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CODE OF PRACTICE FOR DAYLIGHTING OF FACTORY BUILDINGS

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

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Indian Standard

CODE OF PRACTICE FOR DAYLIGHTING OF FACTORY BUILDINGS

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Indian Standard

CODE OF PRACTICE FOR DAYLIGHTING OF FACTORY BUILDINGS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 15 March 1971, after the draft finalized by the Functional Requirements in Buildings Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Utilization of daylight for performing any visual task is healthy and economical. The amount of light required for satisfactory and strain-free performance of the task depends on the nature of task itself and on other factors like contrast, detail, fineness of work and visual acuity. Small variations of illumination are taken care of by the adjustment of the pupil of the eye but large variations result in undesirable eye strain. These considerations apart, changes in daylight intensity from sunrise to sunset provide a harmonious variation of the visual environment inside or outside a building normally welcomed in the performance of visual task.

0.3 In this country, during most part of the year, the sky is clear and sunshine plentiful. Proper utilization of daylighting to get appropriate illumination levels on the working plane in factories will result in considerable economy consistent with efficiency of production and worker's well-being. The Central Building Research Institute, Roorkee has been carrying out research and measurements of daylight requirements for factory buildings and it is as a result of the investigations made that this standard is being prepared.

0.4 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

0.5 This standard is one of a series of Indian Standards on daylighting of buildings. Other standards published so far in the series are:

IS : 2440-1968 Code of practice for daylighting of buildings (*first revision*)

IS : 3646 (Part I)-1966 Code of practice for interior illumination: Part I Principles of good lighting and aspects of design

IS : 3646 (Part II)-1966 Code of practice for interior illumination: Part II Schedule for values of illumination and glare index

0.6 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.

1. SCOPE

1.1 This standard deals with daylighting requirements inside factory buildings in the tropics and various factors that contribute to illumination on the working plane.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms given in IS : 2440-1968† shall apply.

3. RECOMMENDED VALUES OF ILLUMINATION

3.1 The recommended values of illumination for various tasks in factory building are given in Table 1. To get daylight factors from lux value divide these by 80.

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION

(*Clauses* 3.1 *and* 4.1)

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
1)	*General Factory Areas*		
	a) Canteens	150	1·88
	b) Cloakrooms	100	1·25
	c) Entrances, corridors and stairs	100	1·25
2)	*Aircraft Factories and Maintenance Hangers*		
	a) Stock parts productions	450	5·62
	b) Drilling, riveting, screw fastening, sheet aluminium layout and template work, wing sections cowling, welding, sub-assembly, final assembly and inspection	300	3·75
	c) Maintenance and repairs (hangers)	300	3·75
3)	*Assembly Shops*		
	a) Rough work, for example, frame assembly and assembly of heavy machinery	150	1·88

(*Continued*)

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

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

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
	b) Medium work, for example, machined parts, engine assembly and vehicle body assembly	300	3·75
	c) Fine work, for example, radio and telephone equipment, typewriter and office machinery assembly	700	8·75
	d) Very fine work, for example, assembly of very small precision mechanisms and instruments	1 500*	18·75
4)	*Bakeries*		
	a) Mixing and make-up rooms, oven rooms and wrapping rooms	150	1·88
	b) Decorating and icing	200	2·50
5)	*Boiler Houses (Industrial)*		
	a) Coal and ash handling	100	1·25
	b) Boiler rooms:		
	1) Boiler fronts and operating areas	100†	1·25
	2) Other areas	20 to 50	0·25 to 0·62
6)	*Bookbinding*		
	a) Pasting, punching and stitching	200	2·50
	b) Binding and folding — miscellaneous machines	300	3·75
	c) Finishing, blocking and inlaying	300	3·75
7)	*Boot and Shoe Factories*		
	a) Sorting and grading	1 000‡	12·50
	b) Clicking and closing and preparatory operations	700	8·75
	c) Cutting table and presses and stitching	1 000	12·50
	d) Bottom stock preparation, lasting and bottoming and finishing	700	8·75
	e) Shoe rooms	700	8·75
8)	*Breweries and Distilleries*		
	a) General working areas	150	1·88
	b) Brewhouse, bottling and canning plants	200	2·50
	c) Bottle inspection	Special lighting	

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

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
9)	*Canning and Preserving Factories*		
	a) Inspection of beans, rice, barley, etc	450	5·62
	b) Preparation, kettle areas, mechanical cleaning, dicing and trimming	300	3·75
	c) Canned and bottled goods: retorts	200	2·50
	d) High speed labelling lines	300	3·75
	e) Can inspection	450	5·62
10)	*Carpet Factories*		
	a) Winding and beaming	200	2·50
	b) Designing, jacquard card cutting, setting pattern, tufting, topping, cutting, hemming and fringing	300	3·75
	c) Weaving and mending inspection	450	5·62
11)	Ceramics (*see* Pottery)		
12)	*Chemical Works*		
	a) Hand furnaces, boiling tanks, stationery driers, stationery of gravity crystallizers, mechanical driers, evaporators, filtration plants, mechanical crystallizing, bleaching, extractors, percolators nitrators and electrolytic cells	150	1·88
	b) Controls, gauges, values, etc	100*	1·25
	c) Control rooms:		
	1) Vertical control panels	200 to 300	2·50 to 3·75
	2) Control desks	300	3·75
13)	*Chocolate and Confectionery Factories*		
	a) Mixing, blending, boiling	150	1·88
	b) Chocolate husking, winnowing, fat extraction, crushing and refining and feeding	200	2·50
	c) Hand decorating, inspection, wrapping and packing	300	3·75
14)	*Clothing Factories*		
	a) Matching-up	450†	5·62
	b) Cutting, sewing:		
	1) Light	300	3·75
	2) Medium	450	5·62

*Supplementary local lighting may be required for gauge glasses and instrument panels.

