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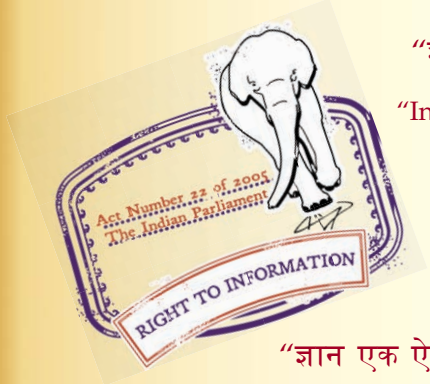
IS 3646-1 (1992): Code of practice for interior illumination, Part 1: General requirements and recommendations for welding interiors [ETD 24: Illumination Engineering and Luminaries]



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IS 3646 (Part 1) : 1992

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(Reaffirmed 2003)

भीतरी प्रदीपन के लिये रीति संहिता

भाग 1 भीतरी प्रकाश व्यवस्था करने की सामान्य अपेक्षाएँ और सिफारिशें

(पहला पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR INTERIOR ILLUMINATION

PART 1 GENERAL REQUIREMENTS AND RECOMMENDATIONS FOR WORKING INTERIORS

(First Revision)

First Reprint MAY 1994

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FOREWORD

This Indian Standard (Part 1) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Illuminating Engineering and Luminaires Sectional Committee had been approved by the Electrotechnical Division Council.

The primary object of this code is to indicate the factors which should be taken into account to achieve good lighting.

It confines itself primarily to the lighting of working interiors, such as factories, workshops, offices, commercial premises, public buildings, hospitals and schools, keeping two objects in mind, namely, to make the task easy to see and to create a good visual environment.

Lighting is good only when it is suitable in both quality and quantity for two purposes; for creating good environmental brightness which is at the same time agreeable and beneficial to the user, and for permitting a high degree of efficiency in seeing whatever is of special interest or importance.

Many of the recommendations hold good whether lighting is artificial, natural or combination of the two and, as far as possible, the lighting of a building is regarded as a service which should be maintained at a high standard whenever the building is occupied.

The conventional methods of planning described herein are still the subject of continual research and in special cases it is felt that planning should be extended to include consideration of the luminance patterns relating to the whole of the visual field.

Provision of a good lighting system calls for co-ordination from the initial stages among the various parties concerned, namely, the architect, the consultant and the illumination engineer. Therefore, it is essential that information regarding lighting should be exchanged between the parties from the stage of planning to installation.

This standard applies to the artificial lighting of interiors; it applies also, where appropriate to the artificial lighting of areas in the open air, where these areas are used for the same purposes as the corresponding interior premises.

This standard (Part 1) is one of the series of Indian Standards which deal with code of practice for interior illumination. This series will consist of the following parts:

Part 1 General requirements and recommendations for working interiors
Part 2 Method of calculation of the glare indices for interiors
Part 3 Recommendations for lighting in industries
Part 4 Recommendations for lighting in offices
Part 5 Recommendations for lighting in hospitals
Part 6 Recommendations for lighting in libraries
Part 7 Recommendations for lighting in educational institutions
Part 8 Emergency lighting

IS 3646 was first published in three parts, Part 1 covering principles for goodlighting and aspects of design, Part 2 covering schedule of illumination and glare index, and Part 3 covering calculation of coefficient of utilization by the BZ method. Since calculation of coefficient of utilization by the BZ method has become obsolete, therefore, in the first revision a new method of calculation of glare indices has been introduced.

Parts 1 and 2 of the standard, when completed, will supersede IS 3646 (Part 1) : 1966, IS 3646 (Part 2), and IS 3646 (Part 3) : 1968. Subsequent parts of the standard are intended to cover additional requirements that should be fulfilled while designing the lighting for a specific area. With the publication of these parts, the existing standards relating to code of practices for individual areas will, therefore, be ultimately withdrawn.

In the preparation of this standard, assistance has been derived from draft CIE-Publication on Interior Lighting, DIN 5035 (Parts 1 and 2) : 1979 and CIBS Code for Interior Lighting, 1984.

Indian Standard

CODE OF PRACTICE FOR INTERIOR ILLUMINATION

PART 1 GENERAL REQUIREMENTS AND RECOMMENDATIONS FOR WORKING INTERIORS

(First Revision)

1 SCOPE

This code (Part 1) covers the principles and practice governing good lighting in buildings and relates chiefly to the lighting of 'working areas' in industrial, commercial and public buildings, hospitals and schools.

2 TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Adaptation

The process by which the properties of the organ of vision are modified according to the luminances or the colour stimuli presented to it. The term is also used, usually qualified, to denote the final state of this process. For example, 'dark adaptation' denotes the state of the visual system when it has become adapted to a very low luminance.

2.2 Candela (cd)

The SI unit of luminous intensity, equal to one lumen per steradian.

2.3 Colour Rendering

A general expression for the appearance of surface colours when illuminated by light from a given source compared, consciously or unconsciously, with their appearance under light from some reference source. 'Good colour rendering' implies similarity of appearance to that under an acceptable light source, such as daylight.

2.4 Colour Rendering Index (CRI)

A measure of the degree to which the colours of surfaces illuminated by a given light source confirm to those of the same surfaces under a reference illuminent. Suitable allowance having been made for the state of chromatic adaptation.

2.5 Colour Temperature (K)

The temperature of the black body that emits radiation of the same chromaticity as the radiation considered.

2.6 Contrast

A term that is used subjectively and objectively. Subjectively, it describes the difference in appearance of two parts of a visual field seen simultaneously or successively. The difference may be one of brightness or colour, or both. Objectively, the term expresses the luminance difference between the two parts of the field by such relationship as:

$$\text{Contrast} = \frac{L_o - L_b}{L_b}$$

L_b is the dominent or background luminance. L_o is the task luminance.

Quantitatively, the sign of the contrast is ignored.

2.7 Contrast Rendering Factor (CRF)

The ratio of the contrast of a task under a given lighting installation to its contrast under reference lighting conditions.

2.8 Contrast Sensitivity

The reciprocal of the minimum perceptible contrast.

2.9 Correlated Colour Temperature (Unit : K)

The temperature of a block body which emits radiation having a chromaticity nearest to that of the light source being considered, for example, the colour of a full radiator at 3 500 K is the nearest match to that of a 'White' tubular fluorescent lamp.

2.10 Diffuse Reflection

Diffusion by reflection in which, on the macroscopic scale, there is no regular reflection.

2.11 Diffused Lighting

Lighting in which the light on the working plane on an object is not incident predominantly from any particular direction.

2.12 Direct Lighting

Lighting by means of luminaires with a light distribution such that 90 to 100 percent of the emitted luminous flux reaches the working plane directly, assuming that this plane is unbounded.

2.13 Directional Lighting

Lighting in which the light on the working plane or on an object is incident predominantly from a particular direction.

2.14 Disability Glare

Glare which impairs the vision of objects without necessarily causing discomfort.

2.15 Discomfort Glare

Glare which causes discomfort without necessarily impairing the vision of objects.

2.16 Emergency Lighting

Lighting intended to allow the public to find the exists from a building with ease and certainty in the case of failure of the normal lighting system.

2.17 Flicker

Impression of fluctuating luminance or colour.

2.18 General Lighting

Lighting designed to illuminate the whole of an area uniformly, without provision for special local requirements.

2.19 Glare

Condition of vision in which there is discomfort or a reduction in the ability to see significant objects, or both, due to an unsuitable distribution or range of luminance or to extreme contrasts in space or time.

2.20 Illuminance (E)

At a point of surface, quotient of the luminous flux incident on an element of the surface containing the point by the area of that element.

(Unit : Lux, lx).

2.21 Illumination

The application of visible radiation to an object.

2.22 Indirect Lighting

Lighting by means of luminaires with a light distribution such that not more than 10 percent of the emitted luminous flux reaches the working plane directly, assuming that this plane is unbounded.

2.23 Light Loss Factor

Ratio of the average illuminance on the working plane after a specified period of use of a lighting installation to the average illuminance obtained under the same conditions for a new installation.

2.24 Local Lighting

Lighting designed to illuminate a particular small area which usually does not extend far beyond the visual task, for example, a desk light.

2.25 Localized Lighting

Lighting designed to illuminate an interior and at the same time to provide higher illuminance over a particular part or parts of the interior.

2.26 Lumen (lm)

Luminous flux emitted within unit solid angle (one steradian) by a point source having a uniform luminous intensity of 1 candela.

2.27 Luminaire

Apparatus that distributes, filters or transforms the light given by a lamp or lamps and which includes all the items necessary for fixing and protecting these lamps and for connecting them to the supply circuit.

2.28 Luminance (L)

In a given direction, at a point on the surface of the source or a recepter or at a point on the path of a beam.

Quotient of the luminous flux leaving, arriving at, or passing through an element of surface at this point and propagated in direction defined by an elementary cone containing the given direction and the product of the solid angle of the cone and the area of the orthogonal projection of the element surface on a plane perpendicular to the given direction (Unit : Candela per square metre, cd/m^2).

2.29 Luminous Efficacy (Unit : lm/W)

The ratio of luminous flux emitted by a lamp to the power consumed by the lamp. When the power consumed by control gear is taken into account, this term is sometime known as lamp circuit luminous efficacy and is expressed in lumens/circuit watt.

2.30 Luminous Flux (ϕ)

The quantity derived from radiant flux by evaluating the radiation according to its action upon a selective receptor, the spectral sensitivity of which is defined by the standard spectral luminous efficiencies (Unit : lumen).

2.31 Luminous Intensity (I) (Of a source in a given direction)

Quotient of the luminous flux leaving the source propagated in an element of solid angle containing the given direction, by the element of solid angle (Unit : candela, cd).

2.32 Lux (lx), Lumen Per Square Metre

(SI Unit of Illuminance)

Illuminance produced by a luminous flux of one lm uniformly distributed over a surface of area one square metre.

2.33 Reflectance (Reflection Factor)

Ratio of the reflected radiant or luminous flux to the incident flux.

2.34 Service Illuminance

The mean illuminance throughout the maintenance cycle of an installation, averaged over the relevant area. The area may be the whole of the working plane or just the area of the visual task and its immediate surround, depending on the lighting approach used.

2.35 Specular Reflection — Regular Reflection

Reflection without diffusion in accordance with the laws of optical reflection as in a mirror.

2.36 Stroboscopic Effect

Apparent change of motion or immobilization of an object, when the object is illuminated by a periodically varying light of appropriate frequency.

2.37 Uniformity Ratio

The ratio of the minimum illuminance to the average illuminance. In some instances, the ratio of the minimum to the maximum illuminance is quoted. The ratio usually applies to values on the working plane over the working area.

2.38 Visual Environment

The environment either indoors or outdoors as seen by an observer.

2.39 Visual Field

The full extent in space of what can be seen when looking in a given direction.

3 FUNCTIONS OF LIGHTING

3.1 The lighting of an interior should fulfill three functions. It should : (a) ensure the safety of people in the interior, (b) facilitate performance of visual tasks, and (c) aid the creation of an appropriate visual environment.

3.2 Safety is always important but the emphasis given to task performance and the appearance of the interior will depend on the nature of the interior. For example, the lighting considered suitable for a factory toolroom will place more emphasis on lighting the task than on the appearance of the room, but in a hotel lounge the priorties will be reversed. This variation in emphasis should not be taken to imply that either task performance or visual appearance can be completely neglected. In almost all situations the designer should give consideration to both these aspects of lighting.

3.3 Lighting affects safety, task performance and the visual environment by changing the extent to and the manner in which different elements of the interior are revealed. Safety is ensured by making any hazards visible. Task performance is facilitated by making the relevant details of the task easy to see. Different visual environments can be created by changing the relative emphasis given to the various objects and surfaces in an interior. Different aspects of lighting influence the appearance of the elements in an interior in different ways. However, it should always be remembered that lighting design involves integrating the various aspects of lighting into a unity appropriate to the design objectives.

