IS 6665 (1972): Code of practice for industrial lighting
[ETD 24: Illumination Engineering and Luminaries]

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IS : 6665 - 1972
(Reaffirmed 2005)

Indian Standard

CODE OF PRACTICE FOR INDUSTRIAL LIGHTING

(Fifth Reprint May 1997)

UDC 628·977·1

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002

Gr 7

April 1973

Indian Standard

CODE OF PRACTICE FOR INDUSTRIAL LIGHTING

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Indian Standard
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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 8 August 1972, after the draft finalized by the Illuminating Engineering Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 Taking into consideration the increasing industrial activities in India whereby a large number of people have to work on tasks and processes of increasing intricacy and detail with working hours extending into the night, need has been felt for well planned and efficient industrial lighting which would create easier seeing conditions and agreeable atmosphere. This has led to the publication of this code of practice.

0.3 This code has been drawn up in order to deal with the special aspects of industrial lighting and shall be read in conjunction with IS: 3646 (Part I)-1966*, IS: 3646 (Part II)-1966† and IS: 3646 (Part III)-1968‡.

0.4 In preparing this code, assistance has been derived from the following:

IES Code. Recommendations for good interior lighting. 1961. The Illuminating Engineering Society, London.

IES Technical Report No. 2. The calculation of coefficients of utilization. The British zonal method. The Illuminating Engineering Society, London.

Interior lighting design. British Lighting Council, UK.

IES Lighting handbook. 1966. The Illuminating Engineering Society, USA.

Modern factory lighting. British Electrical Development Association and the ELMA Lighting Service Bureau, London.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS: 2-1960§. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Code of practice for interior illumination: Part I Principles of good lighting and aspects of design.

†Code of practice for interior illumination: Part II Schedule for values of illumination and glare index.

‡Code of practice for interior illumination: Part III Calculations of coefficients of utilization by the BZ method.

§Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This code covers the principles and practice governing good lighting for various industrial premises. It recommends the levels of illumination and quality requirements to be achieved by general principles of lighting.

2. TERMINOLOGY

2.1 For the purpose of this standard the definitions given in IS: 1885 (Part XVI/Sec 1)-1968* shall apply.

3. GENERAL FEATURES OF INDUSTRIAL LIGHTING

3.1 Industrial lighting encompasses seeing tasks, operating conditions and economic conditions. Visual tasks may be classified either small or very large; dark or light; opaque, transparent or translucent; specular of diffuse surfaces; flat or contoured shapes. With each of the various task conditions, lighting should be suitable for adequate visibility in developing raw materials into finished products. Physical hazards exist in manufacturing processes and, therefore, lighting should contribute to the utmost as a safety factor in preventing accidents. The speed of operations may be such as to allow only minimum time for visual perception and, therefore, lighting should be a compensating factor to increase the speed of vision.

3.2 Light should serve not only as a production tool and an aid to safety but should also contribute to the overall environment conditions of the work space. The lighting system should be a part of a planned environment contributing to the comfort and well-being of the users.

3.3 The design of a lighting system and selection of equipment is influenced by many economic factors. The choice, however, should not only be based on the project and the running costs of the lighting but also on the relationship of total lighting cost to costs arising out of other plant producing facilities and labour.

4. FACTORS INFLUENCING GOOD INDUSTRIAL LIGHTING PRACTICE

4.1 A good industrial lighting should take into account:

a) adequate quantity of illumination, and
b) good quality of illumination.

4.2 Quantity of Illumination — The utilitarian goal of a lighting system is to provide for optimal performance of a given task. A starting point will be the determination of relationship between illumination and performance, but the final recommendation has to take into consideration other factors such as avoidance of fatigue, physiological and psychological effects,

*Electrotechnical vocabulary: Part XVI Lighting, Section 1 General aspects.

economics, etc. Desirable criteria for determining the quantity of illumination are:

a) adequacy for preventing occupational eye-strain and the risk of accidental injury due to bad visibility;

b) adequacy for creating an agreeable luminous environment; and

c) adequacy for different satisfactory levels of visual performance, each standard being applicable to a particular range of visual task.

4.2.1 A general lighting system should be designed to provide a uniform distribution of light over the entire work area. Where work areas are close to walls, such as work benches, the first row of luminaires should be located closer to wall or additional lighting should be provided over the particular work space.

4.2.2 To ensure that a given illumination level will be maintained, it is necessary to design a system to give initially more light than the required minimum.

4.2.3 In locations where dirt will collect very rapidly on luminaire surfaces and where adequate maintenance is not available, the initial value should be still higher.

4.2.4 Higher initial values shall be provided for the absorption of the light while designing lighting requirements.

4.3 Quality of Illumination — Quality of illumination pertains to the distribution of brightness in the visual environment. The term is used in a positive sense and implies that all brightness should contribute favourably to visual performance, visual comfort, ease of seeing, safety and aesthetics for the specific visual task involved. Glare, diffusion, direction, uniformity, colour, luminance and luminance ratios all have a significant effect on visibility and the ability to see easily, accurately and quickly. Certain seeing tasks such as discernment of fine details, require much more careful analysis and higher quality illumination than others. Areas where seeing tasks are severe and performed over long periods of time require much higher quality than where seeing tasks are casual or of relatively short duration.

4.3.1 *Direct Glare*

4.3.1.1 To reduce direct glare in industrial areas, the following steps should be taken:

a) Decrease the luminance of light sources or lighting equipment, or both;

b) Reduce the area of high luminance causing the glare condition;

c) Increase the angle between the glare source and the line of vision; and

d) Increase the luminance of the area surrounding the glare source and against which it is seen.

4.3.1.2 There is such a wide divergence of tasks and environmental

conditions in industry that it may not be economically feasible to recommend a degree of quality which will satisfy all cases. The luminance control required depends on the task, length of time in which the task is performed, and the mounting height of the luminaires.

4.3.2 *Luminance and Luminance Ratios*

4.3.2.1 *Ratios* — The ability to see detail depends upon the contrast between the detail and its background. The greater the contrast, difference in luminance, the more readily the seeing task is performed. However, the eyes function most comfortably and more efficiently when the luminances within the remainder of the environment are relatively uniform. Therefore, all luminances in the field of view should be carefully controlled. The recommended procedure for planning brightness pattern and controlling glare is detailed in IS: 3646 (Part I)-1966* and IS: 3646 (Part II)- 1966†.

4.3.2.2 To achieve the recommended luminance relationships, it is necessary to select the reflectances of all finishes of the room surfaces and equipment as well as control the luminance distribution. The recommended reflectance values for industrial interiors and equipment are given in Table 1. Reflectance should be maintained as near as practical to recommended values.

TABLE 1 REFLECTANCE VALUES

SURFACES	REFLECTANCE Percent
Ceiling	80 to 90
Walls	40 to 60
Desks and bench tops, machines and equipment	25 to 45
Floors	Not less than 20

4.3.2.3 High reflectance surfaces are generally desirable to provide the recommended luminance relationships and high utilization of light. They also improve the appearance of the work space. It is also desirable that the background is slightly darker than the seeing task.

4.3.3 *Reflected Glare*

4.3.3.1 Reflected glare is caused by the reflection of high luminance light sources from shiny surfaces. In manufacturing processes this may be a particularly serious problem where critical seeing is involved with highly polished surfaces such as polished sheet metal, vernier scales, and critically machined metal surfaces.