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

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
	3) Dark	700	8·75
	4) Pressing	300	3·75
	c) Inspection:		
	1) Light	450	5·62
	2) Medium	1 000	12·50
	3) Dark	1 500	18·75
	d) Hand tailoring		
	1) Light	450	5·62
	2) Medium	1 000	12·50
	3) Dark	1 500	18·75
15)	*Collieries (Surface Buildings)*		
	a) Coal preparation plant:		
	1) Working areas	150	1·88
	2) Other areas	100	1·25
	3) Picking belts	300	3·75
	4) Winding houses	150	1·88
	b) Lamp rooms:		
	1) Main areas	100	1·25
	2) Repair sections	150	1·88
	3) Weigh cabins	150	1·88
	c) Fan houses		
16)	*Dairies*		
	a) General working areas	200*	2·50
	b) Bottle inspection	Special lighting	
	c) Bottle filling	450	5·62
17)	*Die Sinking*		
	a) General	300	3·75
	b) Fine	1 000	12·50
18)	*Dye Works*		
	a) Reception, ' grey ' perching	700	8·75

*Supplementary local lighting may be required for sight glasses.

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
	b) Wet processes	150*	1·88
	c) Dry processes	200*	2·50
	d) Dyers' offices	700†	8·75
	e) Final perching	2 000†	25·00
19)	*Electricity Generating Stations: Indoor Locations*		
	a) Turbine halls	200	2·50
	b) Auxiliary equipment; battery rooms, blowers, auxiliary generators, switchgear and transformer chambers	100	1·25
	c) Boiler houses (including operating floors) platforms, coal conveyors, pulverizers, feeders, precipitators, soot and slag blowers	70 to 100	0·88 to 1·25
	d) Boiler house and turbine house	100	1·25
	e) Basements	70	0·88
	f) Conveyor houses, conveyor, gentries and junction towers	70 to 100	0·88 to 1·25
	g) Control rooms:		
	1) Vertical control panels	200 to 300	2 50 to 3·75
	2) Control desks	300	3·75
	3) Rear of control panels	150	1·88
	4) Switch houses	150	1·88
	h) Nuclear reactors and steam raising plants:		
	1) Reactor areas, boilers and galleries	150	1·88
	2) Gas Circulator bays	150	1·88
	3) Reactor charge/discharge face	200	2·50
20)	*Electricity Generating Stations: Outdoor Locations*		
	a) Coal unloading areas	20	0·25
	b) Coal storage areas	20	0·25
	c) Conveyors	50	0·62
	d) Fuel oil delivery headers	50	0·62
	e) Oil storage tanks	50	0·62
	f) Catwalks	50	0·62
	g) Platforms, boiler and turbine decks	50	0·62
	h) Transformers and outdoor switchgear	100	1·25

*Supplementary local lighting should be used where necessary.
†Special attention should be paid to the colour quality of the light.

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
21)	*Engraving*		
	a) Hand	1 000	12·50
	b) Machine (*see* Die sinking)		
22)	*Farm Buildings (Dairies)*		
	a) Milk rooms	50	0·62
	b) Washing and sterilizing rooms	150	1·88
	c) Milking parlours	150	1·88
23)	*Flour Mills*		
	a) Roller, purifier, silks and packing floors	150	1·88
	b) Wetting tables	300	3·75
24)	*Forges*		
	General	150	1·88
25)	*Foundries*		
	a) Charging floors tumbling, cleaning, pouring, shaking out, rough moulding and rough core making	150	1·88
	b) Fine moulding and core making and inspection	300	3·75
26)	*Garages*		
	a) Parking areas (interior)	70	0·88
	b) Washing and polishing, greasing, general servicing and pits	150	1·88
	c) Repairs	300	3·75
27)	*Gas Works*		
	a) Retort nouses, oil gas plants, water gas plants, purifiers, coke screening and coke handling plants (indoor)	30 to 50*	0·38 to 0·50
	b) Governor-, meter-, compressor-, booster- and exhauster-houses	100	1·25
	c) Open type plants :		
	1) Catwalks	20*	0·25
	2) Platforms	50*	0·62

Supplementary local lighting should be used at important points.