4 LIGHTING REQUIREMENTS

4.1 General

4.1.1 *Lighting Engineering Criteria*

Lighting requirements are based on the following lighting engineering criteria:

- Lighting level,
- Luminance distribution,
- Glare restriction,
- Direction of incidence of light and shadow effect, and
- Colour appearance and colour rendering.

A lighting installation can satisfy the requirements laid down, only if all the quality criteria are complied with; one or other quality criterion may be given priority, depending on the nature and difficulty of the visual task or on the type of room.

4.1.2 *Visual Tasks (Visual Tasks Differ)*

The size of the critical details of the task:

- Their contrast with the background,
- The speed at which these details have to be perceived,
- The desired reliability of recognition, and
- The duration of the visual work.

The quality requirements of the lighting increase with the difficulty of the visual task.

4.1.3 *Economic Aspect*

The selection of nominal illuminance for particular activities has to take into account economic aspects too. Although a higher level of lighting involves greater overall costs, these may be more than out-weighed by increased productivity and lower accident rate. A compromise has often to be made between desirable illuminance levels and those which are possible due to the economic climate prevailing. In consequence, it may be necessary to accept a lower standard of lighting than that which would be required from the point of view of performance.

The overall costs of a lighting installation can be reduced by using lamps having a high luminous efficacy and luminaires having a high efficiency and suitable light distribution.

4.2 Lighting Levels

4.2.1 *Illuminance*

The lighting level produced by a lighting installation is usually qualified by the illuminance produced on a specified plane. In most cases, this plane is the major plane of the tasks in the interior and is commonly called the working plane. The illuminance provided by an installation affects both the performance of the tasks and the appearance of the space.

4.2.2 *Recommendations on Illuminance*

4.2.2.1 *Scale of illuminance*

In order to be able just to discern features of the human face, a luminance of approximately 1 cd/m^2 is necessary. This can be achieved under normal lighting conditions with a horizontal illuminance of approximately 20 lux. So 20 lux is regarded as the minimum illuminance for all non-working interiors. A factor of approximately 1·5 represents the smallest significant difference in subjective effect of illuminances. Therefore, the following scale of illuminances is recommended.

20-30-50-75-100-150-200-300-500-750-1 000

1 500-2 000, etc, lux.

4.2.2.2 *Illuminance ranges*

Because circumstances may be significantly different for different interiors used for the same application or for different conditions for the same kind of activity, a range of illuminances is recommended for each type of interior or activity intended of a single value of illuminance. Each range consists of three successive steps of the recommended scale of illuminances. For working interiors the middle value of each range represents the recommended service illuminance that would be used unless one or more of the factors mentioned below apply.

The higher value of the range should be used when:

- Unusually low reflectances or contrasts are present in the task;
- Errors are costly to rectify;
- Visual work is critical;
- Accuracy or higher productivity is of great importance; and
- The visual capacity of the worker makes it necessary.

The lower value of the range may be used when:

- Reflectances or contrasts are unusually high;
- Speed and accuracy is not important; and
- The task is executed only occasionally.

Table 1 gives the recommended illuminance ranges for different tasks and activities. The values are related to the visual requirements of the task, to users' satisfaction, to practical experience and to the need for cost effective use of energy.

The values in the table are service values, which are the values which are obtained as an average during the maintenance cycle. They apply to the average illuminance at the reference surface. For lighting for work the reference surface will usually be the working plane. The reference surface may be limited to the area of the working zone(s) or to the task area(s) when the task locations are known and clearly specified. The reference surface should be at a specific angle or at a specific height when the task is not in a horizontal plane or at a different height. For other purposes, for example, for circulation lighting or for ambient lighting the reference surface may be the floor, the wall or any other relevant plane in the interior. It should always be clearly stated to which reference surface the illuminance applies.

4.3 Luminance Distribution on Major Room Surfaces

The distribution of luminance should be regarded as complementary to the design on the illuminance in the interior. It should take into account the following aspects:

- Luminance of the task and its immediate surroundings;
- Luminance of ceiling, walls and floor; and
- Avoidance of glare by limiting the luminance of luminaires and windows.

4.3.1 *Luminance Distribution in the Task Area*

The luminance of the immediate surroundings of the task should, if possible, be lower than the task luminance, preferably not less than 1/3 of this value. This implies that the ratio of the reflectance of the immediate background of a task to that of the task itself should preferably be in the range 0·3 to 0·5.

4.3.2 *Luminance of Ceilings, Walls and Floors*

The average luminance in the peripheral field of view should, if possible, be not lower than 1/10th of the task luminance.

4.3.2.1 *Reflectances and illuminances*

In working interior, in order to reduce the contrast between luminaires and surrounding ceiling, the ceiling reflectance should be as high as possible. In order to avoid that the ceiling may otherwise appear too dark, the ceiling illuminance should not be lower than 1/10th of the task illuminance.

In order to obtain a well balanced luminance distribution, the ratio of the minimum to the average illuminance should not be less than 0·8.

The average illuminance of the general areas of a working interior should normally not be less than 1/3 of the average illuminance of the task area(s).

The average illuminance of adjacent interiors should not vary from each other by a ratio exceeding 5 : 1.

4.4 Restriction of Glare

4.4.1 *General*

Glare may be caused by lamps, luminaires and windows (direct glare) or by the reflection of bright sources from surface with high reflectance (reflected glare).

In interior lighting, discomfort glare from lamps and luminaires is likely to be more of a problem than disability glare.

4.4.2.1 *Restriction of direct glare*

Direct glare is deemed to be adequately restricted, if the mean luminance of the luminaires in the critical glare range $45° \leqslant \gamma \leqslant 85°$ (*see* Fig. 1) does not exceed the limiting luminance plotted in Diagram I and Diagram II. The luminance curves represent the luminance limits for luminaires, in relation to the viewing angle from nadir (from 45° to 85°), for quality classes 1, 2 and 3 of glare restriction corresponding to values 1·5, 2·2 and 2·55 of glare rating G, for different illuminance and horizontal distance a $\geqslant h_s$ where h_s is the vertical distance between observers eye and the foremost luminaire (Fig. 1). The stepped scales of the glare rating G is based on the following interpretation of observers' impressions:

0 = No glare,

2 = Perceptible,

4 = Uncomfortable, and

6 = Intolerable glare.

representing quality classes from 1 to 3, for various values of illuminance.

For different activities and/or interiors, the importance and extent of glare limitation is different. For that reason, proper quality classes from 1 to 3 has to be selected for various values of illuminance:

Class 1 High quality

Class 2 Medium quality

Class 3 Low quality

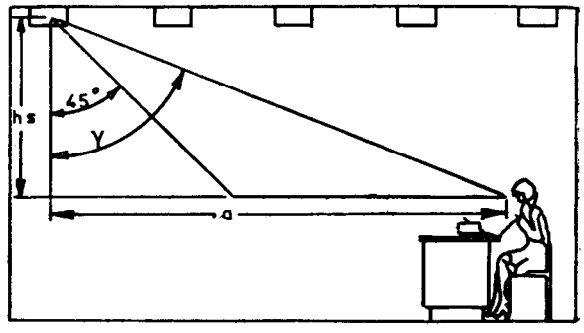

FIG. 1 RADIANT ZONE OF A LUMINAIRE IN WHICH THE LUMINANCE HAS TO BE CONSIDERED. IT LIES BETWEEN 45° $\left(\frac{a}{h_s} = 1\right)$ AND THE CONNECTING LINE BETWEEN THE EYE OF THE OBSERVER AND THE REMOTEST LUMINAIRE, $\gamma = \frac{a_{max}}{h_s}$

Guidance as to which quality class has to be used is given in Table 1, together with the recommended luminance values.

The luminances limiting curves of Diagram I should be used for all luminaires without luminous sides and for elongated luminous sides when viewed parallel to their longitudinal axis.

The curves of Diagram II should be used for luminaires with luminous sides viewed at right angles to their longitudinal axis.

The following factors have to be kept in view while using the curves in Diagrams I and II:

a) They are intended to be used for working interiors only,

b) It is assumed that the luminaires are arranged in a regular pattern in the ceiling,

c) The curves are valid for medium to bright room surface reflectances (ceiling reflectance of not less than 0·5 and wall reflectance of not less than 0·25),

d) A luminaire is considered to be elongated if the ratio of the length to the width of its luminous area is equal to or greater than 2 : 1, and

e) Luminaires without luminous sides include those with projected luminous area less than 0·03 m in height.