4.3.3.2 Reflected glare can be minimized or eliminated by using light

*Code of practice for interior illumination: Part I Principles of good lighting and aspects of design.

†Code of practice for interior illumination: Part II Schedule for values of illumination and glare index.

sources of low luminance or by orienting the work so that reflections are not directed in the normal line of vision. Supplementary lighting is a solution to such problems.

4.3.4 *Distribution, Diffusion and Shadows*

4.3.4.1 The general lighting system for a factory should be designed for uniformly distributed illumination. In uniform illumination, the distribution of light with a maximum and minimum illumination at any point should not be more than one-sixth above or below the average level in the area.

4.3.4.2 Harsh shadows should be avoided, but some shadow effect may be desirable from the general lighting system to accentuate the depth and form of objects.

4.3.4.3 There are a few specific visual tasks where clearly defined shadows improve visibility and such effects should be provided by supplementary lighting equipment arranged for the particular task.

4.3.5 *Colour Quality of Light* — For general seeing tasks in industrial areas there appears to be no effect upon visual acuity by variations in colour of light. However, where colour discrimination and colour matching are a part of the work process, the light source selected should have the desired colour rendering properties.

5. RECOMMENDED ILLUMINATION VALUES

5.1 Any recommended illumination values should be graded according to the difficulty of the visual task. These values should be maintained in service through proper cleaning and relamping of lighting equipment, the cleaning of windows, and the maintenance of reflectance values of the room surfaces. Initial values shall be greater from the artificial lighting system by a percentage sufficient to compensate for the normal depreciation expected in service. An industry may also have an office or a conference room and for lighting of these spaces, the illumination values as given under the head 'Offices, Schools and Public Buildings' in IS: 3646 (Part II)-1966* shall apply. The recommended values of illumination and limiting values of glare index for industrial buildings and processes are given in Table 2 (*see* page 21).

5.2 It is not a simple matter to specify suitable intensity levels if these are to be based upon sound reasoning. Since there is no distinct threshold level of illumination below which the performance of particular visual task is greatly impeded, some compromise has to be sought between an ideal level and one which is obviously inadequate. Generally, a recommended level is arrived at after being carefully weighed in the relation it bears to the eyesight, the visual task, the environment, and the economics involved. Any specification is, therefore, always open to a great deal of controversy. It may, however, be summarised that any of the above recommended levels of illumination could serve chiefly as a guide to good practices. It is not always sufficient to provide just enough light and leave it at that. Adequate illumination will benefit

people with normal sight, but the benefit will be far greater to those with faulty vision. For example, elderly people require higher illumination values for the same facility of seeing as young people [*see also* **3.4** of IS: 3646 (Part I)-1966*].

5.3 In any lighting arrangement the required level of illumination could be achieved through a combined usage of the natural daylighting and the artificial lighting. The object of designing artificial lighting specifically to supplement the available natural light is to provide light which satisfies the recommendations of both quantity and quality in all parts of the room or building, while at the same time preserving the sense that the lighting is predominantly natural [*see also* **5.3** of IS: 3646 (Part I)-1966*].

6. DAYLIGHTING

6.1 Most people prefer to work in buildings having good daylighting. One of the characteristics of daylight which gives it this appeal is the constant change both in quality and quantity, creating interest and avoiding monotony. This variation is taken into account when planning a scheme to ensure that at no time will the illumination over the working area be less than that recommended for the particular visual task. In some buildings it will be possible to achieve this by natural lighting alone, but in other buildings, especially those located in obstructed city areas, it will be necessary to supplement the natural lighting by artificial lighting designed to operate permanently during day time; this should be properly co-ordinated with natural lighting as recommended in IS: 3646 (Part I)-1966*. For detailed aspects of daylighting, reference may be made to IS: 2440-1968† and IS: 6060-1971‡.

6.2 The uniformity of illumination will depend on the design of the fenestration. Since this is part of the overall design of the building many factors come into picture. Generally there appears to be greater scope and freedom in industrial buildings for providing window arrangements which will give the desired daylighting conditions. Industrial buildings are generally located in unobstructed areas where there is sufficient open spaces all around; they have mostly one storey so that there is possibility of having skylights or windows in roofing, as for example, saw tooth roofing and monitor windows. The heights of the buildings are also enough to have a satisfactory spacing to height ratio of the windows.

7. PERMANENT SUPPLEMENTARY ARTIFICIAL LIGHTING (PSAL)

7.1 This refers to artificial lighting provided for use in daytime to supplement natural daylight.

*Code of practice for interior illumination: Part I Principles of good lighting and aspects of design.

†Code of practice for daylighting of buildings (*first revision*).

‡Code of practice for daylighting of factory buildings.

7.2 The need for providing PSAL in buildings arises due to two reasons:

a) Due to various reasons adequate daylighting over the whole working area may not be available.

b) To create acceptable brightness levels on the various surfaces in the working interior.

7.2.1 For areas where the depths of the rooms are much more than the height of the room, and windows may be available at one or two sides only, it is necessary to bring up the lighting to a level necessary for the task. At the dark spots, supplementary lighting is required.

7.2.2 *Brightness Considerations* — The eye adapts itself to the prevailing brightness of the surroundings. The apparent brightness of the various surfaces or objects will depend on this adaptation level. For instance, when a room interior is seen through an open door from outside with bright daylight, it will appear gloomy. But on entering the room, after the eye has adapted, things will appear brighter. When a room is lit by daylight the eye has a fairly high adaptation level due to the bright sky seen through the window opening. Therefore, the parts of the room remote from the windows will appear gloomy even if the illumination in these parts in terms of lux is of the order normally recommended for the type of visual task. It is, therefore, necessary to brighten up these parts if a proper balance of brightness is to be restored which will create comfortable visual environment. This second consideration is at least as important as the first while determining the amount of light to be supplied by the supplementary lighting system. This requirement in some cases, may result in having higher levels of illumination than required for the particular visual task involved or higher than the amenity level. During night time since the entire area is illuminated to a level recommended for the satisfactory performance of the task carried out in the work area concerned, no additional problem of balance of brightness is involved provided the general requirement of avoidance of high brightness contrast by having suitably finished surfaces in the room is satisfied (*see* Fig. 1).

8. SUPPLEMENTARY LIGHTING

8.1 Difficult seeing tasks often require a specific amount or quality of lighting which cannot readily be obtained by standard general lighting methods. To solve such problems supplementary luminaires often are used to provide higher illumination levels for small or restricted areas. Also they are used to furnish a certain luminance, or colour, or to permit special aiming or positioning of light sources to produce or avoid highlights or shadows to best portray the details of the task (*see* Fig. 2).

8.2 Before supplementary lighting can be specified it is necessary to recognise the exact nature of the visual task and to understand its light reflecting or transmitting characteristics. An improvement in the visibility of the task will

depend upon one or more of the four fundamental visibility factors—luminance, poor contrast, size and time available for seeing.

8.3 The planning of supplementary lighting also entails consideration of the visual comfort of both those workers who benefit directly and those who are in the immediate areas. Supplementary equipment must be carefully shielded to prevent glare for the user and his associates. Luminance ratios should be carefully controlled. Ratios between task and immediate surroundings should be limited as recommended earlier. To attain these limits it is necessary to co-ordinate the design of supplementary and general lighting.