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
28)	*Gauge and Tool Rooms*		
	General	700*	8·75
29)	*Glass Works and Processes*		
	a) Furnace rooms, bending and annealing lehrs	100	1·25
	b) Mixing rooms and forming (blowing, drawing, pressing, rolling)	150	1·88
	c) Cutting to size, grinding, polishing and toughening	200	2·50
	d) Finishing (bevelling, decorating, etching, silvering)	300	3·75
	e) Brilliant cutting	700	8·75
	f) Inspection :		
	1) General	200	2·50
	2) Fine	700	8·75
30)	*Glove Making*		
	a) Pressing, knitting, sorting cutting	300	3·75
	b) Sewing :		
	1) Light	300	3·75
	2) Medium	450	5·62
	3) Dark	700	8·75
	c) Inspection :		
	1) Light	450	5·62
	2) Medium	1 000	12·50
	3) Dark	1 500	18·75
31)	*Hat Making*		
	a) Stiffening, braiding, cleaning, refining, forming, sizing, pouncing, flanging, finishing and ironing	150	1·88
	b) Sewing :		
	1) Light	300	3·75
	2) Medium	450	5·62
	3) Dark	700	8·75
32)	*Hosiery and Knitwear*		
	a) Circular and flat knitting machines universal winders, cutting out, folding and pressing	300	3·75

*Supplementary local lighting and optical aide should be used where necessary.

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION—*Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(3)	(3)	(4)
	b) Lock stitch and overlocking machines :		
	1) Light	300	3·75
	2) Medium	450	5·62
	3) Dark	700	8·75
	c) Mending	1 500	18·75
	d) Examining and hand finishing light, medium and dark	700	8·75
	e) Linking or running-on	450	5·62
33)	*Inspection Shops (Engineering)*		
	a) Rough work, for example, counting and rough checking of stock parts	150	1·88
	b) Medium work for example, 'Go' and 'No-Go' gauges and sub-assemblies	300	3·75
	c) Fine work, for example, radio and telecommunication equipment, calibrated scales, precision mechanisms and instruments	700	8·75
	d) Very fine work, for example, gauging and inspection of small intricate parts	1 500	18·75
	e) Minute work, for example, very small instruments	3 000*	37·50
34)	*Iron and Steel Works*		
	a) Stairs, gangways basements, quarries and loading docks	100	1·25
	b) Slab yards, melting shops, ingot stripping, soaking pits, blast furnace working areas and picking and cleaning lines, mechanical plant and pump houses	100	1·25
	c) Mould preparation, rolling and wire mills, mill motor rooms, power and blower houses	150	1·88
	d) Slab inspection and conditioning, cold strip mills, sheet and plate finishing, tinning, glavanizing, machine and roll shops	200	2·50
	e) Plate inspection	300	3·75
	f) Tinplate inspection	Special lighting	
35)	*Jewellery and Watchmaking*		
	a) Time processes	700*	8·75
	b) Minute processes	3 000*	37·50

*Optical aids should be used where necessary.

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION—*Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
	c) Gem cutting, polishing and setting	1 500*	18·75
36)	*Laboratories and Test Rooms*		
	a) General laboratories and balance rooms	300	3·75
	b) Electrical and instrument laboratories	450	5·62
37)	*Laundries and Drycleaning Works*		
	a) Receiving, sorting, washing, drying, ironing (calendering) and despatch	200	2·50
	b) Drycleaning and bulk machine work	200	2·50
	c) Fine hand ironing, pressing, inspection, mending and spotting	300	3·75
38)	*Leather Dressing*		
	a) Vats, cleaning, tanning, stretching, cutting, fleshing and stuffing	150	1·88
	b) Finishing, staking, splitting and scarfing	200	2·50
39)	*Leather Working*		
	a) Pressing and glazing	450	5·62
	b) Cutting, scarfing and sewing	700	8·75
	c) Grading and matching	1 000†	12·50
40)	*Machine and Fitting Shops*		
	a) Rough bench and machine work	150	1·88
	b) Medium bench and machine work, ordinary automatic machines, rough grinding, medium buffing and polishing	300	3·75
41)	*Motor Vehicle Plants*		
	a) General sub-assemblies, chassis assembly and car assembly	300	3·75
	b) Final inspection	450	5·62
	c) Trim shops, body sub-assemblies and body assembly	300	3·75
	d) Spray booths	450	5·62
42)	*Paint Works*		
	a) General and automatic processes	200	2·50

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

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
	b) Special batch mixing	450	5·62
	c) Colour matching	700*	8·75
43)	*Paint Shops and Spraying Booths*		
	a) Dipping, firing, rough spraying	150	1·88
	b) Rubbing, ordinary painting, spraying and finishing	300	3·75
	c) Fine painting, spraying and finishing	450	5·62
	d) Retouching and matching	700*	8·75
44)	*Paper Works*		
	a) Paper and board making:		
	1) Machine houses, calendering, pulp mills, preparation plants, cutting, finishing and trimming	200	2·50
	2) Inspection and sorting (overhauling)	300	3·75
	b) Paper converting processes:		
	1) Corrugated board, cartons, containers and paper sack manufacture, coating and laminating processes	200	2·50
	2) Associated printing	300	3·75
45)	*Pharmaceuticals and Fine Chemical Works*		
	a) Raw material storage	200	2·50
	b) Control laboratories and testing	300	3·75
	c) Pharmaceuticals manufacturing: grinding, granulating, mixing and drying, tableting, sterilizing and washing, preparation of solutions and filling, labelling, capping, cartoning and wrapping and inspection	300	3·75
	d) Fine chemical manufacture:		
	1) Plant processing	200	2·50
	2) Fine chemical finishing	300	3·75
46)	*Plastics Works*		
	a) Manufacture (*see* Chemical Works)		
	b) Processing:		
	1) Calendering and extrusion	300	3·75
	2) Moulding-compression and injection	200	2·50