Table 1 Recommended Illumination

(*Clause* 4.2.2.2)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
1 AGRICULTURE AND HORTICULTURE			
1.1 Inspection of Farm Produce Where Colour is Important	300-500-750	1	Local lighting may be appropriate
Other Important Tasks	200-300-500	2	Local lighting may be appropriate
1.2 Farm Workshops			
1.2.1 General	50-100-150	3	
1.2.2 Workbench or machine	200-300-500	2	Local or portable lighting may be appropriate
1.3 Milk Premises	50-100-150	3	
1.4 Sick Animal Pets, Calf Nurseries	30-50-100	3	
1.5 Other Firm and Horticultural Buildings	20-30-50	3	
2 COAL MINING (SURFACE BUILDINGS)			
2.1 Coal Preparation Plant			
2.1.1 Walkways, floors under conveyors	30-50-100	3	
2.1.2 Wagon loading, bunkers	30-50-100	3	
2.1.3 Elevators, chute transfer pits, washbox area	50-100-150	3	
2.1.4 Drum filters, screen, rotating shafts	100-150-200	3	
2.1.5 Picking belts	150-200-300	3	Directional and colour properties of lighting may be important for easy recognition of coal and rock
2.2 Lamp Rooms			
2.2.1 Repair section	200-300-500	2	
2.2.2 Other areas	100-150-200	3	
2.3 Weight Cabins, Fan Houses	100-150-200	3	
2.4 Winding Houses	100-150-200	3	
3 ELECTRICITY GENERATION, TRANSMISSION AND DISTRIBUTION			
3.1 General Plant			
3.1.1 Turbine houses (operating floor)	150-200-300	2	
3.1.2 Boiler and turbine house basements	50-100-150	3	
3.1.3 Boiler houses, platforms, areas around burners	50-100-150	3	
3.1.4 Switch rooms, meter rooms, oil plant rooms, HV substations (indoor)	100-150-200	2	
3.1.5 Control rooms	200-300-500	1	Localized lighting of control display and the control desks may be appropriate
3.1.6 Relay and telecommunication rooms	200-300-500	2	
3.1.7 Diesel generator rooms, compressor rooms	100-150-200	3	
3.1.8 Pump houses, water treatment plant houses	100-150-200	3	
3.1.9 Battery rooms, chargers, rectifiers	50-100-150	3	
3.1.10 Precipitator chambers, platforms, etc	50-100-150	3	
3.1.11 Cable tunnels and basements, circulating water culverts and screen chambers, storage tanks (indoor), operating areas and filling points at outdoor tanks	30-50-100	3	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
3.2 Coal Plant			
3.2.1 Conveyors, gantries, junction towers, unloading hoppers, ash handling plants, settling pits, dust hoppers outlets	50-100-150	3	
3.2.2 Other areas where operators may be in attendance	100-150-200	3	
3.3 Nuclear Plants			
Gas circulation bays, reactor area, boiler platform, reactor charges and discharge face	100-150-200	2	
4 METAL MANUFACTURE			
4.1 Iron Making			
4.1.1 Sinter plant:			
Plant floor	150-200-300	3	
Mixer drum, fan house, screen houses, coolers, transfer stations	I00-150-200	3	
4.1.2 Furnaces, cupola:			
General	100-150-200	3	
Control platforms	200-300-500	2	Local lighting may be appropriate
Conveyor gelleries, walkways	30-50-100	3	
4.2 Steel Making			
4.2.1 Electric melting shops	150-200-300	3	
4.2.2 Basic oxygen steel making plants			
4.2.2.1 General	100-150-200	3	
4.2.2.2 Convertor floor, teeming bay	150-200-300	3	
4.2.2.3 Control platforms	200-300-500	2	Local lighting may be appropriate
4.2.2.4 Scrap bays	100-150-200	3	
4.3 Metal forming and treatment			
4.3.1 Ingot stripping, soaking pits, annealing and heat treatment bays, acid recovery plant	150-200-300	3	
Pickling and cleaning bays, roughing mills, cold mills, finishing mills, tinning and galvanizing lines, cut up and rewind lines			
4.3.2 General	100-150-200	3	
4.3.3 Control platforms	200-300-500	2	Local lighting may be appropriate
4.3.4 Wire mills, product finishing, steel inspection and treatment	200-300-500	3	
4.3.5 Plate/strip inspection	300-500-700	2	
4.3.6 Inspection of tin plate, stainless steel, etc	—	—	Special lighting to reveal faults in the specular surface of the material will be required
4.4 Foundries			
4.4.1 Automatic plant			
4.4.1.1 Without manual operation	30-50-100	3	
4.4.1.2 With occasional manual operation	100-150-200	3	
4.4.1.3 With continuous manual operation	150-200-300	3	
4.4.1.4 Control room	200-300-500	1	Localized lighting of the control display and the control desks may be appropriate
4.4.1.5 Control platforms	200-300-500	2	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
4.4.2 Non-automatic plants			
4.4.2.1 Charging floor, pouring, shaking out, cleaning, grinding fettling	200-300-500	3	
4.4.2.2 Rough moulding, rough core making	200-300-500	3	
4.4.2.3 Fine moulding, fine core making	300-500-750	2	
4.4.2.4 Inspection	300-500-750	2	
4.5 Forges (Severe vibration is likely to occur)			
4.5.1 General	200-300-500	2	
4.5.2 Inspection	300-500-750	2	
5 CERAMICS			
5.1 Concrete products			
Mixing, casting, cleaning	150-200-300	3	
5.2 Potteries			
5.2.1 Grinding, moulding, pressing, cleaning, trimming, glazing, firing	200-300-500	3	
5.2.2 Enamelling, colouring	500-750-1 000	1	
5.3 Glass Works			
5.3.1 Furnace rooms, bending, annealing	100-150-200	3	
5.3.2 Mixing rooms, forming, cutting, grinding, polishing, toughening	200-300-500	3	
5.3.3 Bevelling, decorative cutting, etching, silvering	300-500-750	2	
5.3.4 Inspection	300-500-750	2	
6 CHEMICALS			
6.1 Petroleum, Chemical and Petrochemical Works			
6.1.1 Exterior walkways, platforms, stairs and ladders	30-50-100	3	
6.1.2 Exterior pump and valve areas	50-100-150	3	
6.1.3 Pump and compressor houses	100-150-200	3	
6.1.4 Process plant with remote control	30-50-100	3	
6.1.5 Process plant requiring occasional manual intervention	50-100-150	3	
6.1.6 Permanently occupied work stations in process plant	150-200-300	3	
6.1.7 Control rooms for process plant	200-300-500	1	
6.2 Pharmaceutical Manufacturer and Fine Chemicals Manufacturer			
6.2.1 Pharmaceutical manufacturer			
Grinding, granulating, mixing, drying, tableting, sterilizing, washing, preparation of solutions, filling, capping, wrapping, hardening	300-500-750	2	
6.2.2 Fine chemical manufacture			
6.2.2.1 Exterior walkways, platforms, stairs and ladders	30-50-100	3	
6.2.2.2 Process plant	50-100-150	3	
6.2.2.3 Fine chemical finishing	300-500-750	2	
6.2.2.4 Inspeciion	300-500-750	1	Local lighting may be appropriate
6.3 Soap Manufacture			
6.3.1 General area	200-300-500	2	
6.3.2 Automatic processes	100-200-300	2	
6.3.3 Control panels	200-300-500	1	Local lighting may be appropriate
6.3.4 Machines	200-300-500	2	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
6.4 Paint Works			
6.4.1 General	200-300-500	2	
6.4.2 Automatic processes	150-200-300	2	
6.4.3 Control panels	200-300-500	2	
6.4.4 Special batch mixing	500-750-1 000	2	
6.4.5 Colour matching	750-1 000-1 500	1	
7 MECHANICAL ENGINEERING			
7.1 Structural Steel Fabrication			
7.1.1 General	200-300-500	3	
7.1.2 Marking off	300-500-750	3	Local lighting may be appropriate
7.2 Sheet Metal Works			
7.2.1 Pressing, punching shearing, stamping, spinning, folding	300-500-750	2	
7.2.2 Benchwork, scribing, inspection	500-750-1 000	2	
7.3 Machine and Tool Shops			
7.3.1 Rough bench and machine work	200-300-500	3	
7.3.2 Medium bench and machine work	300-500-750	2	
7.3.3 Fine bench and machine work	500-750-1 000	2	
7.3.4 Gauge rooms	750-1 000-1 500	1	Optical aids may be required
7.4 Die Sinking Shops			
7.4.1 General	300-500-750	2	
7.4.2 Fine work	1 000-1 500-2 000	1	Flexible local lighting is desirable
7.5 Welding and Soldering Shops			
7.5.1 Gas and arc welding, rough spot welding	200-300-500	3	
7.5.2 Medium soldering, brazing, spot welding	300-500-750	3	
7.5.3 Fine soldering, fine spot welding	750-1 000-1 500	2	Local lighting is desirable
7.6 Assembly Shops			
7.6.1 Rough work for example, frame and heavy machine assembly	200-300-500	3	The lighting of vertical surface may be important
7.6.2 Medium work, for example, engine assembly, vehicle body assembly	300-500-750	2	
7.6.3 Fine work, for example, office machinery assembly	500-750-1 000	1	Localized lighting may be useful
7.6.4 Very fine work, for example, instrument assembly	750-1 000-1 500	1	Local lighting and optical aids are desirable
7.6.5 Minute work, for example, watch making	1 000-1 500-2 000	1	Local lighting and optical aids are desirable
7.7 Inspection and Testing Shops			
7.7.1 Coarse work, for example, using go/no go gauges, inspection of large sub-assemblies	300-500-750	2	Local or localized lighting may be appropriate
7.7.2 Meduim work, for example, inspection of painted surfaces	500-750-1 000	1	Local or localized lighting may be appropriate
7.7.3 Fine work, for example, using calibrated scales, inspection of precision mechnisms	750-1 000-1 500	1	Local or localized lighting may be appropriate
7.7.4 Very fine work, for example, inspection of small intricate parts	1 000-1 500-2 000	1	Local lighting and optical aids are desirable
7.7.5 Minute work, for example, inspection of very small instruments	2 000	1	Local lighting and optical aids are desirable

Table 1 (*continued*)

Type of Interior or Activity	Range of Sevrice Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
7.8 Points Shops and Spray Booths			
7.8.1 Dipping, rough spraying	200-300-500	3	
7.8.2 Preparation, ordinary painting, spraying and finishing	200-500-750	2	
7.8.3 Fine painting, spraying and finishing	500-750-1 000	2	
7.8.4 Inspection, retouching and matching	750-1 000-1 500	2	
7.9 Plating Shops			
7.9.1 Vats and baths	200-300-500	3	
7.9.2 Buffing, polishing burnishing	300-500-750	2	
7.9.3 Final buffiing and polishing	500-750-1 000	2	
7.9.4 Inspection	—	—	Special light to reveal fault in the surface of the material will be required
8 ELECTRICAL AND ELECTRONIC ENGINEERING			
8.1 Electrical Equipment Manufacture			
8.1.1 Manufacture of cables and insulated wires, winding, varnishing and immersion of coils, assembly of large machines, simple assembly work	200-300-500	3	
8.1.2 Medium assembly, for example, telephones, small motors	300-500-750	3	Local lighting may be appropriate
8.1.3 Assembly of precision components, for example, telecommunication equipment, adjustment, inspection and calibration	750-1 000-1 500	1	Local lighting is desirable. Optical aids may be useful
8.1.4 Assembly of high precision parts	1 000-1 500-2 000	1	Local lighting is desirable. Optical aids may be useful
8.2 Electronic Equipment Manufacture			
8.2.1 Printed circuit board			
8.2.1.1 Silk screening	300-500-750	1	Local lighting may be appropriate
8.2.1.2 Hand insertion of components, soldering	500-750-1 000	1	Local lighting may be appropriate.
8.2.1.3 Inspection	750-1 000-1 500	1	A large, low luminance luminaire overhead ensures specular reflection conditions which are helpful for inspection of printed circuits
8.2.1.4 Assembly of wiring harness, cleating harness, testing and calibration	500-750-1 000	1	Local lighting may be appropriated
8.2.1.5 Chassis assembly	750-1 000-1 500	1	Local lighting may be appropriated
8.2.2 Inspection and testing:			
8.2.2.1 Soak test	150-200-300	2	
8.2.2.2 Safety and functional tests	200-300-500	2	
9 FOOD, DRINK AND TOBACCO			
9.1 Slaughter Houses			
9.1.1 General	200-300-500	3	
9.1.2 Inspection	300-500-750	2	
9.2 Canning, Preserving and Freezing			
9.2.1 Grading and sorting of raw materials	500-750-1 000	2	Lamps of colour rendering group 1A or 1B will be required, if colour judgment is required

