three States. 136 pp. 1932.  
 No. 66-II. Chronological Development of Labor Legislation for Women in the United States. Revised December, 1931. 176 pp. 1932.  
 No. 67. Women Workers in Flint, Mich. 80 pp. 1929.  
 No. 68. Summary: The Effects of Labor Legislation on the Employment Opportunities of Women. (Reprint of Chapter II of bulletin 65.) 22 pp. 1928.  
 No. 69. Causes of Absence for Men and for Women in Four Cotton Mills. 24 pp. 1929.  
 No. 70. Negro Women in Industry in 15 States. 74 pp. 1929.  
 No. 71. Selected References on the Health of Women in Industry. 8 pp. 1929.  
 No. 72. Conditions of Work in Spin Rooms. 41 pp. 1929.  
 No. 73. Variations in Employment Trends of Women and Men. 143 pp. 1930.  
 No. 74. The Immigrant Woman and Her Job. 179 pp. 1930.  
 No. 75. What the Wage-Earning Woman Contributes to Family Support. 21 pp. 1929.  
 No. 76. Women in 5-and-10-cent Stores and Limited-Price Chain Department Stores. 58 pp. 1930.  
 No. 77. A study of Two Groups of Denver Married Women Applying for Jobs. 11 pp. 1929.  
 No. 78. A Survey of Laundries and Their Women Workers in 23 Cities. 166 pp. 1930.  
 No. 79. Industrial Home Work. 20 pp. 1930.  
 No. 80. Women in Florida Industries. 115 pp. 1930.  
 No. 81. Industrial Accidents to Men and Women. 48 pp. 1930.  
 No. 82. The Employment of Women in the Pineapple Canneries of Hawaii. 30 pp. 1930.  
 No. 83. Fluctuation of Employment in the Radio Industry. 66 pp. 1931.  
 No. 84. Fact Finding with the Women's Bureau. 37 pp. 1931.  
 No. 85. Wages of Women in 13 States. 213 pp. 1931.  
 No. 86. Activities of the Women's Bureau of the United States. 15 pp. 1931.

\* Supply exhausted.

- No. 87. Sanitary Drinking Facilities, with Special Reference to Drinking Fountains. 28 pp. 1931.  
 No. 88. The Employment of Women in Slaughtering and Meat Packing. 210 pp. 1932.  
 No. 89. The Industrial Experience of Women Workers at the Summer Schools, 1928 to 1930. 62 pp. 1931.  
 No. 90. Oregon Legislation for Women in Industry. 40 pp. 1931.  
 No. 91. Women in Industry. A Series of Papers to Aid Study Groups. 79 pp. 1931.  
 No. 92. Wage-Earning Women and the Industrial Conditions of 1930. A Survey of South Bend. 84 pp. 1932.  
 No. 93. Household Employment in Philadelphia. 88 pp. 1932.  
 No. 94. State Requirements for Industrial Lighting. A Handbook for the Protection of Women Workers, Showing Lighting Standards and Practices. 65 pp. 1932.  
 No. 95. Bookkeepers, Stenographers, and Office Clerks in Ohio, 1914 to 1929. 34 pp. 1932.  
 No. 96. Women Office Workers in Philadelphia. 17 pp. 1932.  
 No. 97. The Employment of Women in the Sewing Trades of Connecticut.—Preliminary Report. 13 pp. 1932.  
 No. 98. Labor Laws for Women in the States and Territories. (Revision of Bulletin 63.) (In press.)  
 No. 99. The Installation and Maintenance of Toilet Facilities in Places of Employment. (In press.)  
 No. 100. The Effects on Women of Changing Conditions in the Cigar and Cigarette Industries. (In press.)  
 Pamphlet—Women's Place in Industry in 10 Southern States. 14 pp. 1931.  
 Annual Reports of the Director, 1919\*, 1920\*, 1921\*, 1922, 1923, 1924\*, 1925, 1926, 1927\*, 1928\*, 1929\*, 1930\*, 1931, 1932. (In press.)

\* Supply exhausted.