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

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
	3) Sheet fabrication:		
	i) Shaping	200	2·50
	ii) trimming, machining, polishing	300	3·75
	iii) cementing	200	2·50
47)	*Plating Shops*		
	a) Vat and baths, buffing, polishing and burnishing	150	1·88
	b) Final buffing and polishing	Special lighting	
48)	*Pottery and Clay Products*		
	a) Grinding, filter pressing, kiln rooms, moulding, pressing, cleaning, trimming, glazing and firing	150	1·88
	b) Enamelling, colouring and decorating	450*	5·62
49)	*Printing Works*		
	a) Type foundries:		
	1) Matrix making, dressing type, hand and machine casting	200	2·50
	2) Front assembly and sorting	450	5·62
	b) Printing plants:		
	1) Machine composition, imposing stones	200	2·50
	2) Presses	300	3·75
	3) Composing room	450	5·62
	4) Proof-reading	300	3·75
	c) Electrotyping:		
	1) Block-making, electroplating and washing, backing	200	2·50
	2) Moulding, finishing and routing	300	3·75
	d) Photo-engraving:		
	1) Block-making, etching and masking	200	2·50
	2) Finishing and routing	300	3·75
50)	*Rubber Processing*		
	a) Fabric preparation creels	200	2·50
	b) Dipping, moulding, compounding and calenders	150	1·88
	c) Tyre and tube making	200	2·50

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

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
51)	*Sheet Metal Works*		
	a) Benchwork, scribing, pressing, punching, shearing, stamping, spinning and folding	200	2·50
	b) Sheet inspection	Special lighting	
52)	*Soap Factories*		
	a) Kettle houses and ancillaries, glycerine evaporation and distillation and continuous indoor soap making plants:		
	1) General areas	150	1·88
	2) Control panels	200 to 300	2·50 to 3·75
	b) Batch or continuous soap cooling, cutting and drying, soap milling and plodding:		
	1) General areas	150	1·88
	2) Control panels and key equipment	200 to 300	2·50 to 3·75
	c) Soap stamping, wrapping and packing, granules making, granules storage and handling, filling and packing granules:		
	1) General areas	150	1·88
	2) Control panels and machines	200 to 300	2·50 to 3·75
	d) Edible products processing and packing	200	2·50
53)	*Structural Steel Fabrication Plants*		
	a) General	150	1·88
	b) Marking off	300	3·75
54)	*Textile Mills (Cotton or Linen)*		
	a) Bale breaking, blowing, carding, roving, slubbing, spinning (ordinary counts), winding, heckling, spreading and cabling	150	1·88
	b) Warping, slashing, dressing and dyeing, doubling (fancy) and spinning (fine counts)	200	2·50
	c) Healding (drawing-in)	700	8·75
	d) Weaving:		
	1) Patterned cloths and fine counts, dark	700	8·75
	2) Patterned cloths and fine counts, light	300	3·75
	3) Plain ' grey ' cloth	200	2·50
	e) Cloth inspection	700*	8·75

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

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	
55)	*Textile Mills (Silk or Synthetics)*		
	a) Soaking, fugitive tinting, conditioning or setting of twist	200	2·50
	b) Spinning	450	5·62
	c) Winding, twisting, rewinding and coning, quilting and slashing:		
	1) Light thread	200	2·50
	2) Dark thread	300	3·75
	d) Warping	300	3·75
	e) Healding (drawing-in)	700	8·75
	f) Weaving	700	8·75
	g) Inspection	1 000*	12·50
56)	*Textile Mills (Woollen)*		
	a) Scouring, carbonizing, teasing, preparing, raising, brushing, pressing, back-washing, gilling, crabbing and blowing	150	1·88
	b) Blending, carding, combing (white), tentering, drying and cropping	200	2·50
	c) Spinning, weaving, winding, warping and combing (coloured) twisting	450	5·62
	d) Healding (drawing-in)	700	8·75
	e) Weaving:		
	1) Fine worsteds	700	8·75
	2) Medium worsteds and fine woollens	450	5·62
	3) Heavy woollens	300	3·75
	f) Burling and mending		
	g) Perching:		
	1) Grey	700	8·75
	2) Final	2 000*	25·00
57)	*Textile Mills (Jute)*		
	a) Weaving, spinning, flat, jacquard carpet looms and cop winding	200	2·50
	b) Yarn calendar	150	1·88

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

(*Continued*)