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
9.2.2 Preparation	300-500-750	3	
9.2.3 Canned and bottled goods			
9.2.3.1 Retorts	200-300-500	3	
9 2.3.2 Automatic processes	150-200-300	3	
9.2.3.3 Labelling and packaging	200-300-500	3	
9.2.4 Frozen foods			
9.2.4.1 Process area	200-300-500	3	
9.2.4.2 Packaging and storage	200-300-500	3	
9.3 Bottling, Brewing and Distilling			
9.3.1 Keg washing and handling, bottle washing	150-200-300	3	
9.3.2 Keg inspection	200-300-500	3	
9.3.3 Bottle inspection	—	—	Special lighting will be required
9.3.4 Process areas	200-300-500	3	
9.3.5 Bottle filling	500-750-1 000	3	
9.4 Edible Oils and Fats Processing			
9.4.1 Refining and blending	200-300-500	3	
9.4.2 Production	300-500-750	2	
9.5 Mills-Milling, Filtering and Packing	200-300-500	3	
9.6 Bakeries			
9.6.1 General	200-300-500	2	
9.6.2 Hand decorating, icing	300-500-750	2	
9.7 Chocolate and Confectionery Manufacture			
9.7.1 General	200-300-500	3	
9.7.2 Automatic processes	150-200-300	3	
9.7.3 Hand decoration, inspection, wrapping and packing	300 500-750	2	If accurate colour judgements are required, lamps of colour rendering group 1A or 1B are used
9.8 Tobacco Processing			
9.8.1 Material preparation, making and packing	300-500-750	2	
9.8.2 Hand processes	500-750-1 000	2	
10 TEXTILES			
10.1 Fibre Preparation			
10.1.1 Bale breaking, washing	200-300-500	3	
10.1.2 Stock dyeing, tinting	200-300-500	3	
10.2 Yarn Manufacture			
10.2.1 Spinning, roving, winding, etc	300-500-750	2	
10.2.2 Healding (drawing in)	750-1 000-750	2	
10.3 Fabric Production			
10.3.1 Knitting	300-500-750	2	
10.3.2 Weaving			
10.3.2.1 Jute and hemp	200-300-500	2	
10.3.2.2 Heavy woollens	300-500-750	1	
10.3.2.3 Medium worsteds, fine woollens, cottons	500-750-1 000	1	
10.3.2.4 Fine worsteds, fine linens, synthetics	750-1 000-1 500	1	
10.3.2.5 Mending	1 000-1 500-2 000	1	
10.3.2.6 Inspection	1 000-1 500-2 000	1	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
10.4 Fabric Finishing			
10.4.1 Dyeing	200-300-500	3	
10.4.2 Calendering, chemical treatment, etc	300-500-750	2	
10.4.3 Inspection			
10.4.3.1 'Grey' cloth	750-1 000-1 500	1	
10.4.3.2 Final	1 000-1 500-2 000	1	
10.5 Carpet Manufacture			
10.5.1 Winding, beaming	200-300-500	3	
10.5.2 Setting pattern, tufting cropping, trimming, fringing, latexing and latex drying	300-500-750	2	
10.5.3 Designing, weaving, mending	500-750-1 000	2	
10.5.4 Inspection			
10.5.4.1 General	750-1 000-1 500	1	Local lighting may be appropriate
10.5.4.2 Piece dyeing	500-750-1 000	1	Local lighting may be appropriate
11 LEATHER INDUSTRY			
11.1 Leather Manufacture			
11.1.1 Cleaning, tanning and stretching, vats, cutting, fleshing, stuffing	200-300-500	3	
11.1.2 Finishing, scarfing	300-500-750	2	
11.2 Leather Working			
11.2.1 General	200-300-500	3	
11.2.2 Pressing, glazing	300-500-750	2	
11.2 3 Cutting, splitting, scarfing, sewing	500-750-1 000	2	Directional lighting may be useful
11.2.4 Grading, matching		2	Local lighting may be appropriate
12 CLOTHING AND FOOTWEAR			
12.1 Clothing Manufacture			
12.1.1 Preparation of cloth	200-300-500	2	
12.1.2 Cutting	500-750-1 000	1	
12.1.3 Matching	500-750-1 000	1	
12.1.4 Sewing	750-1 000-1 500	1	
12.1.5 Pressing	300-500-750	2	
12.1.6 Inspection	1 000-1 500-2 000	1	Local lighting may by appropriate
12.1.7 Hand tailoring	1 000-1 500-2 000	1	Local lighting may be appropriate
12.2 Hosiery and Knitwear Manufacture			
12.2.1 Flat bed knitting machines	300-500-750	2	
12.2.2 Circular knitting machines	500-750-1 000	2	
12.2.3 Lockstitch and overlocking machine	750-1 000-1 500	1	
12.2.4 Linking or running on	750-1 000-1 500	1	
12.2.5 Mending, handfinishing	1 000-1 500-3 000	—	Local lighting may by appropriate
12.2.6 Inspection	1 000-1 500-2 000	2	Local lighting may be appropriate
12.3 Glove Manufacture			
12.3.1 Sorting and grading	500-750-1 000	1	
12.3.2 Pressing, knitting, cutting	300-500-750	2	
12.3.3 Sewing	500-750-1 000	2	
12.3.4 Inspection	1 000-1 500-2 000	—	Local lighting may be appropriate

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
12.4 Hat Manufacture			
12.4.1 Stiffening, braiding, refining, forming, sizing, pounding, ironing	200-300-500	2	
12.4.2 Cleaning, flanging, finishing	300-500-750	2	
12.4.3 Sewing	500-750-1 000	2	
12.4.4 Inspection	1 000-1 500-2 000	—	Local lighting may be appropriate
12.5 Boot and Shoe Manufacture			
12.5.1 Leather and Synthetics			
12.5.2 Sorting and grading	750-1 000-1 500	1	
12.5.3 Clicking, closing	750-1 000-1 500	2	Local or localized lighting may be appropriate
12.5.4 Preparatory operations	750-1 000-1 500	2	Local or localized lighting may be appropriate
12.5.5 Cutting tables and pressure	1 000-1 500-2 000	1	Local or localized lighting may be appropriate
12.5.6 Bottom stock preparation, lasting, bottoming finishing, shoe rooms	750-1 000-1 500	1	Local or localized lighting may be appropriate
12.5.7 Rubber			
12.5.7.1 Washing, compounding, coating, drying, varnishing, vulcanizing, calendering, cutting	200-300-500	3	
12.5.7.2 Lining, making and finishing	300-500-750	2	
13 TIMBER AND FURNITURE			
13.1 Sawmills			
13.1.1 General	150-200-300	3	
13.1.2 Head saw	300-500-750	2	Local lighting may be appropriate
13.1.3 Grading	500-750-1 000	2	Directional lighting may be useful
13.2 Woodwork Shops			
13.2.1 Rough sawing, bench work	200-300-500	2	
13.2.2 Sizing, planning, sanding, medium machining and bench work	300-500-750	2	
13.2.3 Fine bench and machine work, fine sanding, finishing	500-750-1 000	2	Localized lighting may be appropriate
13.3 Furniture Manufacture			
13.3.1 Raw material stores	50-100-150	3	
13.3.2 Finished goods stores	100-150-200	3	
13.3.3 Wood matching and assembly, rough sawing, cutting	200-300-500	2	
13.3.4 Machining, sanding and assembly, polishing	300-500-750	2	Localized lighting may be appropriate
13.3.5 Tool rooms	300-500-750	2	
13.3.6 Spray booths			
13.3.6.1 Colour finishing	300-500-750	2	
13.3.6.2 Clear finishing	200-300-500	2	
13.3.7 Cabinet making			
13.3.7.1 Vaneer sorting and grading	750-1 000-1 500	1	
13.3.7.2 Marquetry, pressing, patching and fitting	300-500-750	2	
13.3.7.3 Final inspection	500-750-1 000	1	Special lighting will be required

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
13.4 Upholstry Manufacture			
13.4.1 Cloth inspection	1 000-1 500- 2 000	1	Social lighting will be required
13.4.2 Filling, covering	300-500-750	2	
13.4.3 Slipping, cutting, sewing	500-750-1 000	2	
13.4.4 Mattress making			
13.4.5 Assembly	300-500-750	2	
13.4.6 Tape edging	750-1 000-1 500	2	Local lighting may be appropriate
14 PAPER AND PRINTING			
14.1 Paper Mills			
14.1.1 Pulp mills, preparation plants	200-300-500	3	
14.1.2 Paper and board making			
14.1.2.1 General	200-300-500	3	
14.1.2.2 Automatic process	150-200-300	3	Supplementary lighting may be necessary for maintenance work
14.1.2.3 Inspection, sorting	300-500-750	1	
14.1.3 Paper converting processes			
14.1.3.1 General	200-300-500	3	
14.1.3.2 Associated printing	300-500-750	2	
14.2 Printing Works			
14.2.1 Type foundries			
14.2.1.1 Matrix making, dressing type, hand and machine coating	200-300-500	3	
14.2.1.2 Front assembly, sorting	500-750-1 000	2	
14.2.2 Composing rooms			
14.2.2.1 Hand composing, imposition and distribution	500-750-1 000	1	
14.2.2.2 Hot metal keyboard	500-750-1 000	1	
14.2.2.3 Hot metal casting	200-300-500	2	
14.2.2.4 Photo composing keyboard or setters	300-500-750	1	
14.2.2.5 Paste up	500-750-1 000	1	
14.2.2.6 Illuminated tables — general lighting	200-300-500	—	Dimming may be required
14.2.2.7 Proof presses	300-500-750	2	
14.2.2.8 Proof reading	500-750-1 000	1	
14.2.3 Graphic Reproduction			
14.2.3.1 General	300-500-750	2	
14.2.3.2 Precision proofing, retouching, etching	750-1 000-1 500	1	Local lighting may be appropriate
14.2.3.3 Colour reproduction and inspection	750-1 000-1 500	1	
14.2.4 Printing machine room			
14.2.4.1 Presses	300-500-750	2	
14.2.4.2 Premake ready	300-500-750	2	
14.2.4.3 Printed sheet inspection	750-1 000-1 500	1	
14.2.5 Binding			
14.2.5.1 Folding, pasting, punching and stitching	300-500-750	2	
14.2.5.2 Cutting, assembling, embossing	500-750-1 000	2	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Lumitation	Remarks
15 PLASTICS AND RUBBER			
15.1 Plastic Products			
15.1.1 Automatic plant			
15.1.1.1 Without manual control	30-50-100	3	
15.1.1.2 With occasional manual control	50-100-150	3	
15.1.1.3 With continuous manual control	200-300-500	3	
15.1.1.4 Control rooms	200-300-500	1	
15.1.1.5 Control platforms	200-300-500	2	Local lighting may be appropriate
15.1.2 Non-automatic plant			
15.1.2.1 Mixing, calendering, extrusion, injection, compression and blow moulding, sheet fabrication	200-300-500	3	
15.1.2.2 Trimming, cutting, polishing, cementing	300-500-750	2	
15.1.2.3 Printing, inspection	750-1 000-1 500	1	
15.2 Rubber Products			
15.2.1 Stock preparation — plasticizing, milling	150-200-300	3	
15.2.2 Calendering, fabric preparation, stock-cutting	300-500-750	3	
15.2.3 Extruding, moulding	300-500-750	2	
15.2.4 Inspection	750-1 000-1 500	—	
16 DISTRIBUTION AND STORAGE			
16.1 Work Stores	100-150-200	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.1 Unpacking, sorting	150-200-300	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.2 Large item storage	50-100-150	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.3 Small item rack storage	200-300-500	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.4 Issue counter, records, storeman's desk	300-500-750	2	Local or localized lighting may be appropriate
16.2 Warehouses and Bulk Stores			
16.2.1 Storage of goods where indentification requires only limited preparation of detail	50-100-150	3	
16.2.2 Storage of goods where identification requires perception of detail	100-150-200	3	
16.2.3 Automatic high bay rack stores			
16.2.3.1 Gangway	20	—	
16.2.3.2 Control station	150-200-300	3	
16.2.3.3 Packing and despatch	200-300-500	3	
16.2.3.4 Loading bays	100-150-200	3	Avoid glare to drivers of vehicles approaching the loading bay
16.3 Cold Stores			
16.3.1 General	200-300-500	3	
16.3.2 Breakdown, make-up and despatch	200-300-500	3	
16.3.3 Loading bays	100-150-200	3	Avoid glare to drivers of vehicles approaching bay

