TECHNICAL DATA

LIGHTING MAGNITUDES

Luminous intensity

Symbol : I
Unit : Candela (cd)

Luminous intensity is the luminous flux emitted over a three-dimensional angle, divided by the magnitude of such angle. The distribution of luminous flux are normally shown in polar coordinate graphics. Joining the endpoints of the light intensities provides the geometric shape of the distribution of the intensities. The light distribution graph shows the distribution of the light on a plane, that is, a cross-section of the three dimensional figure of intensity distribution.

Luminous Flux (also "luminous flux", and "light output")

Symbol : f
Unit : Lumen (lm)

The luminous flux is the radiated power emitted by a light source, perceived and evaluated according to the internationally-established value for the sensitivity of the human eye.
The luminous flux of lamps are stated in the manufactures technical documentation and are also summarized in this catalogue. One magnitude derived from the luminous flux is the lighting efficiency in lumens/Watts.

Luminance

Symbol : L
Unit: candela per square metre (cd/m^2)

Luminance is the magnitude that determines the impression of greater or less brightness produced by a surface.
It is calculated using the illuminance E on the surface and the degree of the surface's reflection (r) using the formula:

$$L = \frac{r}{p} \cdot E$$

(This formula does not apply to very bright surfaces.) The degree of reflection can be determined using the tables included in many technical publications. As an example of one of the most common, we can state the Degree of Reflection Table.

Illuminance

Symbol : E
Unit : Lux (lux)

Illuminance is the luminous flux falling on a surface, divided by the area of the surface. Illuminance is the magnitude expressing the level of lighting on a surface or spatial area.
Minimum illuminance values are recommended for different visual tasks.

Light output ratio

Symbol : h

The output of spotlights and illuminaires is the result of dividing the luminous flux they emit by the luminous flux of the lamp operating without any obstacle, thus in spotlights and illuminaires with reflector lamps the output is h

Colour rendering index

Symbol: CRI or Ra

Colour rendering indicates the effect of the radiation from a light source on the colour appearance of the objects it illuminates, in comparison with the colour appearance of such objects when lit by a reference source.
The maximum value of Ra = 100 means that the colour rendition of the light source at hand is completely equal to that of the reference source. As can be seen in Colour Rendering table, the colour rendition requirements depend on the visual task.

Colour temperature

The colour temperature depends on the spectral energy distribution in the visible field.
Light sources with a predominance of red are said to be 'warm'. When blue predominates, they are said to be 'cold'.
For the same agreeable lighting effect, cold colour sources need higher lighting levels than warm ones.
The light sources generally used to light interiors can be divided into three colour temperature groups.

Degrees of reflection

Colour	Factor	Material	Factor
White	0.7 - 0.8	Maple	0.6
Cream	0.7 - 0.8	Birch	0.6
Yellow	0.55 - 0.65	Red brick	0.05-0.25
Light green	0.45 - 0.5	Concrete	0.15-0.4
Pink	0.45 - 0.5	Light oak	0.4
Blue	0.4 - 0.45	Dark oak	0.15-0.20
Light grey	0.4 - 0.45	White lacquer	0.65-0.75
Beige	0.25 - 0.35	Clear glass	0.06 - 0.08
Ochre yellow	0.25 - 0.35	Cream wood	
Light chestnut	0.25 - 0.35	fibre plates	
Olive green	0.25 - 0.35	Tiles, white	0.5 - 0.6
Orange	0.2 - 0.25	Dark chestnut	0.6 - 0.75
Red	0.2 - 0.25	Whitewash	0.15 - 0.20
Medium grey	0.2 - 0.25	(plaster)	0.8
Dark green	0.1 - 0.15		
Dark blue	0.1 - 0.15		
Dark red	0.1 - 0.15		
Dark grey0.	1 - 0.15	For comparison	
Sea blue	0.05 - 0.1	soot or black	
Black	0.04	velvet	0.02 - 10

Luminance Values (cd/m2)

Sun at Noon	$16x10^9$
Sun at sunset	$6x10^6$
Clear Sky	8.000
Cloudy sky	2.000
Incandescent Lamp 60W clear Bulb	$5x10^6$
Incandescent Lamp 60W Opaque Bulb	$5x10^4$
Fluorescent Linear Lamp 18W	4.000

Colour rendition index

Output group	Range of CRI	Colour Appearance	Examples of potential use
1A	Ra>90	Warm,neutral,cold	Colour discrimination medical examination
1B	80<Ra<90	Warm, neutral, cold	Offices, hospitals,shops and schools,paint textile&printing industries.
2B 3 2	60<Ra<80 40<Ra<60 20<Ra<40	Warm,neutral, cold	Industries and stores Heavy industries Roads

Colour temperature

Colour appearance Group	colour appearance	colour temperature	suitable locations
1,WW	Warm	Below 3,300 K	Residential areas
2nW	Neutral	Between 3,300 & 5,000 K	Work areas
3tW	cold	Above 5,000 K	Highlevels(lux).Special tasks Dry climates.

AN APPROACH TO ILLUMINATION DESIGN

Illumination design calls for creative and engineering abilities of the designer. It is now a matter of common knowledge that a well designed interior adds to the productivity of its occupant, creates congenial atmosphere and reduces fatigue. The scope of interior lighting design can vary widely from installation to installation. Here, an attempt is being made to furnish, step by step preparation of lighting design by lumen method for a simple interior. However, more complex designs involving numerous variables and demanding critical evaluation of photometric results, should be dealt with by professional lighting engineers. In such cases, please approach our nearest branch office or our LAB at Bombay.