TABLE 1 RECOMMENDED VALUES OF ILLUMINATION — *Contd*

Sl No.	Industrial Buildings and Processes	Illumination Lux	Daylight Factor (DF)
(1)	(2)	(3)	(4)
58)	*Tobacco Factories*		
	All processes	300*	3·75
59)	*Upholstering*		
	Furniture and vehicles	300	3·75
60)	*Warehouses and Bulk Stores*		
	a) Large material and loading bays	100	1·25
	b) Small material and racks	150	1·88
	c) Packing and despatch	150	1·88
61)	*Welding and Soldering*		
	a) Gas and arc welding and rough spot welding	150	1·88
	b) Medium soldering, brazing and spot welding for example domestic hardware	300	3·75
	c) Fine soldering and spot welding, for example, instruments and radio set assembly	700	8·75
	d) Very fine soldering and spot welding, for example, radio valves	150	1·88
62)	*Woodworking Shops*		
	a) Rough sawing and bench work	150	1·88
	b) Sizing, planing, rough sanding, medium machine and bench work, gluing veneering and cooperage	200	2·50
	c) Fine bench and machine work, fine sanding and finishing	300	3·75

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

4. GENERAL PRINCIPLES

4.1 The design of openings, glazings and such similar sources of daylight should be so positioned as to give levels of illumination given in Table 1.

4.2 Usually north lights are employed in factories to provide the required amount of illumination on the working plane. It is to be noted that entry of direct sunlight during certain hours of the day may be a source of distraction to the workers. The duration of the direct sunlight penetration for any given latitude may be ascertained from Table 2. Location of work should be such as to avoid glare from the north light glazed openings.

TABLE 2 SUNSHINE HOURS ON NORTH FACING WALL (SOLAR TIME)

LOCATION	SEPT 23 AND MARCH 21	APRIL 16 AND AUGUST 27	MAY 16 AND JULY 28	JUNE 21
(1)	(2)	(3)	(4)	(5)
9 N. Lat (degrees)	Nil	Sunrise to sunset	Sunrise to sunset	Sunrise to sunset
11	Nil	Up to 1020 h After 1340 h	do	do
13	Nil	Up to 0915 h After 1445 h	do	do
15	Nil	Up to 0840 h After 1520 h	do	do
17	Nil	Up to 0815 h After 1545 h	do	do
19	Nil	Up to 0800 h After 1600 h	do	do
21	Nil	Up to 0740 h After 1620 h	Up to 1030 h After 1330 h	do
23	Nil	Up to 0730 h After 1630 h	Up to 0930 h After 1430 h	do
25	Nil	Up to 0725 h After 1635 h	Up to 0910 h After 1450 h	Up to 1030 h After 1330 h
27	Nil	Up to 0720 h After 1640 h	Up to 0850 h After 1510 h	Up to 1000 h After 1400 h
29	Nil	Up to 0710 h After 1650 h	Up to 0830 h After 1530 h	Up to 0920 h After 1430 h
31	Nil	Up to 0705 h After 1655 h	Up to 0820 h After 1540 h	Up to 0900 h After 1500 h
33	Nil	Up to 0700 h After 1700 h	Up to 0810 h After 1550 h	Up to 0850 h After 1510 h
35	Nil	Up to 0650 h After 1710 h	Up to 0800 h After 1600 h	Up to 0830 h After 1530 h

NOTE — The above timings are based on solar noon. To obtain local times or standard times proceed according to usual methods.

4.3 In establishments where work is carried out during dusk hours, the daylighting should be combined with artificial lighting in such a manner that the diminution of daylight is unnoticeable specially for those engaged in precision work involving eye strain.

5. LEVEL OF NATURAL ILLUMINATION

5.1 A careful interpretation of daylight factors should be made before designing the fenestration. The possibility that the required level of illumination may change due to a change in the layout caused by modification in production methods should be kept in view.

5.2 In normal circumstances factories should be designed to give atleast 1·25 percent. Daylight factor, which may exceed current requirements over part or whole of the building.

5.3 Obstructions like structural members, overhead installations, vertical and horizontal machines and the like should be considered in relation to the glazing. It is essential to foresee the proposed layout of the machines, as ignorance of this aspect is likely to cut down the light reaching the working plane.

5.4 There should be a good distribution of light over the whole interior. Unilateral systems should, therefore, be avoided when possible. Light colours should predominate on the surface of the interior, wherever practicable. In case of north light rooftruss, shadows caused at working planes by machines and operators can be minimized by providing openings in the side walls and/or by use of light coloured finish for ceiling surfaces.

6. FENESTRATION

6.1 Some examples of methods of fenestration, providing daylight are shown in Fig. 1 to 9 For these figures, the values of daylight factors include sky and reflected openings for the glare design sky, the value of 0·85 has been assumed for clause transmission.

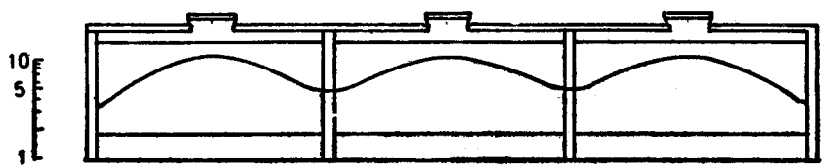


FIG. 1 CONTINUOUS HORIZONTAL ROOF LIGHTS WITH DIFFUSED GLAZING (17 PERCENT OF FLOOR AREA)