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
17 COMMERCE			
17.1 Offices			
17.1.1 General offices	300-500-750	1	
17.1.2 Deep plan general offices	500-750-1 000	1	
17.1.3 Computer work stations	300-500-750	1	
17.1.4 Conference rooms, executive offices	300-500-750	1	
17.1.5 Computer and data preparation rooms	300-500-750	1	
17.1.6 Filing rooms	200-300-500	1	
17.2 Drawing Offices			
17.2.1 General	300-500-750	1	
17.2.2 Drawing boards	500-750-1 000	1	
17.2.3 Computer aided design and drafting	—	—	Special lighting is required
17.2.4 Print rooms	200-300-500	1	
17.3 Banks and Building Societies			
17.3.1 Counter, office area	300-500-750	1	
17.3.2 Public area	200-300-500	1	
18 SERVICES			
18.1 Garages			
18.1.1 Interior parking areas	20-30-50	3	
18.1.2 General repairs, servicing, washing, polishing	200-300-500	2	
18.1.3 Workbench	300-500-750	1	Local or localized lighting may be appropriate
18.1.4 Spray booths	300-500-750	1	
18.1.5 External apron			
18.1.5.1 General	30-50-100	—	Care should be taken to avoid glare to drivers and neighbouring residents
18.1.5.2 Pump area (retail sales)	200-300-500	—	*See* 'Retailing'
18.2 Appliance servicing			
18.2.1 Workshop			
18.2.1.1 General	200-300-500	2	
18.2.1.2 Workbench	300-500-750	2	Localized lighting may be appropriate
18.2.1.3 Counter	200-300-500	2	Localized lighting may be appropriate
18.2.1.4 Stores	200-300-500	3	
18.3 Laundries			
18.3.1 Commercial laundries			
18.3.2 Receiving, sorting, washing, drying, ironing, despath, dry-cleaning, bulk machine work	200-300-500	3	
18.3.3 Head ironing, pressing, mending, spotting, inspection	300-500-750	3	
18.3.4 Launderettes	200-300-500	3	
18.4 Sewage Treatment Works			
18.4.1 Walkways	30-50-100	3	
18.4.2 Process areas	50-100-150	3	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
19 RETAILING			
19.1 Small Shops with Counters	300-500-750	1	The service illuminance should be provided on the horizontal plane of the counter. Where wall displays are used, a similar illuminance on the walls is desirable.
19.2 Small Self-Service Shops with Island Displays	300-500-750	1	
19.3 Supper Markets, Hyper-Markets			
19.3.1 General	300-500-750	2	
19.3.2 Checkout	300-500-750	2	
19.3.3 Showroom for large objects, for example, cars, furnitures	300-500-750	1	
19.3.4 Shopping precincts and arcades	100-150-200	2	
20 PLACES OF PUBLIC ASSEMBLY			
20.1 Public Rooms, Village Halls, Worship Halls	200-300-500	1	
20.2 Concert Halls, Cinemas and Theatres			
20.2.1 Foyer	150-200-300	—	
20.2.2 Booking office	200-300-500	—	Local or localized lighting may be appropriate
20.2.3 Auditorium	50-100-150	—	Dimming facilities will be necessary. Special lighting of the aisles is desirable
20.2.4 Dressing rooms	200-300-500	—	Special mirror lighting for make-up may be required
20.2.5 Projection room	100-150-200	—	
20.3 Churches			
20.3.1 Body of church	100-150-200	2	
20.3.2 Pulpit, lectern	200-300-500	2	Use local lighting
20.3.3 Choir stalls	200-300-500	2	Local lighting may be appropriate
20.3.4 Alter, communion table, chancel	100-150-200	2	Additional lighting to provide emphasis is desirable
20.3.5 Vestries	100-150-200	2	
20.3.6 Organ	200-300-500	—	
20.4 Hospitals			
20.4.1 Anaesthatic rooms			
20.4.1.1 General	200-300-500	—	
20.4.1.2 Local	750-1 000-1 500	—	
20.4.2 Consulting areas			
20.4.2.1 General	200-300-500	—	
20.4.2.2 Examination	750-1 000-1 500	—	
20.4.3 Corridors			
20.4.3.1 General	100-150-200	—	
20.4.4 Ward corridors			
20.4.4.1 Day, screened from bays	150-200-300	—	
20.4.4.2 Day, open to natural light	150-200-300 (total)	— —	
20.4.4.3 Morning/evening	100-150-200	—	
20.4.4.4 Night	5-10	—	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
20.4.5 Cubicles			
20.4.5.1 General	200-300-500	—	
20.4.5.2 Treatment	750-1 000-1 500	—	
20.4.6 Examination			
20.4.6.1 General	200-300-500	—	
20.4.6.2 Local inspection	750-1 000-1 500	—	
20.4.7 Intensive therapy			
20.4.7.1 Bad head	30-50	—	
20.4.7.2 Circulation between bed ends	50-100-150	—	
20.4.7.3 Observation	200-300-500	—	
20.4.7 4 Local observation	750-1 000-1 500	—	
20.4.7.5 Staff base (day)	200-300-500	—	
20.4.7.6 Staff base (night)	30	—	
20.4.8 Laboratories			
20.4.8.1 General	200-300-500	—	
20.4.8.2 Examination	300-500-750	—	
20.4.9 Nurses' stations			
20.4.9.1 Morning/day/evening	200-300-500	—	
20.4.9.2 Night desks	30	—	
20.4.9.3 Night, medical trolleys	50-100-150	—	
20.4.10 Operating theatres			
20.4.10.1 General	300-500-750	—	
20.4.10.2 Local	10 000 to 50 000	—	Special operating lights are used
20.4.11 Pathology departments			
20.4.11.1 General	200-300-500	—	
20.4.11.2 Examination	300-500-750	—	
20.4.11.3 Pharmacies	200-300-500	—	
20.4.11.4 Reception/enquiry	200-300-500	—	
20.4.11.5 Recovery rooms	200-300-500	—	
20.4.12 Ward-circulation			
20.4.12.1 Day	50-100-150	—	
20.4.12.2 Morning/evening	50-100-150	—	
20.4.12.3 Night	3-5	—	
20.4.13 Ward-bed head			
20.4.13.1 Morning/evening	30-50		
20.4.13.2 Reading	100-150-200		
20.4.14 Night			
20.4.14.1 Adult	0·1-1		
20.4.14.2 Paediatric	1		
20.4.14.3 Psychiatric	1-5		
20.4.14.4 Watch	5		
20.4.15 X-Ray areas			
20.4.15.1 General	150-200-300		
20.4.15.2 Diagnostic	150-200-300		
20.4.15.3 Operative	200-300-500		
20.4.15.4 Process dark room	50		
20.4.16 Surgeries			
20.4.16.1 General	200-300-500	—	
20.4.16.2 Waiting rooms	100-150-200	—	
20.4.17 Dental surgeries			
20.4.17.1 Chair	Special lighting		
20.4.17.2 Laboratories	300-500-750	—	
20.4.18 Consulting rooms			
20.4.18.1 General	200-300-500	—	
20.4.18.2 Desk	300-500-750	—	
20.4.18.3 Examination couch	300-500-750	—	
20.4.18.4 Ophthalmic wall and near-vision charts	300-500-750	—	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
20.5 Hotels			
20.5.1 Entrance halls	50-100-150		
20.5.2 Reception, cashier's and porters' desks	200-300-500		Localized lighting may be appropriate
20.5.3 Bars, coffee base, dining rooms, grill rooms, restaurants, lounges	50-200		The lighting should be designed to create an appropriate atmosphere
20.5.4 Cloak rooms, baggage rooms	50-100-150	3	
20.5.5 Bed rooms	30-50-100	—	Supplementary local lighting at the bed head, writing table should be provided
20.5.6 Bathroom	50-100-150		Supplementary local lighting near the mirror is desirable
20.5.7 Food preparation and stores, cellars, lifts and corridors	—	—	*See* 'General Building Areas'
20.6 Libraries			
20.6.1 Lending library			
20.6.1.1 General	200-300-500	1	
20.6.1.2 Counters	300-500-750	1	Localized lighting may be appropriate
20.6.1.3 Bookshelves	100-150-200	2	The service illuminance should be provided on the vertical face at the bottom of the bookstack
20.6.1.4 Reading rooms	200-300-500	1	
20.6.1.5 Reading tables	200-300-500	1	Localized lighting may be appropriate
20.6.2 Catalogues			
20.6.2.1 Card	100-150-200	2	
20.6.2.2 Microfiche/Visual display units	100-150-200	2	
20.6.3 Reference libraries			
20.6.3.1 General	200-300-500	1	
20.6.3.2 Counters	300-500-750	1	Localized lighting may be appropriate
20.6.3.3 Bookshelves	100-150-200	2	The service illuminance should be provided on a vertical surface at the foot of the bookshelves
20.6.3.4 Study tables, carrels	300-500-750	1	
20.6.3.5 Map room	200-300-500	1	
20.6.4 Display and exhibition areas			
20.6.4.1 Exhibits insensitive to light	200-300-500	—	
20.6.4.2 Exhibit sensitive to light, for example, pictures, prints, rare books in archives	50 to 150	—	
20.6.5 Library workrooms			
20.6.5.1 Book repair and binding	300-500-750	2	
20.6.5.2 Catalogue and sorting	300-500-750	2	
20.6.5.3 Remote book stores	100-150-200	3	
20.7 Museums and Art Galleries			
20.7.1 Exhibits insensitive to light	200-300-500	—	

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illuminance in Lux	Quality Class of Direct Glare Limitation	Remarks
20.7.2 Light sensitive exhibits, for example, oil and temper paints, undyed leather, bone, ivory, wood, etc	150	—	This is a maximum illuminance to be provided on the principal plane of the exhibit
20.7.3 Extremely light sensitive exhibits, for example, textiles, water colours, prints and drawings, skins, botanical specimens, etc	50	—	This is the maximum illuminance to be provided on the principal plane of the object
20.7.4 Conservation studies and workshops	300-500-750	1	
20.8 Sports Facilities			
Multi-purpose sports halls	300-750	—	This lighting system should be sufficiently flexible to provide lighting suitable for the variety of sports and activities that take place in sports halls. Higher illuminance of 1 000-2 000 lux would be required for television coverage
21 EDUCATION			
21.1 Assembly Halls			
21.1.1 General	200-300-500	3	
22.1.2 Platform and stage	—	—	Special lighting to provide emphasis and to facilitate the use of the platform/ stage is desirable
21.2 Teaching Spaces			
General	200-300-500	1	
21.3 Lecture Theatres			
21.3.1 General	200-300-500	1	
21.3.2 Demonstration benches	300-500-750	1	Localized lighting may be appropriate
21.4 Seminar Rooms	300-500-750	1	
21.5 Art Rooms	300-500-750	1	
21.6 Needlework Rooms	300-500-750	1	
21.7 Laboratories	300-500-750	1	
21.8 Libraries	200-300-500	1	
21.9 Music Rooms	200-300-500	1	
21.10 Sports Halls	200-300-500	1	
21.11 Workshops	200-300-500	1	
22 TRANSPORT			
22.1 Airports			
22.1.1 Ticket counters, checking desks, and information desks	300-500-750	2	Localized lighting may be appropriate
22.1.2 Departure lounges, other w aiting areas	150-200-300	2	
22.1.3 Baggage reclaim	150-200-300	2	
22.1.4 Baggage handling	50-100-150	2	
22.1.5 Customs and immigration halls	300-500-750	2	
22.1.6 Concourse	150-200-300	2	
22.2 Railway Sta tions			
22.2.1 Ticket office	300-500-750	2	Localized lighting over the counter may be appropriate
22.2.2 Information office	300-500-750	2	Localized lighting over the counter may be appropriate

Table 1 (*continued*)

Type of Interior or Activity	Range of Service Illumination in Lux	Quality Class of Direct Glare Limitation	Remarks
22.2.3 Parcels office, left			
22.2.4 Luggage office			
22.2.4.1 General	50-100-150	2	
22.2.4.2 Counter	150-200-300	2	
22.2.5 Waiting rooms	150-200-300	2	
22.2.6 Concourse	150-200-300	2	
22.2.7 Time table	150-200-300	2	Localized lighting may be appropriate
22.2.8 Ticket barriers	150-200-300	2	Localized lighting may be appropriate
22.2.9 Platforms (covered)	30-50-100	2	Care should be taken to light and mark the edge of the platform clearly
22.2.10 Platforms (open)	20	—	Care should be taken to light and mark the edge of the platform clearly
22.3 Coach Stations			
22.3.1 Ticket offices	300-500-750	2	Localized lighting over the counter may be appropriate
22.3.2 Information offices	300-500-750	2	Localized lighting over the counter may be appropriate
22.3.3 Left luggage office			
22.3.3.1 General	50-100-150	3	
22.3.3.2 Counter	150-200-300	3	Localized lighting is appropriate
22.3.4 Waiting rooms	150-200-300	2	
22.3.5 Concourse	150-200-300	2	
22.3.6 Time tables	150-200-300	2	Local lighting is appropriate
22.3.7 Loading areas	100-150-200	3	
23 GENERAL BUILDING AREAS			
23.1 Entrance			
23.1.1 Entrance halls, lobbies, waiting rooms	150-200-300	2	
23.1.2 Enquiry desks	300-500-750	2	Localized lighting may be appropriate
23.1.3 Gatehouses	150-200-300	2	
23.2 Circulation Areas			
23.2.1 Lifts	50-100-150	—	
23.2.2 Corridors, passageways, stairs	50-100-150	2	
23.2.3 Escalators, travellators	100-150-200	—	
23.3 Medical and First Aid Centres			
23.3.1 Consulting rooms, treatment rooms	300-500-750	1	
23.3.2 Rest rooms	100-150-200	1	
23.3.3 Medical stores	100-150-200	2	
23.4 Staff Rooms			
23.4.1 Changing, locker and cleaners rooms, cloakrooms, lavatories	50-100-I50	—	
23.4.2 Rest rooms	100-150-200	1	
23.5 Staff Restaurants			
23.5.1 Canteens, cafeterias, dining rooms, mess rooms	150-200-300	2	
23.5.2 Servery, vegetable preparation, washing-up area	200-300-500	2	