9. GENERAL CONSIDERATIONS OF DESIGN FOR LIGHTING INDUSTRIAL AREAS

9.1 The designer of an industrial lighting system should consider the following factors as the first and important requirement of good planning:

a) Determine the quantity and quality of illumination desirable for the manufacturing processes involved;

b) Select lighting equipment that will provide the quantity and quality requirements by examining photometric characteristics, and mechanical performance that meet installation, operating and actual maintenance conditions;

c) Select and arrange equipment so that it will be easy and practical to maintain; and

d) Balance all the economic factors including initial, operating and maintenance costs, versus the quantity and quality requirements for optimum visual performance. The choice of the electricity distribution system may affect overall economics.

9.2 Types of Lighting Equipment

9.2.1 The manner in which the light from the lamps is controlled by the lighting equipment governs, to a large extent, the important effects of glare, shadows, distribution and diffusion.

9.2.2 Most industrial applications call for either direct or semi-direct types. Luminaires with some upward components of light are preferred for most areas because an illuminated ceiling or upper structure reduces luminance ratios between luminaires and the background. The upward light reduces the 'dungeon' effect of totally direct lighting and creates a more comfortable and more cheerful environment. Good environmental luminance relationships can also often be achieved with totally direct lighting if the illumination level and the room reflectances are high (*see* Fig. 3.).

9.2.3 In selecting industrial lighting equipment, it will be noted that other factors leading to more comfortable installations include:

a) Light-coloured finishes on the outside of luminaires to reduce luminance ratios between the outside of the luminaire and the inner reflecting surfaces.

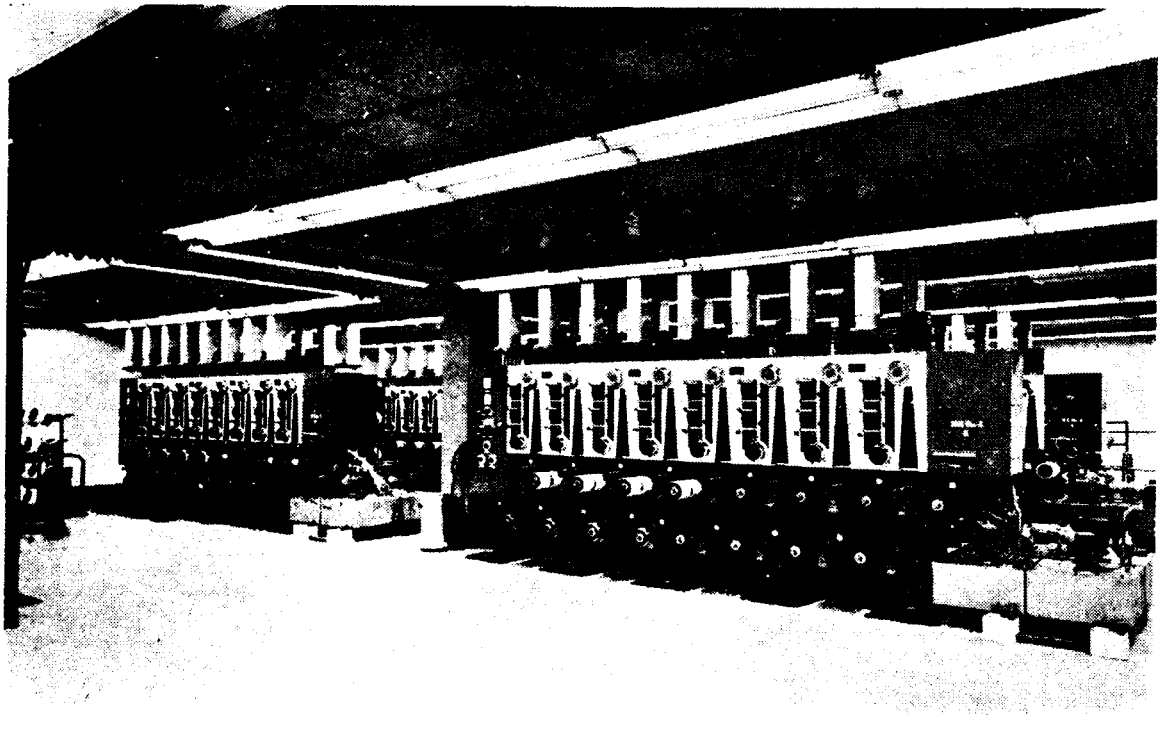

FIG. 1 GOOD ENVIRONMENTAL LUMINANCE RELATIONSHIP WITH TOTALLY DIRECT LIGHTING WITH ILLUMINATION LEVEL

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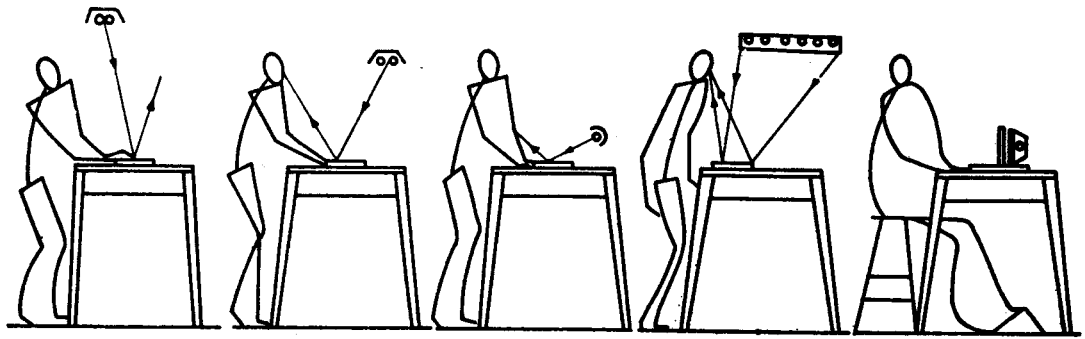

a — Luminaire located to prevent reflected glare; reflected light does not coincide with angle of view.

b — Reflected light coincides with angle of view.

c — Low-angle lighting to emphasize surface irregularities.

d — Large-area surface source and pattern are reflected toward the eye.

e — Transillumination from diffuse source.

FIG. 2 EXAMPLES OF PLACEMENT OF SUPPLEMENTED LUMINAIRES

b) Higher mounting heights to raise luminaires out of the normal field of view.

c) Better shielding of the light source by deeper reflectors, cross baffles, or louvres. This is particularly important with high wattage incandescent filament or mercury vapour discharge sources.

d) Selecting light control material, such as specular or nonspecular aluminium or prismatic configurated glass or plastic that can limit the luminaire luminance in the shielded zone.

9.2.4 Top openings in luminaires generally minimise dirt collection on the reflector and lamp by allowing an air draft path to move dirt particles upward and through the luminaire to the outer air. Therefore, ventilated types of luminaires have proven their ability to minimise maintenance of luminaires.

9.2.5 Special attention is required to be paid to the selection of lighting equipment for industrial interiors with highly corrosive atmosphere or fire and explosion hazard [*see also* IS: 4013-1967*, IS: 4012-1967†, and IS: 2206 (Part I)-1962‡]. Lighting fittings made of corrosion resistant material specially designed for corrosive atmosphere are to be selected for chemical factories, fertilizer plants and other similar industries where corrosive fumes are present in the atmosphere. For industrial areas containing inflammable dust and gases, the choice of lighting equipment will be guided by relevant Indian Standard specifications.