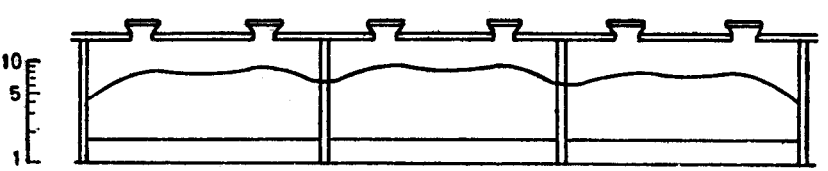


FIG. 2 CONTINUOUS HORIZONTAL ROOF LIGHTS (GLASS AREA 11·5 PERCENT OF FLOOR AREA)

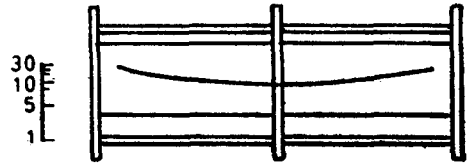


FIG. 3 SIDE GLAZING IN A MULTI-STORRY BUILDINGS (50 PERCENT OF FLOOR AREA)

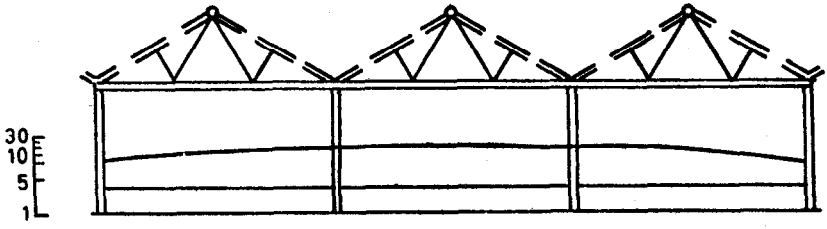
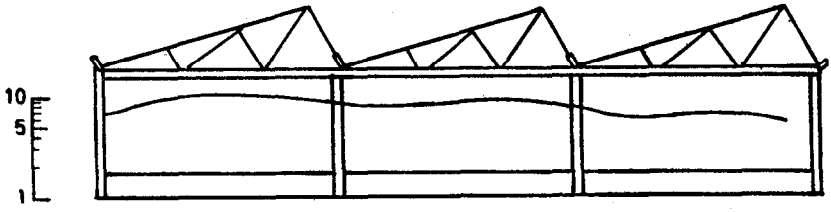
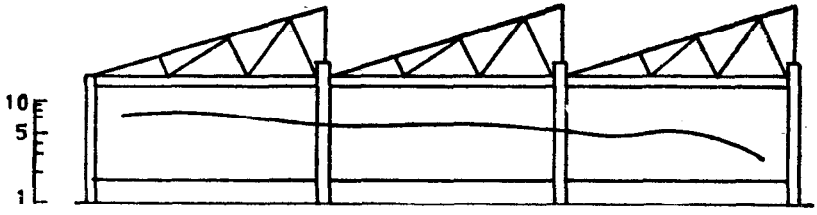


FIG. 4 SHED TYPE ROOF WITH CONTINUOUS STRIPS OF GLAZING (GLASS AREA 10 PERCENT OF FLOOR AREA)



5A Inclined Glazing



5B Vertical Glazing

FIG. 5 NORTH LIGHT ROOF LIGHTING (GLAZING 20 PERCENT OF FLOOR AREA)

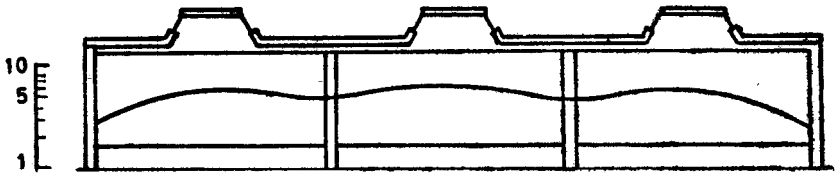


FIG. 6 MONITOR ROOF WITH 60° SLOPE GLAZING (GLASS AREA 16 PERCENT OF FLOOR AREA)

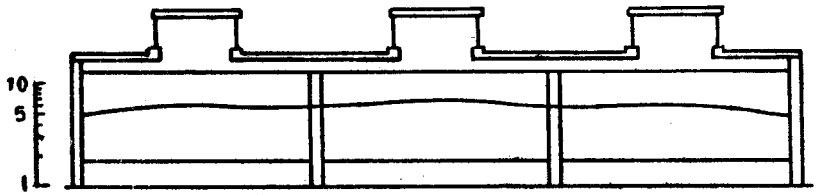


FIG. 7 MONITOR ROOF WITH VERTICAL GLAZING (GLASS AREA 30 PERCENT OF FLOOR AREA)

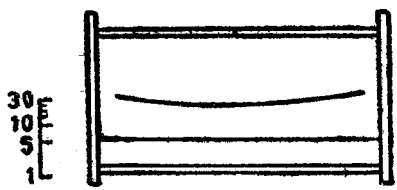


FIG. 8 SIDE GLAZING IN A MULTI-STOREY BUILDING (GLASS AREA 74 PERCENT OF FLOOR AREA)

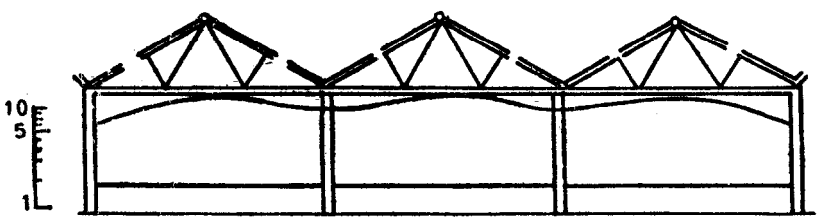


FIG. 9 SHED TYPE ROOF WITH CONTINUOUS STRIPS OF GLAZING

6.2 Allowance should be made for anything that may obstruct the light such as tall buildings, overhead equipment and large machines.