Table 1 (*concluded*)

Type of Interior or Activity	Range of Service Illumination in Lux	Quality Class of Direct Glare Limitation	Remarks
23.5.3 Food preparation and cooking	300-500-750	2	
23.5.4 Food stores, cellars	100-150-200	2	
23.6 Communications			
23.6.1 Switchboard rooms	200-300-500	2	
23.6.2 Telephone apparatus rooms	100-150-200	2	
23.6.3 Telex room, post room	300-500-750	2	
23.6.4 Reprographic room	200-300-500	2	
23.7 Building Services			
23.7.1 Boiler houses			
23.7.1.1 General	50-100-150	3	
23.7.1.2 Boiler front	100-150-200	3	
23.7.1.3 Boiler control room	200-300-500	2	Localized lighting of the control display and the control desk may be appropriate
23.7.1.4 Control rooms	200-300-500	2	Localized lighting of the control display and the control desk may be appropriate
23.7.1.5 Mechanical plant room	100-150-200	2	
23.7.1.6 Electrical power supply and distribution rooms	100-150-200	2	
23.7.1.7 Store rooms	50-100-150	3	
3.8 Car Parks			
23.8.1 Covered car parks			
23.8.1.1 Floors	5-20	—	
23.8.1.2 Ramps and corners	30	—	
23.8.1.3 Enterances and exits	50-100-150	—	
23.8.1.4 Control booths	150-200-300	—	
23.8.1.5 Outdoor car parks	5-20	—	

4.4.2.2 *Shielding angle*

For luminaires whose lamps or parts thereof are visible when viewed at angles from the vertical 45° and greater, not only should the average luminance of luminaire be limited according to the limiting curves of the diagrams (*see* Fig. 2), but in addition the lamps should be sufficiently shielded depending on the luminance of the lamp and the selected quality class. The required shielding angles (*see* Fig. 3) are given in Table 2.

If the shielding angle is less than the tabulated value, the lamp luminance must be used in Diagram II for checking the glare limitation.

4.4.2.3 *Procedure for the use of the luminance limiting curves*

a) Luminaire manufacturers should provide in the photometric data sheet of the luminaire the average luminance distribution in the C_0 and C_{90} planes, either in the form of luminance values (*see* Table 3) or in the form of luminance curves (*see* Fig. 5); and

b) Compare plots of these luminance values on the correct scale against the reference curves:

   i) For all types of luminaires seen lengthwise and for those luminaires seen crosswise and having only horizontal light emitting surfaces, Diagram I; and

   ii) For those luminaires seen crosswise and having luminous side panels, Diagram II.

c) Determine the value of $\frac{a}{h_s}$ up to which, according to Fig. 1, has to be considered.

Thus, two ranges of ν between 45° and this value are obtained, one for each viewing direction.

For comparison, within these ranges there are two possible results:

i) For the whole range of ν the luminance curve of the luminaire lies on the left hand side of the reference curve for the required quality class and illuminance level. In this case, it is permissible to use this luminaire for that level and quality class; and

ii) For substantial parts of the range of ν, the luminance curve of the luminaire lies on the right hand side of the reference curve. In such a case the design will require to be changed as the degree of discomfort glare from the installation will be higher than that permitted for the quality class chosen.

Table 2 Recommended Shielding Angle

(*Clause* 4.4.2.2)

Type of Lamp	Mean Luminance Range cd/m²	Quality Class of Glare Restriction		
		1	2	3
Fluorescent lamps	$L < 2 \times 10^4$	10°	0°	0°
High-pressure discharge lamps with fluorescent or diffuse-light tubes Sodium vapour low-pressure lamps	$2 \times 10^4 < L < 50 \times 10^4$	15°	5°	0°
High-pressure discharge lamps with clear glass tubes or in a linolite modal Incandescent lamps with clear glass tubes	$L > 50 \times 10^4$	30°	15°	10°

Table 3 Luminance Values of a Luminaire in the Zone 45°-85° for C_0 and C_{90} Planes

(*Clause* 4.4.2.3)

ν	Luminance (cd/m²)	
	Plane 0°-180°	Plane 90°-270°
45	4 270	3 900
50	3 650	3 280
55	3 110	2 750
60	2 590	2 310
65	2 140	2 120
70	1 890	2 040
75	1 850	2 070
80	1 850	2 190
85	1 880	2 430

4.4.2.4 *Luminous ceilings*

For high requirement of lighting quality, the luminance values of luminous ceilings should not exceed 500 cd/m above a viewing angle of 45°.

4.4.2.5 *Reflected glare and vailing reflection*

If any of the surfaces of the task or its immediate surroundings are such that their luminance is strongly dependent on the direction of incidence of the light and on the viewing direction, glare may be produced by the reflection of a high luminance (for example, of a luminaire or of a window) towards the eyes. This is the phenomenon referred to as glare by reflection.

If the above surfaces are such that their luminance is dependent on the direction of the light and on the viewing direction to a much lesser extent, visual difficulties may arise when a high luminance (for example, of a luminaire or of a window) is reflected by the task towards the eyes because these reflections veil the task and reduce contrasts within the task. This is the phenomenon referred to as contrast reduction caused by veiling reflections.

What is true for the luminances and luminance contrasts also hold for the colours and colour contrasts of not perfectly matt surfaces at which the reflections take place.

4.4.2.6 *Contrast rendering*

Task contrast is usually defined as the relative luminance difference between the task detail and the background against which it is seen.

Since for matt surfaces for a given illuminance the luminances are proportional to their reflectances, task contrast of matt tasks are determined completely by the reflectances of detail and background. Increased task visibility due to improved lighting for matt tasks, therefore, results entirely from increased contrast sensitivity of the visual system.

4.4.2.7 *Restriction of reflected glare*

The most effective method for restricting reflected glare is by arranging the location of the worker and the light source such that reflections from the latter are not towards the eyes, but directed away or to the sides.

It shall also be minimized using large area, low luminance luminaires and by using non-glassy finishes on furniture, equipment, and room surfaces.