10. LIGHT SOURCES AND THEIR APPLICATION IN INDUSTRIAL LIGHTING

10.1 For industrial lighting the sources of light generally available in the country at present are tungsten filament lamps, tubular fluorescent lamps and high pressure mercury vapour (HPMV) discharge lamps. The selection of any one of these or a combination of these depends on:

a) Type of application,

b) Atmospheric conditions of industrial interiors and/or exteriors,

c) Structural features,

d) Initial outlay,

e) Running cost, and

f) Ease of maintenance.

10.1.1 Apart from these, factors such as luminous efficiency, lamp luminance, lamp life, colour rendering properties and ease of optical control, play a very vital role in the choice of light sources. All these aspects should be carefully considered while designing an industrial lighting scheme.

10.2 It may also be added here as a broad guideline that for low and medium height ceilings in industry, tubular fluorescent lamps are applied for general

*Specification for dust-tight electric lighting fittings.
†Specification for dust-proof electric lighting fittings.
‡Specification for flameproof electric lighting fittings: Part I Well-glass and bulkhead types.

uniform lighting whereas for highbays it is desired from lighting technique, economic and maintenance considerations to use HPMV lamps or combination of HPMV and tungsten filament lamps. Application of tungsten filament lamps is limited according to modern lighting practice, to local lighting and in certain cases also for colour appreciation and in case of infrequent use for short duration.

10.3 In spite of very low initial outlay due to poor efficiency, short life and eventual very frequent replacement, tungsten filament lamps are not employed for general lighting of industries. Tubular fluorescent lamps and HPMV lamps for general lighting have to be selected after considering variety of above noted aspects.

11. LIGHTING RELATED TO STRUCTURE OF INDUSTRIAL PREMISES

11.1 Factory Spaces With Skylights — Where daylighting is given due consideration in the design of a building, the shape of the building is primarily determined by this requirement. The working area is also planned on the basis of daylighting. While planning the artificial lighting the layout of the lighting fittings has to be related to the layout of the working area so as to obtain the most favourable lighting effect for comfortable working. Where the lighting can be integrated with natural shape and structure of the building while still meeting the requirements of lighting effect on the working place, a better result can be achieved. The trend is noticeable in our country in many industrial buildings where instead of the conventional sawtoothed roofed building on a rectangular plan, other designs like shelled roofing, etc, have been adopted. Close co-ordination between the architect and lighting engineer can result in a lighting installation which is in tune with the architectural form of the building and at the same time satisfactorily fulfils the primary function of supplying light on the work places.

11.2 Closed Ceiling

11.2.1 In this type of construction there is very little dependence on daylighting which is mainly from side windows and is inadequate and consequently the work layout is organized on considerations other than daylighting requirements. The artificial lighting has to be designed purely on the needs of the nature of work, layout of machinery, etc. Where false ceiling is provided, the lighting fittings may be recessed in the false ceiling giving a more streamlined appearance to the whole installation (*see* Fig. 4).

11.2.2 Generally a continuous mounting of the fittings is to be preferred, in case of tubular fluorescent lamps fittings, to an arrangement of reflectors at intervals since it gives a more restful view. Once the total number of fittings for providing a particular level of illumination is determined the possibility of having continuous rows should be examined and should be adopted, if possible, provided the spacing between rows/height above working plane ratio satisfies the conditions for uniform distribution of light (*see* Fig. 5).

11.2.3 It is generally desired from the user's point of view that the fittings should, as far as possible, be fixed to the existing members in the roof structure like the bottom members of the trusses or longitudinal tie members, etc. The fittings have to be oriented according to the layout of the machinery to obtain most satisfactory seeing conditions. A layout decided on such a consideration may not coincide with the existing structural elements and additional members may have to be provided specifically for fixing the lighting fittings. An interesting development which takes care of this problem economically is the trunking system. The trunking, which is essentially metal channels with cover plates at the bottom, of standard lengths joined together, is run across the hall with suspensions at necessary intervals. Incidentally, this minimises the number of suspension points compared to individually mounted fittings each with two suspension pipes. The wiring is run through the trunking itself and the fittings are attached to the trunking at the required locations.

11.3 Highbay Halls

11.3.1 Generally high roofing is provided in factory interiors where sufficient clearance for large workpieces handled in the particular factory is required or where overhead travelling crane is provided or where fumes and smoke have to be carried off. The artificial lighting has to be located at a greater height in the roof structure to allow unobstructed manipulation of crane, etc (*see* Fig. 6). While for low and medium mounting height fluorescent lighting is an immediate choice, for highbay lighting it may sometimes be more advantageous to use less number of high lumen output sources like the high wattage mercury vapour/filament lamp combination or high wattage fluorescent coated mercury vapour lamps.

11.3.2 Due to high mounting the horizontal illumination is much more than the vertical illumination. If the lighting is to be improved, it is generally achieved by having additional fittings at a lower height but fixed to the sides.

12. MAINTENANCE OF LIGHTING INSTALLATIONS

12.1 Regular maintenance of lighting installations cannot be neglected without prejudicing the level of illumination and hence the benefits that proceed from good lighting. Attention is drawn to the progressive depreciation of the lighting installation depending on the locations of usage and hence the maintenance problem is an extremely important one.

12.2 Special mention should be made of group replacement of the lamps and starters in case of fluorescent lamps lighting fittings. The desirability of group replacement is largely determined by lamp replacement costs and should be considered on its merit in each case.