6.3 The glazing should be regularly cleaned, and means of safe and easy access provided for this purpose.

6.4 The area of glazing required for any particular level of illumination will depend primarily upon the position of fenestration adopted. The relative efficiency of different methods may be compared by calculating the ratio of glazed area to floor area in each case.

6.5 Methods using horizontal or low-pitched glazing will generally be more efficient than those using vertical or steeply sloping glass.

7. DESIGN PRINCIPLES AND DESIGN AIDS FOR NORTH LIGHTS

7.1 Since most factories employ north light as the principal source for daylighting it is useful to know the period of the day over which direct sunlight enters such fenestrations. Table 2 indicates the variation of direct sunlight entry throughout the year for several latitudes.

7.2 When the length of a bay in a north light factory exceeds its width by five times one may consider it as infinitely low for the purposes of daylighting.

7.3 The uniformity of illumination on the working plane in a north light factory depends on the width of the bay (distance between the north light openings), the slope of the roof and the reflectance of the ceiling.

7.4 The design for saw-tooth fenestrations for 2, 4, 6 or 8 bay factories can be based on Fig. 10 to 13. The factors that govern the design are given in **7.4.1** to **7.4.3**.

7.4.1 Figures 10 to 13 give the computerized results for the total working plane illumination for the types and sizes of fenestrations expressed as percentage fraction of floor area. These values are for the centre of the area in question, for factories with 2, 4, 6 or 8 north light openings and with wall and ceiling reflectances 0·5 and floor reflectance 0·3.

7.4.2 In these calculations a transmission coefficient of 0·85 has been assumed for the glazing. Presence of dust, sashes or bars, as well as beams or trusses reduces the illumination and allowance for these have to be made. Tall machinery and louvres on windows also affect the daylighting inside.

7.4.3 The values given are for the design sky corresponding to a solar altitude of 15° and an increase in daylighting occurs when the sun goes up in the sky. As a general rule on clear days this increase will be between 1·2 to 1·5 times the value given in Fig. 10 to 13 at noon time. This increase is attributable to the increase of the total illumination on the roof as well as the increase of the sky luminance.

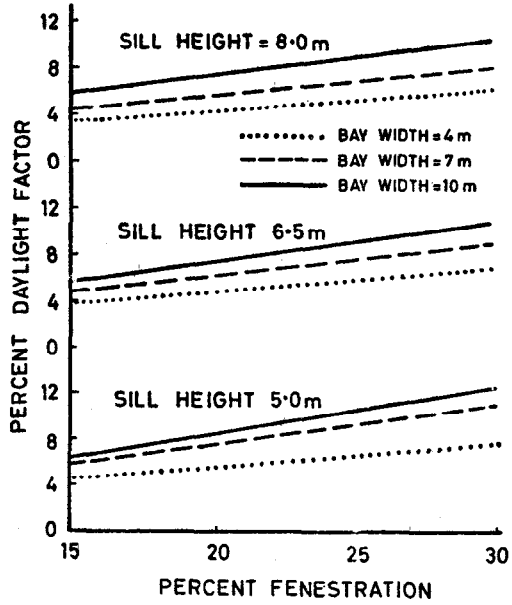


FIG. 10 WORK PLANE ILLUMINATION AT THE CENTRE OF 2-BAYS NORTH LIGHT FACTORY
(BAY WIDTH 4 m, 7 m, 10 m)

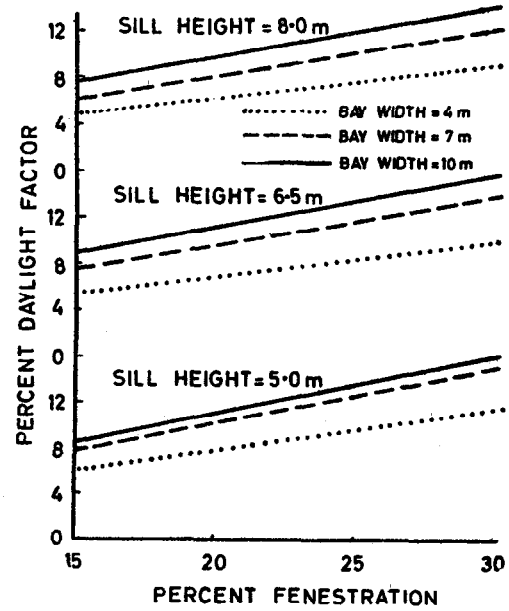


FIG. 11 WORK PLANE ILLUMINATION AT THE CENTRE OF 4-BAYS NORTH LIGHT FACTORY
(BAY WIDTH 4 m, 7 m, 10 m)