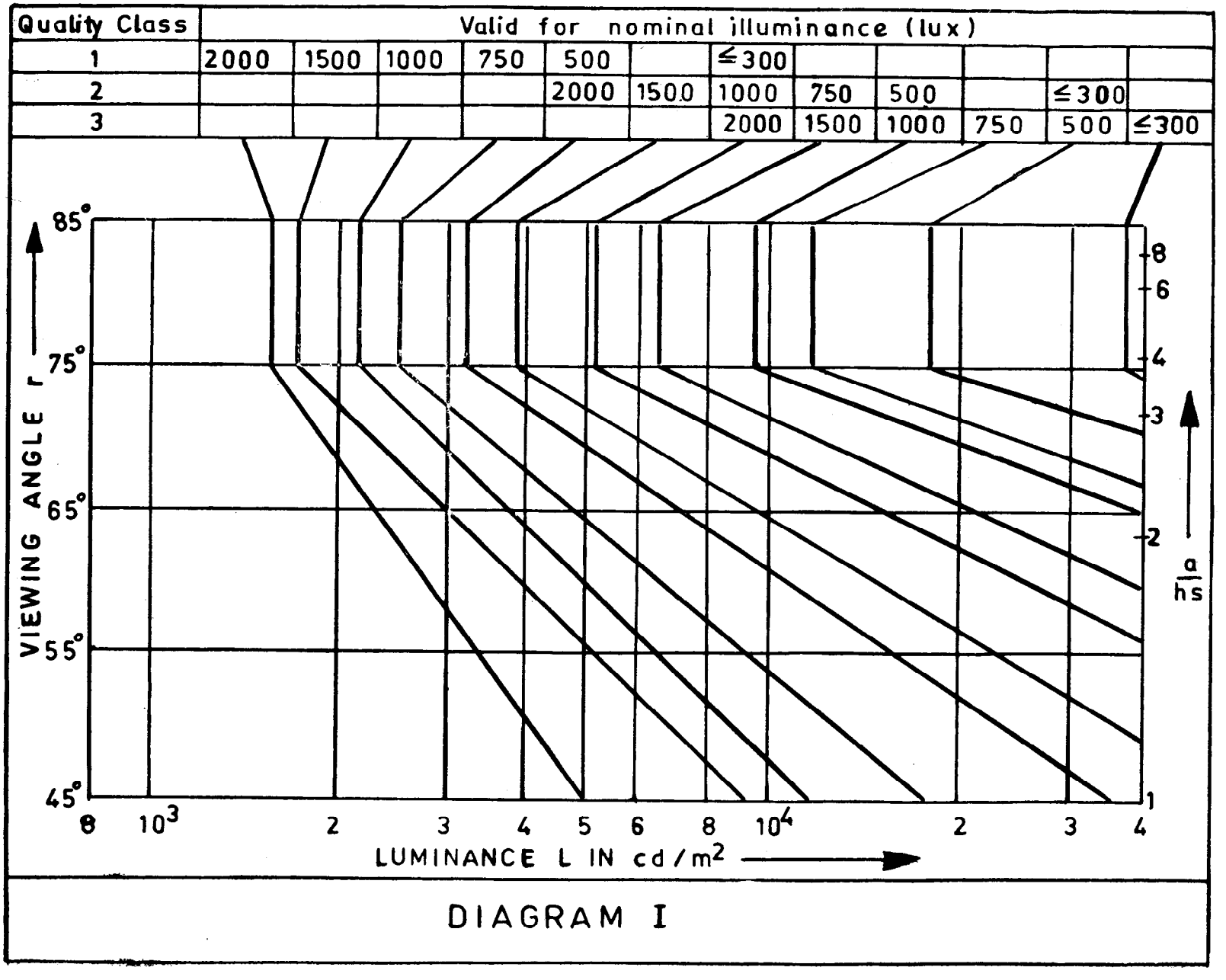

DIAGRAM I

FIG. 2 LUMINANCES LIMITING CURVES — *Continued*

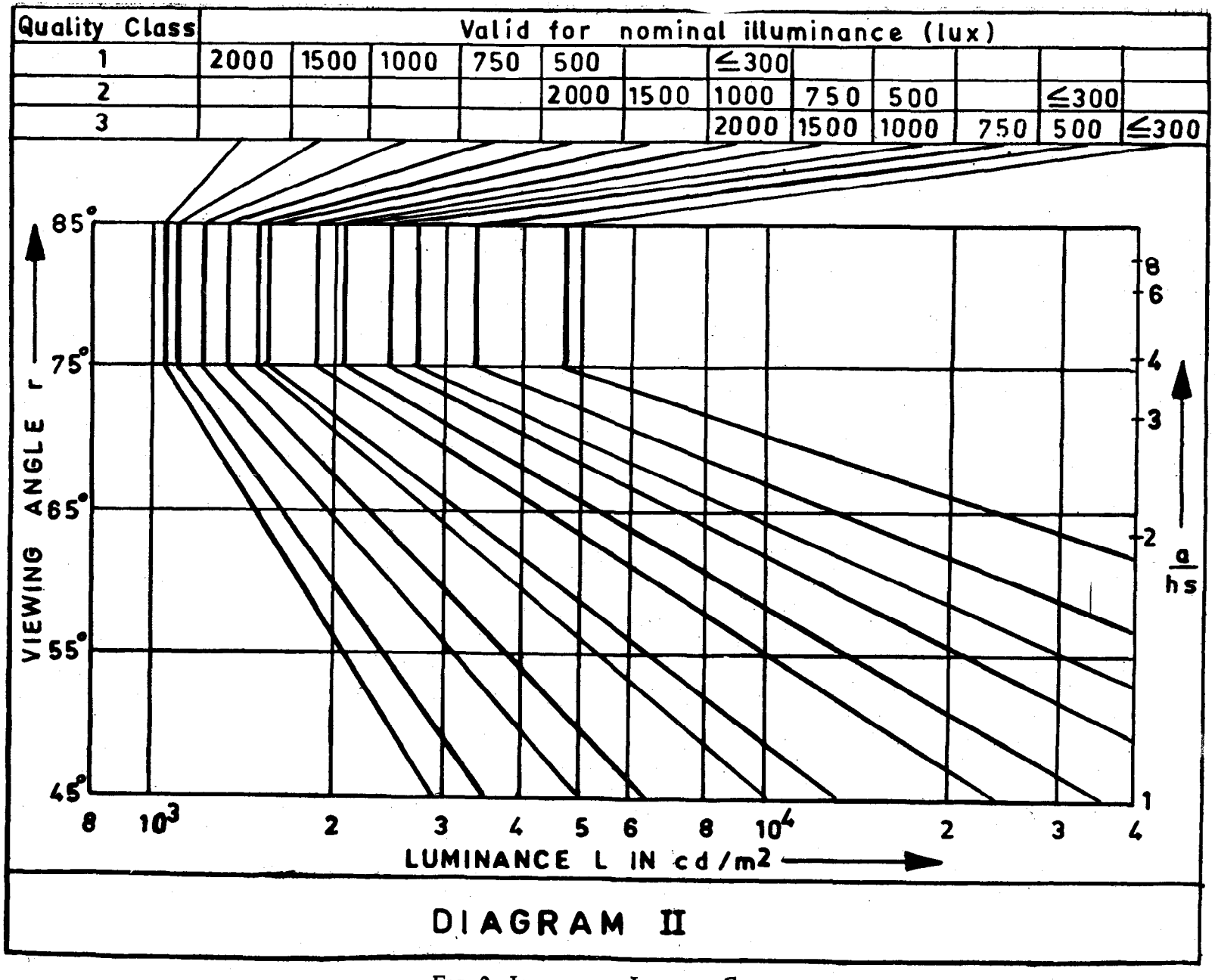

FIG. 2 LUMINANCES LIMITING CURVES

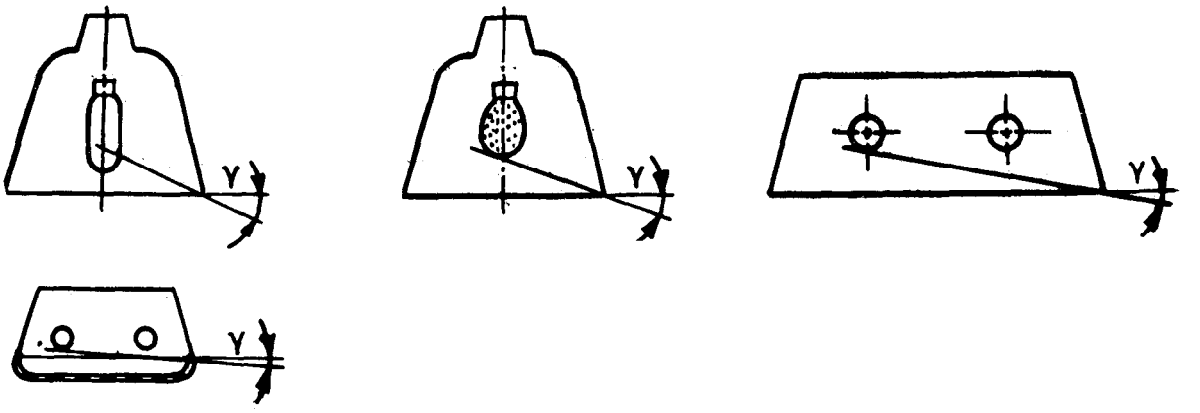

FIG. 3 FOR DEFINITION OF THE MINIMUM SHIELDING ANGLE

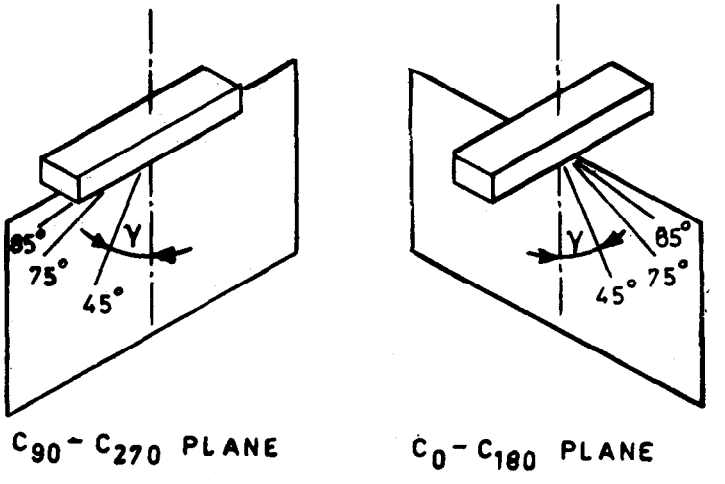

FIG. 4 C PLANES AND γ LIGHT RADIATION RANGE FOR WHICH THE LUMINANCES OF THE LUMINAIRE HAVE TO BE KNOWN

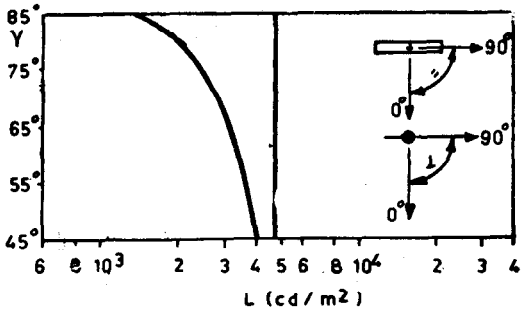

FIG. 5 LUMINANCE DISTRIBUTION CURVES OF A TYPICAL LUMINAIRE, LENGTHWISE AND CROSSWISE

4.4.2.8 *Restriction of veiling reflections*

The veiling reflections shall be reduced by adopting the following guidelines:

a) By proper orientation and positioning of the workers;

b) By proper positioning of the luminaires on either side and behind the worker; and

c) Where possible the written or printed task should be on matt paper using non-glossy ink. Use of glossy paper stock and hard pencils should be minimized.

4.5 Shadows and Modelling

The appearance of interiors is improved when their structural features and the objects and people within them are lighted so that shapes are revealed clearly and pleasingly and shadows are formed without confusion. This occurs when the light flows noticeably more in one direction than in any other. The term modelling is used to describe the way in which the shapes of three dimensional objects are revealed by lighting.

Requirements for revealing shape and texture for some specific types of task may be special and experiments may be necessary in these cases to establish the best solution.

4.6 Stroboscopic Effect and Flicker

The strength of any stroboscopic effect depends on the frequency, regularity and the amplitude of the oscillation in luminous flux relative to the frequency and regularity of the movement of the object. The flicker is the source of distraction and discomfort to people, particularly as it is easily detected by peripheral vision and thus, cannot be readily avoided. Wherever a significant stroboscopic effect and flickering is possible, the lighting should always be designed to minimize such effects for reasons of safety.

4.7 Colour Appearance and Colour Rendering Groups of Lamps

The colour of light emitted by a 'near white' source can be indicated by its correlated colour temperature (CCT). Each lamp type has a specific correlated colour temperature, but for practical use the correlated colour temperatures have been grouped into three classes (*see* Table 4). The choice of appropriate apparent colour of light source in a room is largely determined by the function of the room. This may involve such psychological aspects of the colour as the impression given of warmth, relaxation, clarity, etc, and more mundane considerations such as the need to have a colour appearance compatible with daylight and yet to provide a white colour at night. The ability of the light source to render colours of surfaces accurately may be conveniently quantified by the general colour rendering index. The colour rendering groups of the various lamps to be used for lighting of interiors are specified in Table 4.

5 LIGHTING SYSTEMS

5.1 General

Once the general requirements of the lighting installation and the room to be lighted are known, an analysis of the visual task may lead to more special requirements for the illumination of the interior. This will determine the choice of lighting system to be used and the location and arrangement of the luminaires.

5.2 Choice of Lighting System

5.2.1 *General Lighting*

General lighting produced by a regular array of luminaires with or without an indirect component results in a specific horizontal illuminance with a certain uniformity. In some situations, luminaires with a special light distribution are preferred so that the light comes predominantly from one direction.

5.2.2 *Localized General Lighting*

As an alternative to arrangements of uniformly spaced luminaires advantages in cost and energy saving can sometimes be realized by relating the light to the working zones.

5.2.3 *Local Lighting*

This can be provided by additional luminaires placed at a small distance from the visual task, which illuminate only a limited area. In industrial cases, this is often referred to as supplementary lighting.

Local lighting is recommended for working areas when:

- The work involves very critical visual task, especially where the increased illuminance is required only on restricted areas;
- Perception of forms and textures requires strongly directional light;
- The general lighting does not penetrate to certain places because of obstructions;
- Higher illminances are necessary for people with reduced eye sight; or
- It is necessary to compensate for contrast reductions caused by the general lighting.

5.2.4 *Choice of Lamp*

The designer shall choose appropriate types of lamp(s) suited for the specific application and satisfying the design objectives. Adjacent areas shall not be lit with sources of significantly different apparent colour unless a special effect is required.

Table 4 Correlated Colour Temperature

(*Clause* 4.7)

Correlated Colour Temperature (CCT) (1)	CCT Class (2)
CCT $\leq$ 3300 K	Warm
3300 K $<$ CCT $\leq$ 5300 K	Intermediate
5300 K $<$ CCT	Cold

Colour Rendering Groups	CIE General Colour Rendering Index (Ra)	Typical Application
1A	Ra $\geq$ 40	Wherever accurate colour matching is required, for example, colour printing inspection
1B	80 $\leq$ Ra $<$ 90	Wherever accurate colour judgements are necessary and/or good colour rendering is required for reasons of appearance, for example, shops and other commercial premises
2	60 $\leq$ Ra $<$ 80	Wherever moderate colour rendering is required
3	40 $\leq$ Ra $<$ 60	Wherever colour rendering is of little significance but marked distortion of colour is unacceptable
4	20 $\leq$ Ra $<$ 40	Wherever colour rendering is of no importance at all and marked distortion of colour is acceptable

5.2.5 *Choice of Luminaire*

In the choice of luminaire, the designer can exercise a combination of professional judgement, personal preference and economic analysis. Luminaires may have to withstand a variety of physical conditions, such as vibration moisture, dust, ambient temperature, vandalism and so on. In addition, the onous is on the designer to specify a safer equipment.

6 LIGHTING MAINTENANCE SCHEDULE AND LIGHT LOSS FACTOR

6.1 Illuminance Depreciation

Illuminance values obtained as an average during the maintenance cycle are always less than the initial illuminances by a ratio depending on the characteristics of the installation. This loss of light can be considered under three headings.

6.1.1 *Lamp Lumen Depreciation and Failure*

The luminous flux emitted by all-lamps decreases with time of use but the rate of decrease varies widely between lamp types.

Figure 6 shows typical shapes of lumen depreciation curves; accurate data for specific cases shall be obtained from lamp manufacturers.