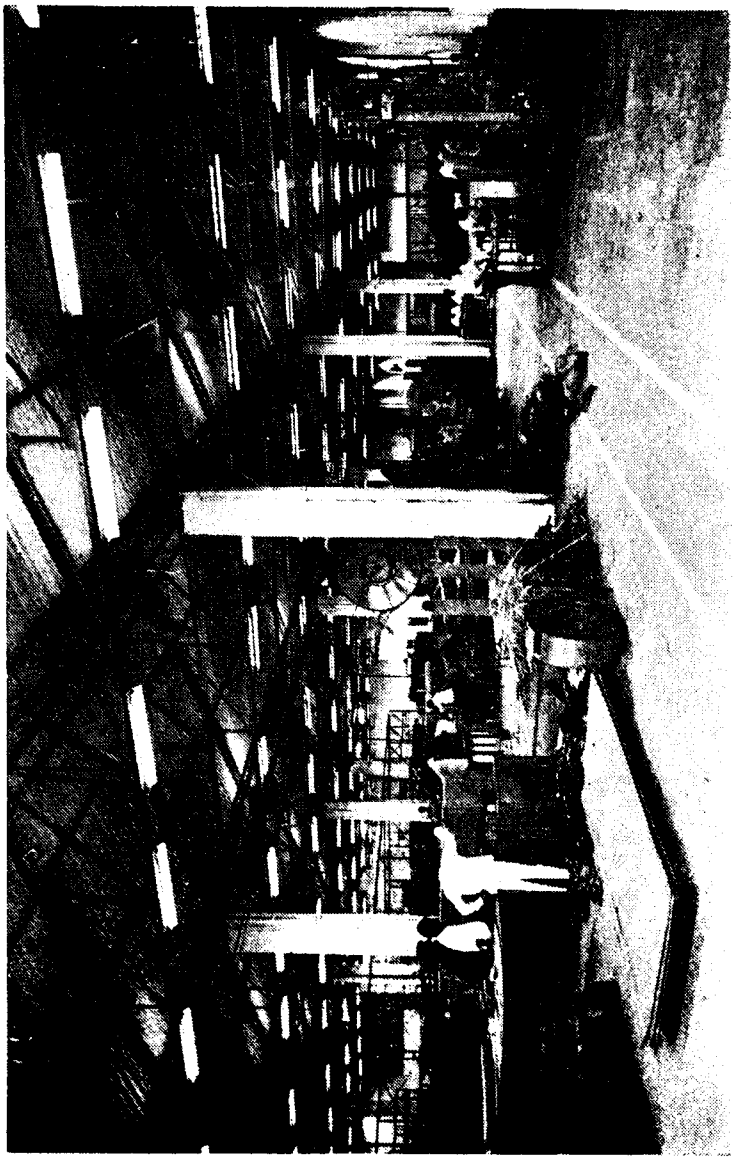

FIG. 3 SEMI-DIRECT LIGHTING FITTINGS REDUCE THE 'DUNGEON' EFFECT

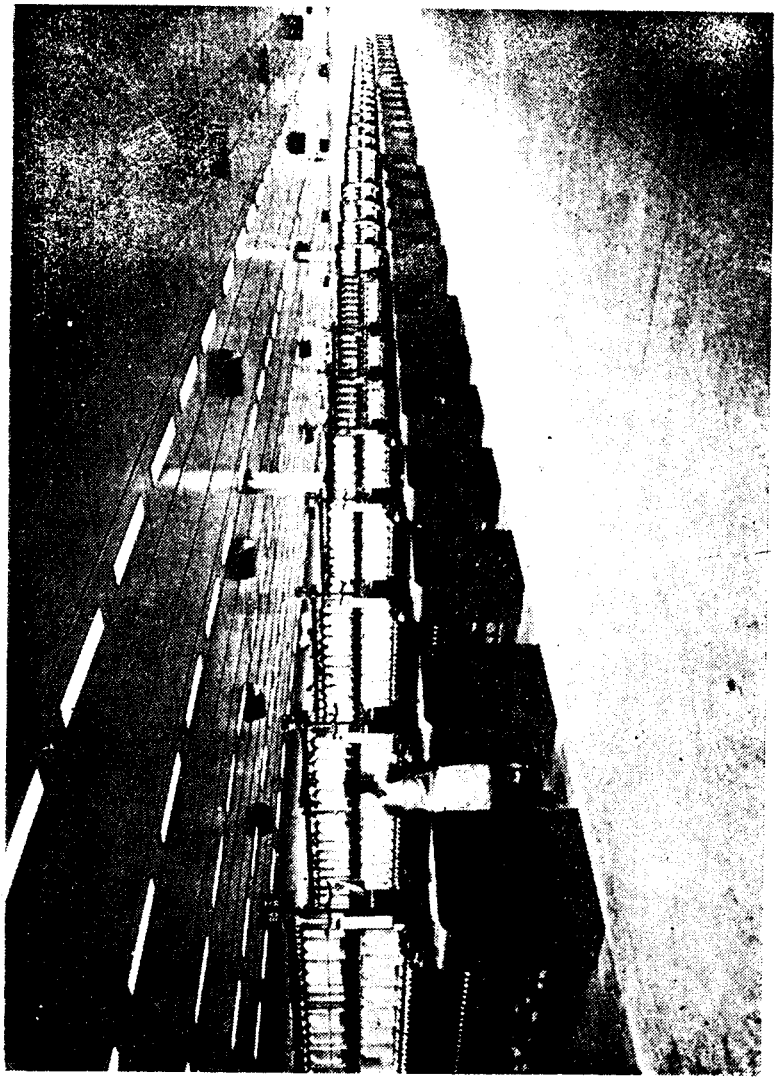

FIG. 4 FALSE CEILING CONSTRUCTION WITH RECESSED LIGHTING FITTINGS

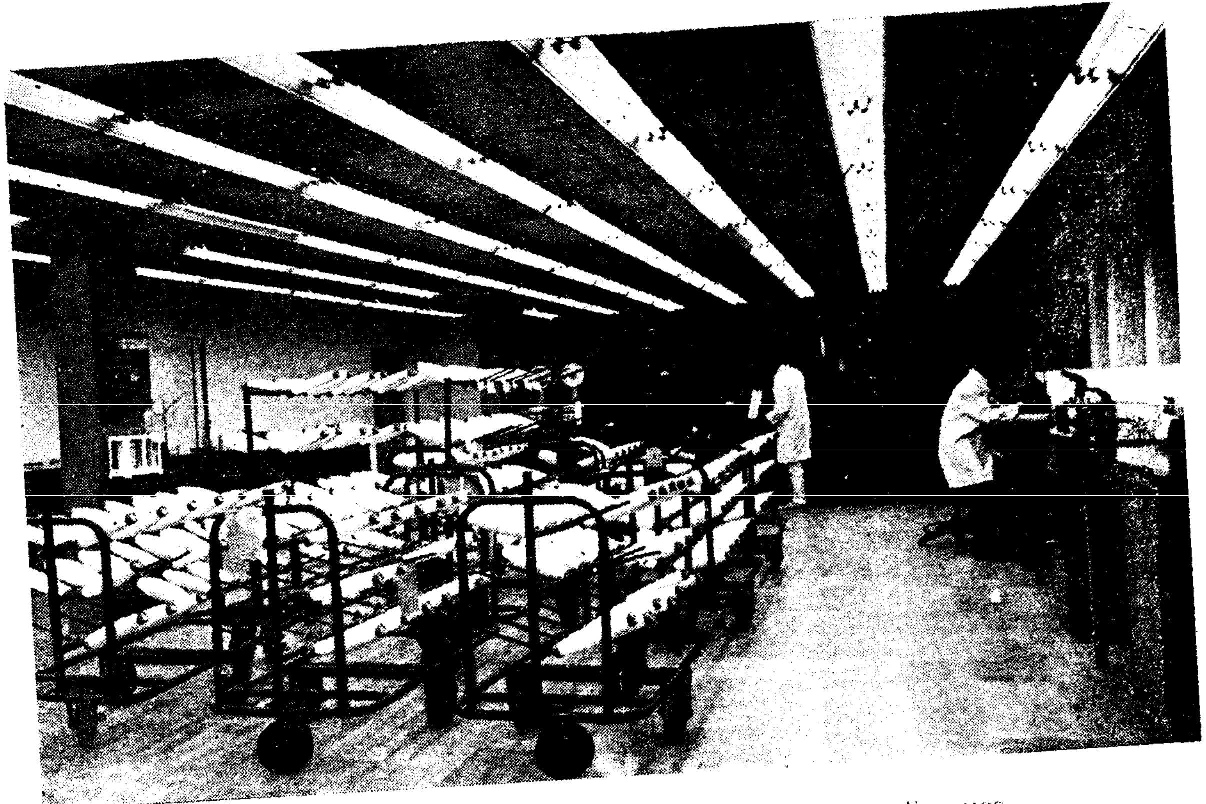

FIG. 5 CONTINUOUS MOUNTING OF FLUORESCENT LAMP FITTINGS

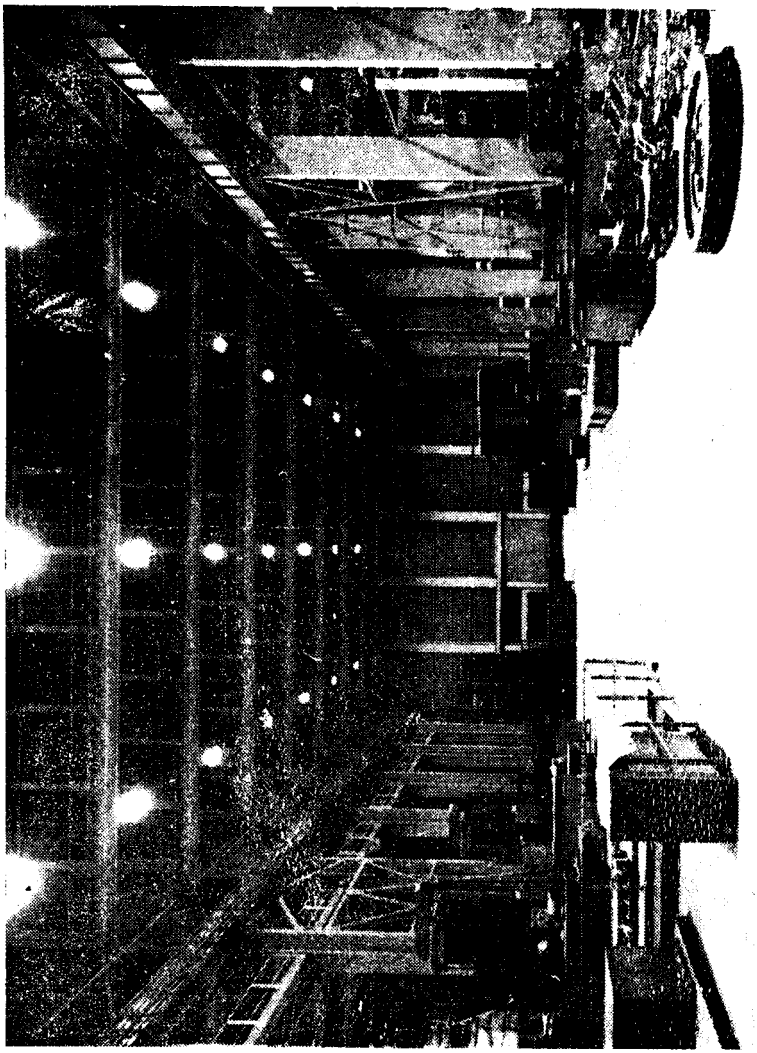

FIG. 6 HIGHBAY LIGHTING WITH HPMV LAMPS

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX

(*Clause* 5.1)

L No.	INDUSTRIAL BUILDINGS AND PROCESSES	AVERAGE ILLUMINATION lux	LIMITING GLARE INDEX
1.	*General Factory Areas*		
	a) Canteens	150	—
	b) Cloakrooms	100	—
	c) Entrances, corridors, stairs	100	—
2.	*Factory Outdoor Areas*		
	Stockyards, main entrances, exit roads, car parks, internal factory roads	20	—
3.	*Aircraft Factories and Maintenance Hangers*		
	a) Stock parts productions	450	25
	b) Drilling, riveting, screw fastening, sheet aluminium layout and template work, wing sections, cowling welding, sub-assembly, final assembly, inspection	300	25
	c) Maintenance and repairs (hangers)	300	25
4.	*Assembly Shops*		
	a) Rough work, for example, frame assembly, assembly of heavy machinery	150	28
	b) Medium work, for example, machined parts, engine assembly, vehicle body assembly	300	25
	c) Fine work, for example, radio and telephone equipment, typewriter and office machinery assembly	700	22
	d) Very fine work, for example, assembly of very small precision mechanisms, instruments	1 500*	19
5.	*Bakeries*		
	a) Mixing and make-up rooms, oven rooms, wrapping rooms	150	25
	b) Decorating and icing	200	25
6.	*Boiler Houses (Industrial)*		
	a) Coal and ash handling	100	—
	b) Boiler rooms:		
	i) Boiler fronts and operating areas	100†	—
	ii) Other areas	20 to 25	—
	c) Outdoor plants:		
	i) Catwalks	20	—
	ii) Platforms	50	—

*Optical aids should be used where necessary.
†Supplementary local lighting may be required for gauge glasses and instrument panels.

(*Continued*)

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
7.	*Bookbinding*		
	a) Pasting, punching and stitching	200	25
	b) Binding and folding—miscellaneous machines	300	22
	c) Finishing, blocking and inlaying	300	22
8.	*Boot and Shoe Factories*		
	a) Sorting and grading	1 000*	19
	b) Clicking and closing, preparatory operations	700	22
	c) Cutting table and presses, stitching	1 000	22
	d) Bottom stock preparation, lasting and bottoming, finishing	700	22