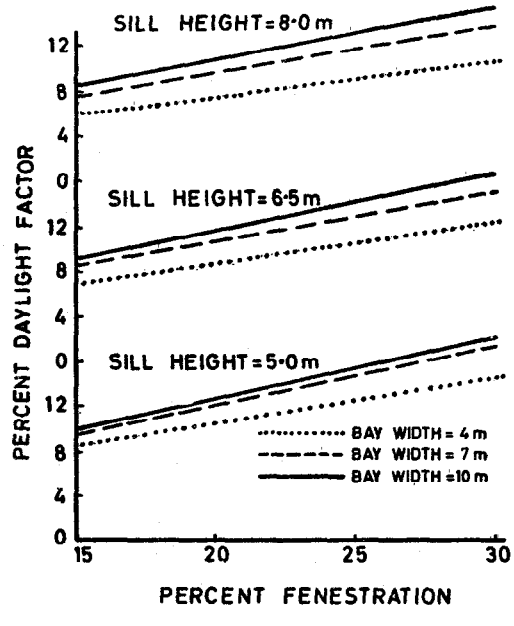


FIG. 12 WORK PLANE ILLUMINATION AT THE CENTRE OF 6-BAYS NORTH LIGHT FACTORY (BAY WIDTH 4 m, 7 m, 10 m)

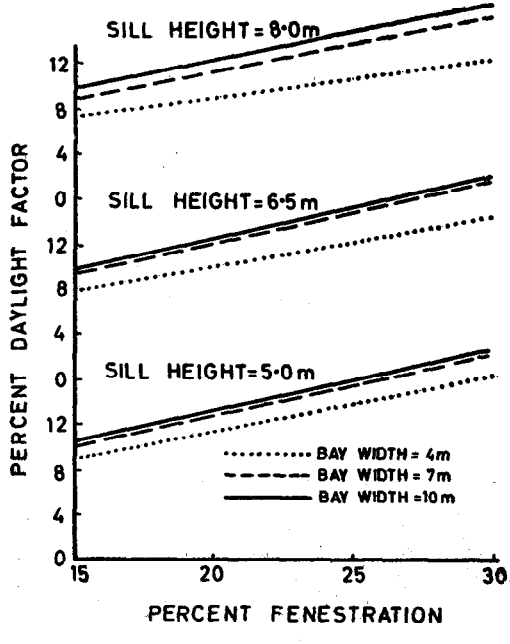


FIG. 13 WORK PLANE ILLUMINATION AT THE CENTRE OF 8-BAYS NORTH LIGHT FACTORY (BAY WIDTH 4 m, 7 m, 10 m)

7.5 Other Types of North Lights — Sawtooth, cylindrical shell or folded plate north light roofs are common. If the vertical glazed areas are equal one may take that sky components from each of the above at any given point inside will be the same in all. There are variations of the reflected components giving rise to differences in the ultimate performance of each one of the above roofs. For cylindrical shell roof the decrease in Internal Reflected Component is proportional to bay width when it goes beyond 6 metre.

7.6 Other Daylighting Apertures

7.6.1 *Side-Lighting* — This is similar to vertical windows and hence the methods given in IS : 2440-1968* are directly applicable.

7.6.2 *Horizontal or Inclined Roof Lighting* — In either of these types of openings direct sunlight will be incident on the fenestrations for part or most of the day time hours. Design will have to be for the design time suggested in IS : 2440-1968*. The value of total illumination due to sun and sky light may be taken as 16 000 Lux. To effectively diffuse this illumination in the interior the use of diffusing glasses of known transmission factors is recommended. The final available illumination on the working plane is calculable by the use of methods employed in artificial lighting techniques. If the area and location of glazed openings are known, the point to point method is suitable. If the illumination required is given the lumen method is preferable.

TABLE 3 TRANSMISSION FACTORS OF SOME GLAZING MATERIALS

Sl No.	Type of Material	Transmission Factor
(1)	(2)	(3)
i)	Transparent window glass	0·80 to 0·85
ii)	Patterned glass	0·70 to 0·85
iii)	Wired rough cast glass	0·80 to 0·60
iv)	Sand blasted glass	0·80 to 0·65
v)	Clean acrylic plastic sheet	0·85 to 0·80
vi)	Clear rigid PVC	0·80
vii)	Wired rigid PVC	0·75 to 0·70
viii)	Corrugated glass fibre reinforced sheet	0·80 to 0·55

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

7.6.3 Transmission factors of a few commonly used materials are given in Table 3. Since there is a large variety of such materials available commercially, reference to commercial literature for their properties is suggested.

7.7 Glass transmission changes due to dust collection and state of maintenance. The maintenance factors for glass under certain conditions are given in Table 4.

TABLE 4 MAINTENANCE FACTORS FOR GLASS

Sl No.	Type of Location	Maintenance Factor		
		Vertical Glazing	Sloping Glazing	(Near) Horizontal Glazing
(1)	(2)	(3)	(4)	(5)
i)	Clean	0·9	0·8	0·7
ii)	Industrial	0·7	0·6	0·5
iii)	Very dirty	0·6	0·5	0·4

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