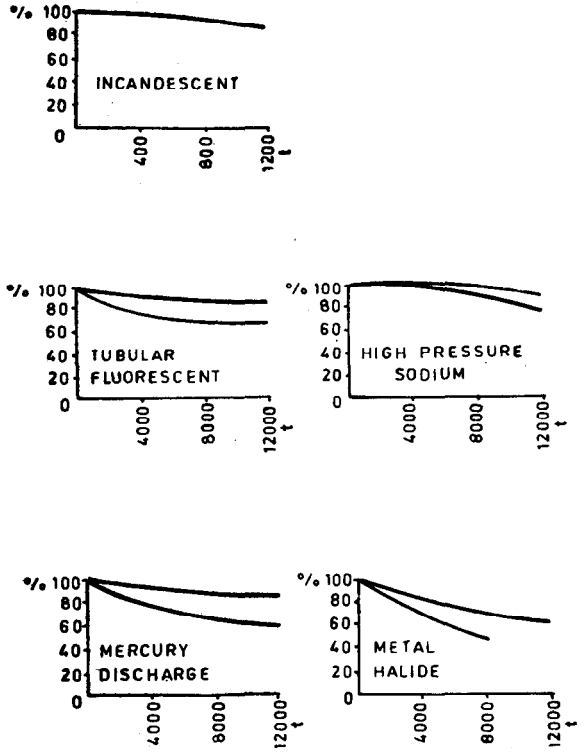

FIG. 6 SHOWS TYPICAL SHAPES OF LUMEN DEPRECIATION CURVES; ACCURATE DATA FOR SPECIFIC CASES SHOULD BE OBTAINED FROM LAMP MANUFACTURERS

It should be noted that this data will be based on certain assumptions regarding operating conditions and one or more of the following factors may influence the rate of depreciation:

a) Ambient temperature;

b) Lamp operating position;

c) Supply voltage; and

d) Type of control gear used, if relevant.

Eventually most types of lamp will cease to operate and a typical morality curve is shown in Fig. 7. However, with many categories, the useful life should be determined from the lumen

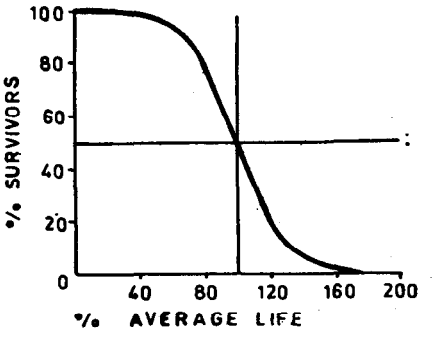

FIG. 7 TYPICAL LAMP MORALITY CURVE (*See also* TABLE 5)

depreciation curves, as the lamps often cease to be economically viable before they finally fail.

6.1.2 *Luminaire Depreciation*

The lamp lumen depreciation mentioned above takes place even if the lamp is perfectly clean, but in practice further light loss results from the accumulation of dirt on the surfaces of the lamp and luminaire. The rate at which this soiling occurs depends mainly on the type of luminaire, the nature of the interior and the location of the building. Table 5 shows a range of possibilities for each of these factors and gives appropriate category letters. Figure 8 shows the relationship between these categories and the continuing depreciation in light output.

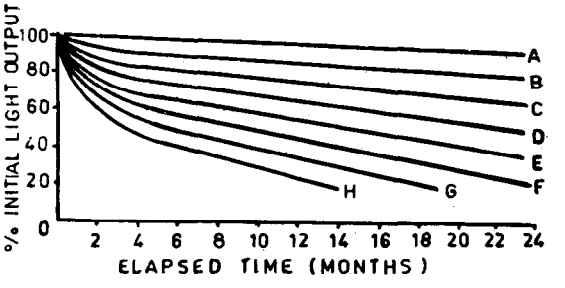

FIG. 8 LUMINAIRE MAINTENANCE FACTOR PLOTTED AGAINST ELAPSED TIME FOR DIFFERENT LUMINAIRE/ACTIVITY/LOCATION CATEGORIES (*See also* TABLE 5)

6.1.3 *Room Surface Depreciation*

In majority of cases the illuminance produced on the relevant surfaces in an interior depends to some extent on inter-reflection from surfaces in the room. The proportion of illuminance so produced will be governed by the light distribution of the luminaires and the reflectance of the relevant surfaces.

Luminaires with a high proportion of direct illuminanee, such as down-lighters, will not be much affected by inter-reflection but indirect schemes will be totally dependent on it. With the passage of time, dirt deposited on the room surfaces will reduce their reflectance and this will result in loss of illuminance. Fig. 9 shows typical curves with room surface loss factor plotted against elapsed time for various room categories.

6.2 Light Loss Factor (LLF)

6.2.1 The light loss factor (LLF) is the ratio of the illuminance produced by the same installation when new. It estimates the effect on the illuminance provided by the installation of the fall in the lamp luminous flux with hours of use and the depreciation caused by dirt deposited on luminaires and room surfaces. Light loss factor is, therefore, product of three other factors.

Light loss factor = Lamp lumen maintenance factor × Luminaire maintenance factor × Room surface maintenance factor

6.2.1.1 The lumen output from nearly all types of lamps reduces with time. The reduction in light output that occurs with time varies for different lamp types and manufacturers' data should be consulted in this regard.

The other two factors, namely, luminaire maintenance factor and room surface maintenance factor depend on the rate of accumulation of dust in the interior concerned. No definite data in this regard may be available for most interiors. On the other hand, the lighting design has to be based on definite value of LLF, since the number of luminaires to be installed for a given service illuminance will depend on it. In the context of the necessity to conserve energy, it is desirable to set certain norms for the light loss factor so as to avoid having to install an unnecessarily high lighting load. At the same time, a reasonable interval between clearing schedule has to be allowed for. It is, therefore, recommended that in interiors with fairly clean atmosphere, for example, offices, air-conditioned factory interiors, etc, a light loss factor of 0·8, in interiors which are prone to accumulate dust faster, for example, most industrial interiors, an LLF of 0·7 and in highly dirt-prone interiors an LLF of 0·6 may be adopted for calculating the number of luminaires to be installed for a particular service illuminance. It will also mean that the average illuminance should be measured at intervals after the installation is commissioned and as soon as it reaches a predetermined level below the designed service illuminance, the cleaning schedule is due. Thereafter, the cleaning should be carried out at regular intervals of similar period so as to ensure that the designed service illuminance is maintained.

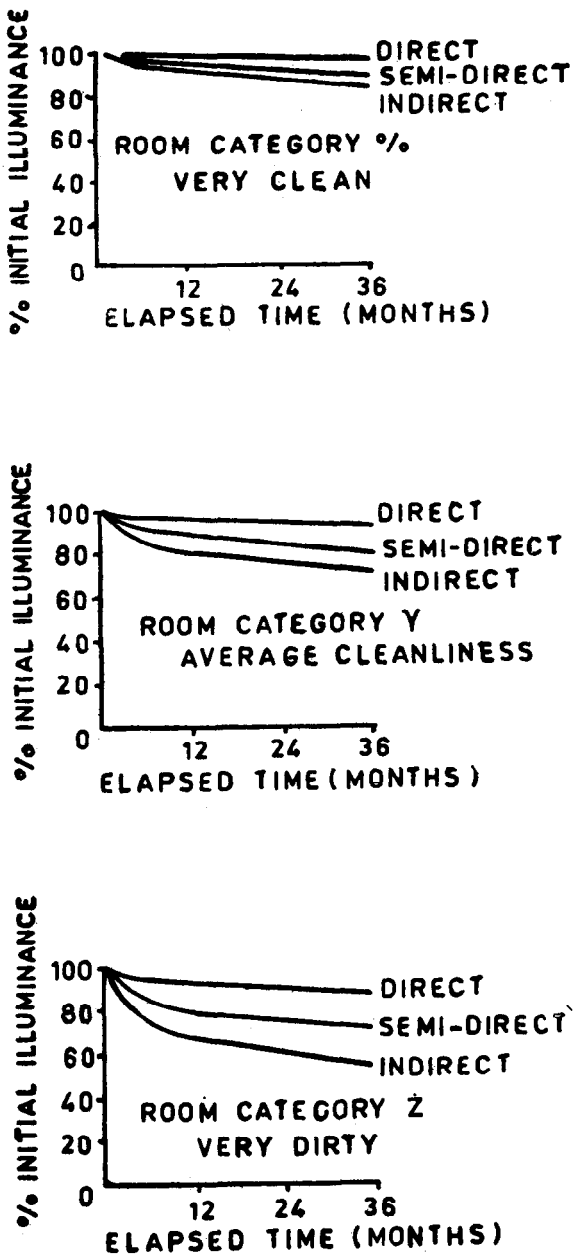

FIG. 9 ROOM SURFACE LOSS FACTOR PLOTTED AGAINST ELAPSED TIME

Table 5 Luminaire/Activity/Location Categories

(*Clause* 6.1.2)

Premises	Location	Room Category Group*	Bare Lamp Batten	Open Ventilated Reflector	Dust Tight, Dust Proof or Reflector Lamp	Open Non-ventilated Reflector, Enclosed Diffuser	Open Base Diffuser or Louvre	Recessed Diffuser or Louvre, Diffusing or Louvred-Luminious-Ceiling	Indirect Cornice
Oiffices, shops stores, clean laboratories, factories, schools, etc	All air-conditioned buildings	X	A	A	A	A/D	A/B	A	B
	Clean country area	X	A/B	A/B	A/B	B	A/B	B	C/D
	City or town outskirts	Y	B	B	B	C	B/C	B	E
	City or town centre	Y	B/C	B/C	B/C	C/D	C	B/C	F/G
	Dirty industrial area	Y	C	C	B/C	D	C/D	C	G
Factories, laboratories, manufacturing, areas, machine shops, etc	All air-conditioned buildings	X	A/B	A	A	C	B/C	B	B/C
	Clean country area	Y	B	A/B	B	C/D	C	B/C	D/E
	City or town outskirts	Y	B/C	B	B	D	C/D	C	F
	City or town centre	Y	C	B/C	B/C	D/E	D	C/D	G
	Dirty industrial area	Z	C/D	C	C	E	D/E	D	H
Steelworks, foundries, welding shops, mines, etc	All air-conditioned buildings	X	B	A/N	A/B	D	C/D	C	—
	Clean country area,	Y	C	B/C	B	D/E	D	C/D	—
	City or town outskirts	Y	C/D	C	B/C	E	D/E	D	—
	City or town centre	Z	D	C/D	B/C	E/F	E	D/E	—
	Dirty industrial area	Z	D/E	D	C	F	E/F	E	—

*Location	*Room Category*
Particularly clean	X
Average	Y
Paticularly dirty	Z

6.2.2 *Use of Light Loss Factor*

The light loss factor can be used in the lumen method of illuminance calculation to estimate what the illuminance produced by the installation will be at any particular stage in its life. This is achieved by the following formula:

$$E = \frac{\phi_{in} \times n \times N \times U \times LLF}{A}$$

where

E = Illuminance in lux;

ϕ_{in} = Initial luminous flux of the light source;

n = Number of lamps per luminaire;

N = Number of luminances;

A = Area to be lit (in m^2);

U = Utilization factor for type of luminaire in specific room conditions; and

LLF = Light loss factor.

By calculating the light loss factor for different maintenance patterns, it is possible to predict the pattern of illuminance produced by the installation in relation to elapsed time. This pattern may be used to assess the merits of alternative maintenance schedules.

6.3 Other Aspects of Maintenance

6.3.1 *Deterioration of Luminaires*

Even with proper cleaning, there will be gradual decreases in the output of luminaires.

This is due to the deterioration of the reflecting surfaces and transmitting materials. Here again there is an economic relationship between the choice of materials and the length of life.

6.3.2 *Deterioration of Room Surfaces*

Despite regular cleaning, there will still be a gradual decrease in the reflectance of most surfaces of rooms in common use.

With painted surfaces, there should be a repainting schedule allowed for at the planning stage.

Obviously, this should be taken into consideration when the initial choice of room surface finishes is being made.

6.4 Maintenance Schedule

In a large installation it may be preferable to replace all the lamps at an agreed time rather than separately as they fail. Individual replacement is usually expensive, can be a nuisance in busy areas of a building and may result in noticeable differences in lamp colour and luminance.

The economic cleaning interval for a given installation will depend on the type of luminaire, on the rate of dirt accumulation and on the cost of cleaning. For the maximum economic advantage, the luminaire clearing interval should be arranged to relate to the lamp replacement interval.

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