	e) Shoe rooms	700	22
9.	*Breweries and Distilleries*		
	a) General working areas	150	25
	b) Brewhouse, bottling and canning plants	200	25
	c) Bottle inspection	Special lighting	—
10.	*Canning and Preserving Factories*		
	a) Inspection of beans, rice, barley, etc	450	22
	b) Preparation: Kettle areas, mechanical cleaning, dicing, trimming	300	25
	c) Canned and bottled goods: Retorts	200	25
	d) High speed labelling lines	300	25
	e) Can inspection	450	—
11.	*Carpet Factories*		
	a) Winding, beaming	200	25
	b) Designing, jacquard card cutting, setting pattern, tufting, topping, cutting, hemming, fringing	450	22
	c) Weaving, mending, inspection	450	22
12.	*Ceramics* (*see* Pottery and Clay Products)	—	—
13.	*Chemical Works*		
	a) Hand furnaces, boiling tanks, stationery driers, stationery or gravity crystallizers, mechanical driers, evaporators, filtration plants, mechanical crystallizing bleaching, extractors, percolators, nitrators, electrolytic cells	150	28
	b) Controls, gauges, values, etc	100†	—

*Special attention should be paid to the colour quality of the light.
†Supplementary local lighting may be required for gauge glasses and instrument panels.

(*Continued*)

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
	c) Control rooms:		
	i) Vertical control panels	200 to 300	19
	ii) Control desks	300	19
14.	*Chocolate and Confectionery Factories*		
	a) Mixing, blending, boiling	150	28
	b) Chocolate husking, winnowing, fat extraction, crushing and refining, feeding, bean cleaning, sorting, milling, cream making	200	25
	c) Hand decorating, inspection, wrapping, packing	300	22
15.	*Clothing Factories*		
	a) Matching-up	450*	19
	b) Cutting, sewing:		
	i) Light	300	22
	ii) Medium	450	22
	iii) Dark	700	22
	iv) Pressing	300	22
	c) Inspection:		
	i) Light	450	19
	ii) Medium	1 000	19
	iii) Dark	1 500	19
	d) Hand Tailoring:		
	i) Light	450	19
	ii) Medium	1 000	19
	iii) Dark	1 500	19
16.	*Collieries (Surface Buildings)*		
	a) Coal preparation plant:		
	i) Working areas	150	—
	ii) Other areas	100	—
	iii) Picking belts	300	—
	iv) Winding houses	150	—
	b) Lamp rooms:		
	i) Main areas	100	—
	ii) Repair sections	150	—
	iii) Weigh cabins	150	—
	c) Fan houses	100	—
17.	*Dairies*		
	a) General working areas	200†	25

*Special attention should be paid to the colour quality of the light.
†Supplementary local lighting may be required for sight glasses.

(*Continued*

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
	b) Bottle inspection	Special lighting	—
	c) Bottle filling	450	25
18.	*Die Sinking*		
	a) General	300	—
	b) Fine	1 000	19
19.	*Dye Works*		
	a) Reception, 'grey' perching	700	—
	b) Wet processes	150*	28
	c) Dry processes	200*	28
	d) Dyers' offices	700†	19
	e) Final perching	2 000†	—
20.	*Electricity Generating Stations: Indoor Locations*		
	a) Turbine halls	200	25
	b) Auxiliary equipment; battery rooms, blowers, auxiliary generators, switchgear and transformer chambers	100	—
	c) Boiler houses (including operating floors) platforms, coal conveyors, pulverizers, feeders, precipitators, soot and slag blowers	70 to 100	—
	d) Boiler house and turbine house	100	—
	e) Basements	70	—
	f) Conveyor houses, conveyor gentries, junction towers	70 to 100	—
	g) Control rooms:		
	i) Vertical control panels	200 to 300	19
	ii) Control desks	300	19
	iii) Rear of control panels	150	19
	iv) Switch houses	150	25
	h) Nuclear reactors and steam raising plants:		
	i) Reactor areas, boilers, galleries	150	25
	ii) Gas circulator bays	150	25
	iii) Reactor charge/discharge face	200	25
21.	*Electricity Generating Stations: Outdoor Locations*		
	a) Coal unloading areas	20	—
	b) Coal storage areas	20	—
	c) Conveyors	50	—

*Supplementary local lighting should be used where necessary.

†Special attention should be paid to the colour quality of the light.

(*Continued*)

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
	d) Fuel oil delivery headers	50	—
	e) Oil storage tanks	50	—
	f) Catwalks	50	—
	g) Platforms, boiler and turbine decks	50	—
	h) Transformers and outdoor switchgear	100	—
22.	*Engraving*		
	a) Hand	1 000	19
	b) Machine (*see* Die Sinking)	—	—
23.	*Farm Buildings (Dairies)*		
	a) Boiler houses	50	—
	b) Milk rooms	150	25
	c) Washing and sterilizing rooms	150	25
	d) Stables	50	—
	e) Milking parlours	150	25
24.	*Flour Mills*		
	a) Roller, purifier, silks and packing floors	150	25
	b) Wetting tables	300	25
25.	*Forges*		
	General	150	28
26.	*Foundries*		
	a) Charging floors, tumbling cleaning, pouring, shaking out, rough moulding and rough core making	150	28
	b) Fine moulding and core making, inspection	300	25
27.	*Garages*		
	a) Parking areas (interior)	70	28
	b) Washing and polishing, greasing, general servicing, pits	150	28
	c) Repairs	300	25
28.	*Gas Works*		
	a) Retort houses, oil gas plants, water gas plants, purifiers, coke screening and coke handling plants (indoor)	30 to 50*	28
	b) Governor-, meter-, compressor-, booster- and exhauster-houses	100	25

*Supplementary local lighting should be used at important points.

(*Continued*)

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
	c) Open type plants:		
	i) Catwalks	20*	—
	ii) Platforms	50*	—
29.	*Gauge and Tool Rooms*		
	General	700†	19
30.	*Glass Works and Processes*		
	a) Furnace rooms, bending, annealing lehrs	100	28
	b) Mixing rooms, forming (blowing, drawing, pressing, rolling)	150	28
	c) Cutting to size, grinding, polishing, toughening	200	25
	d) Finishing (bevelling, decorating, etching, silvering)	300	22
	e) Brilliant cutting	700	19
	f) Inspection:		
	i) General	200	19
	ii) Fine	700	19
31.	*Glove Making*		
	a) Pressing, knitting, sorting, cutting	300	22
	b) Sewing:		
	i) Light	300	22
	ii) Medium	450	22
	iii) Dark	700	22
	c) Inspection:		
	i) Light	450	19
	ii) Medium	1 000	19
	iii) Dark	1 500	19
32.	*Hat Making*		
	a) Stiffening, braiding, cleaning, refining, forming, sizing, pouncing, flanging, finishing, ironing	150	22
	b) Sewing:		
	i) Light	300	22
	ii) Medium	450	22
	iii) Dark	700	22
33.	*Hosiery and Knitwear*		
	a) Circular and flat knitting machines universal winders, cutting out, folding and pressing	300	22

*Supplementary local lighting should be used at important points.

†Supplementary local lighting and optical aids should be used where necessary.

(*Continued*)

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
	b) Lock stitch and overlocking machines:		
	i) Light	300	22
	ii) Medium	450	22
	iii) Dark	700	22
	c) Mending	1 500	19
	d) Examining and hand finishing, light, medium, dark	700	19
	e) Linking or running-on	450	19
34.	*Inspection Shops (Engineering)*		
	a) Rough work, for example, counting, rough checking of stock parts, etc	150	28
	b) Medium work, for example, 'Go' and 'No-go' gauges, sub-assemblies	300	25
	c) Fine work, for example, radio and telecommunication equipment, calibrated scales, precision mechanisms, instruments	700	22
	d) Very fine work, for example, gauging and inspection of small intricate parts	1 500	19
	e) Minute work, for example, very small instruments	3 000*	10
35.	*Iron and Steel Works*		
	a) Marshalling and outdoor stockyards	10 to 20	—
	b) Stairs, gangways, basements, quarries, loading docks	100	—
	c) Slab yards, melting shops, ingot stripping soaking pits, blast furnace working areas, picking and cleaning lines, mechanical plants, pump houses	100	28
	d) Mould preparation, rolling and wire mills, mill motor rooms, power and blower houses	150	28
	e) Slab inspection and conditioning, cold strip mills, sheet and plate finishing, tinning, galvanizing, machine and roll shops	200	28
	f) Plate inspection	300	—
	g) Tinplate inspection	Special lighting	—
36.	*Jewellery and Watchmaking*		
	a) Fine processes	700*	19
	b) Minute processes	3 000*	10
	c) Gem cutting, polishing, setting	1 500†	—

*Optical aids should be used where necessary.
†Special attention to colour quality of light may be necessary.

(*Continued*)

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
37.	*Laboratories and Test Rooms*		
	a) General laboratories, balance rooms	300	19
	b) Electrical and instrument laboratories	450	19
38.	*Laundries and Drycleaning Works*		
	a) Receiving, sorting, washing, drying, ironing (calendering), despatch	200	25
	b) Drycleaning, bulk machine work	200	25
	c) Fine hand ironing, pressing, inspection, mending, spotting	300	25
39.	*Leather Dressing*		
	a) Vats, cleaning, tanning, stretching, cutting, fleshing and stuffing	150	28
	b) Finishing, staking, splitting and scarfing	200	28
40.	*Leather Working*		
	a) Pressing and glazing	450	22
	b) Cutting, scarfing, sewing	700	22
	c) Grading and matching	1 000*	19
41.	*Machine and Fitting Shops*		
	a) Rough bench and machine work	150	28
	b) Medium bench and machine work, ordinary automatic machines, rough grinding, medium buffing and polishing	300	25
	c) Fine bench and machine work, fine automatic machines, medium grinding, fine buffing and polishing	700	22
42.	*Motor Vehicle Plants*		
	a) General sub-assemblies, chassis assembly, car assembly	300	25
	b) Final inspection	450	25
	c) Trim shops, body sub-assemblies, body assembly	300	25
	d) Spray booths	450	—
43.	*Paint Works*		
	a) General automatic processes	200	25
	b) Special batch mixing	450	22
	c) Colour matching	700*	19

*Special attention should be paid to the colour quality of the light.

(*Continued*)

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
44.	*Paint Shops and Spraying Booths*		
	a) Dipping, firing, rough spraying	150	25
	b) Rubbing, ordinary painting, spraying and finishing	300	25
	c) Fine painting, spraying and finishing	450	25
	d) Retouching and matching	700*	19
45.	*Paper Works*		
	a) Paper and board making:		
	i) Machine houses, calendering, pulp mills, preparation plants, cutting, finishing, trimming	200	25
	ii) Inspection and sorting (over hauling)	300	22
	b) Paper converting processes:		
	i) Corrugated board, cartons, containers and paper sack manufacture, coating and laminating processes	200	25
	ii) Associated printing	300	25
46.	*Pharmaceuticals and Fine Chemical Works*		
	a) Raw material storage	200	28
	b) Control laboratories and testing	300	19
	c) Pharmaceuticals manufacturing: grinding, granulating, mixing and drying, tableting, sterilizing and washing, preparation of solutions and filling, labelling, capping, cartoning and wrapping, inspection	300	25
	d) Fine chemical manufacture:		
	i) Plant processing	200	25
	ii) Fine chemical finishing	300	25
47.	*Plastics Works*		
	a) Manufacture (*see* Chemical Works)	—	—
	b) Processing:		
	i) Calendering, extrusion	300	25
	ii) Moulding-compression, injection	200	25
	iii) Sheet fabrication:		
	1) Shaping	200	25
	2) Trimming, machining, polishing	300	25
	3) Cementing	200	25
48.	*Plating Shops*		
	a) Vat and baths, buffing, polishing, burnishing	150	25
	b) Final buffing and polishing	Special lighting	—

*Special attention should be paid to the colour quality of the light.

(*Continued*)

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
49.	*Pottery and Clay Products*		
	a) Grinding, filter pressing, kiln rooms, moulding, pressing, cleaning, trimming, glazing, firing	150	28
	b) Enamelling, colouring, decorating	450*	19
50.	*Printing Works*		
	a) Type foundries:		
	i) Matrix making, dressing type, hand and machine casting	200	25
	ii) Front assembly, sorting	450	22
	b) Printing plants:		
	i) Machine composition, imposing stones	200	25
	ii) Presses	300	25
	iii) Composing room	450	19
	iv) Proof reading	300	19
	c) Electrotyping:		
	i) Block-making, electroplating, washing, backing	200	25
	ii) Moulding, finishing, routing	300	25
	d) Photo-engraving:		
	i) Block-making, etching, masking	200	25
	ii) Finishing, routing	300	25
	e) Colour printing:		
	Inspection area	700*	19
51.	*Rubber Processing*		
	a) Fabric preparation creels	200	25
	b) Dipping, moulding, compounding calendars	150	25
	c) Tyre and tube making	200	25
52.	*Sheet Metal Works*		
	a) Benchwork, scribing, pressing, punching, shearing, stamping, spinning, folding	200	25
	b) Sheet inspection	Special lighting	—
53.	*Soap Factories*		
	a) Kettle houses and ancillaries, glycerine evaporation and distillation, continuous indoor soap making, plants:		
	i) General areas	150	25
	ii) Control panels	200 to 300	25

*Special attention should be paid to the colour quality of the light.

(*Continued*)

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
	b) Batch or continuous soap cooling, cutting and drying, soap milling, plodding:		
	i) General areas	150	25
	ii) Control panels, key equipment	200 to 300	25
	c) Soap stamping, wrapping and packing, granules making, granules storage and handling, filling and packing granules:		
	i) General areas	150	25
	ii) Control panels, machines	200 to 300	25
	d) Edible products processing and packing	200	25
54.	*Structural Steel Fabrication Plants*		
	a) General	150	28
	b) Marking off	300	28
55.	*Textile Mills (Cotton or Linen)*		
	a) Bale breaking, blowing, carding, roving, slubbing, spinning (ordinary counts), winding, heckling, spreading, cabling	150	25
	b) Warping, slashing, dressing and dyeing, doubling (fancy), spinning (fine counts)	200	25
	c) Healding (drawing-in)	700	—
	d) Weaving:		
	i) Patterned cloths, fine counts dark	700	19
	ii) Patterned cloths, fine counts light	300	19
	iii) Plain 'grey' cloth	200	19
	e) Cloth inspection	700*	—
56.	*Textile Mills (Silk or Synthetics)*		
	a) Soaking, fugitive tinting conditioning or setting of twist	200	25
	b) Spinning	450	25
	c) Winding, twisting, rewinding and coning, quilting, slashing:		
	i) Light thread	200	25
	ii) Dark thread	300	25
	d) Warping	300	25
	e) Healding (drawing-in)	700	—
	f) Weaving	700	19
	g) Inspection	1 000*	19
57.	*Textile Mills (Woollen)*		
	a) Scouring, carbonizing, teasing, preparing, raising, brushing, pressing, back-washing, gilling, crabbing and blowing	150	25

*Special attention should be paid to the colour quality of the light.

(*Continued*)

TABLE 2 RECOMMENDED VALUES OF ILLUMINATION AND LIMITING VALUES OF GLARE INDEX — *Contd*

Sl No.	Industrial Buildings and Processes	Average Illumination lux	Limiting Glare Index
	b) Blending, carding, combing (white), tentering, drying, cropping	200	25
	c) Spinning, roving, winding, warping, combing (coloured), twisting	450	25
	d) Healding (drawing-in)	700	—
	e) Weaving:		
	i) Fine worsteds	700	19
	ii) Medium worsteds, fine woollens	450	19
	iii) Heavy woollens	300	19
	f) Burling and mending	700	19
	g) Perching:		
	i) Grey	700	—
	ii) Final	2 000*	—
58.	*Textile Mills (Jute)*		
	a) Weaving, spinning, flat, jacquard carpet looms, cop winding	200	25
	b) Yarn calendar	150	25
59.	*Tobacco Factories*		
	All processes	300†	22
60.	*Upholstering*		
	Furniture and vehicles	300	22
61.	*Warehouses and Bulk Stores*		
	a) Large material, loading bays	100	28
	b) Small material, racks	150	25
	c) Packing and despatch	150	25
62.	*Welding and Soldering*		
	a) Gas and arc welding, rough spot welding	150	28
	b) Medium soldering, brazing and spot welding, for example, domestic hardware	300	25
	c) Fine soldering and spot welding, for example, instruments, radio set assembly	700	22
	d) Very fine soldering and spot welding, for example, radio valves	150	19
63.	*Woodworking Shops*		
	a) Rough sawing, and bench work	150	22
	b) Sizing, planning, rough sanding, medium machine and bench work, gluing, veneering, cooperage	200	22
	c) Fine bench and machine work, fine sanding and finishing	300	22

*Special attention should be paid to the colour quality of the light.
†Special attention should be paid to the colour quality of the light in all processing areas.