CALCULATION STEPS

STEP- 1:

Study the plan and evaluation of installation where the visual task is to be performed.

From standards, and if required thru interaction with user, determine lighting needs viz. illuminance, uniformity, glare limitation, colour quality, etc.

STEP - 2

Select light source and luminaire appropriate to the installation geometry, nature of visual al tasks and energy criteria.

Recommended illumination levels

TYPE OF ROOM, TASK OR ACTIVITY	RANGE OF ILLUMINANCE IN SERVICE (lux)		
GENERAL AREAS IN BUILDINGS			
– Aisles and corridors	50 -	100 -	150
– Stairs and lifts	100 -	150 -	200
– Cloakrooms & services	100 -	150 -	200
– Stores	100 -	150-	200
HEAVY INDUSTRIES			
– Production plants without manual work	50 -	100 -	150
– Production plants with occasional manual work	100 -	150 -	200
– Production plants & permanently attended posts	200 -	300 -	500
– Control and Inspection platforms	300 -	500 -	750
TEXTILE INDUSTRIES			
– Design and cutting	200 -	300 -	500
– Sewing and inspection	750 -	1000 -	1500
OFFICES			
General offices, Computer rooms	300 -	500 -	750
Plan offices	500 -	750 -	1000
Technical offices(drawing)	500 -	750 -	1000
Meeting rooms	300 -	500 -	750
SCHOOLS			
CLASSROOMS			
– General lighting	300 -	500 -	750
– Blackboards	300 -	500 -	750
– Drawing classrooms	500 -	750 -	1000
ART ROOMS	300 -	500 -	750
CRAFT WORK CLASSROOMS	300 -	500 -	750
MEETING ROOMS	150 -	200 -	300

STEP - 3

Arrive at Room Index (R.I) using the following formula :

$$R.I = \frac{\text{Length x Breadth}}{\text{(Length+ Breadth) Mounting Ht.}}$$

STEP - 4

Read co-efficient of utilization (C.O.U.) from COU table for selected luminaire. These values are based on R.I. and room surface reflectance which are generally 70% for light coloures, 50% for average and 30% for dark walls and 50%, 30% and 10% for corresponding ceilings.

STEP - 5

Select the Maintenance Factor (M.F.) A general guideline is given below:

AREA:	**M.F**
A.C rooms, clean rooms, offices, or any other Commercial interior	0.80
Industrial environment, indoor area except control Rooms and outdoor areas.	0.70
Dusty areas eg. Cement Plants, Coal handling areas Foundry etc.	0.60

STEP - 6

Use the following formula to arrive at the quantity of luminarie.

$$\text{Quantity of Luminaire} = \frac{\text{Area x Illuminance}}{\text{C.O.U. x M.F. x No. of lamps per Lumen x Lumen per lamp.}}$$

STEP - 7:

Disposition of luminarie should be in general symmetrical. Due consideration should be given to ceiling details for minimizing mounting cost. The mounting to spacing ratio of the selected luminaire should also be kept in mind while working out disposition to achieve desired uniformity of illumination.

OUTDOOR LIGHTING

As the sun goes down, the safety and comfort of road user also goes down particularly on roads which are not well lighted. The primary purpose of street lighting is to provide safety. Studies in many developed countries reveal that proper road lighting can help to reduce accidents at night by more than 30 per cent.

The objective of street lighting design is not only to find out optimum spacing for a given width of road but also to arrive at appropriate installation parameters like mounting height, overhang and angle of tilt. This calls for constant juggling of numerous variables till optimum lighting solution is obtained. This can be achieved by a computer with speed and accuracy.

Flood lighting design is more complex as it also involves numerous calculations which cannot be performed with speed and accuracy without the help of a computer. It also requires an understanding of the site, application, environment etc.

TYPE OF ROOM, TASK OR ACTIVITY	RANGE OF ILLUMINANCE IN SERVICE (lux)		
HOSPITALS			
Rooms			
– General lighting	50-	100-	150
– Examination	200-	300-	500
– Reading	150-	200-	300
– Night movement	3-	5-	10-
EXAMINATION ROOMS			
– General lighting	300-	500-	750-
– Localised Inspection	750-	1000-	1500-
INTENSIVE CARE			
– Heads of beds	30-	50-	100
– Observation	200-	300-	500
NURSES' ROOMS	**200-**	**300-**	**500**
OPERATING THEATRES			
– General lighting	500-	750-	1000
– Local	10000-	30000-	100000
Autopsy rooms			
– General lighting	500-	750-	1000
– Local	5000-	10000-	15000
SURGERIES			
– General lighting	300-	500-	750
– Local	500-	750-	1000
LABORATORIES & PHARMACIES			
– General lighting	300-	500-	750
– Local	500-	750-	1000
SHOPS			
– General lighting in shopping malls	500-	750-	
– In any place	300-	500-	
– In supermarkets	500-	750-	

Luminaire are classified according to the type of protection against electric shock provided as classII, class III

CLASS I  Luminaire provided with an earth connection. Under any fault.

CLASS II  Double insulation with no grounding required.

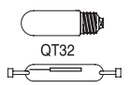
CLASS III  Luminaire design for operation on safety of extra low voltage. Incase of failure of an insulation no admissibly high touch voltage can develop either between conductors or between a conductor and earth.

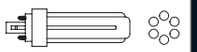
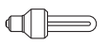
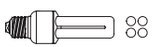
MARKING

 Luminaire for use high pressure sodium lamps that require an extra ignitor(to the lamp)

 Luminaire for use high pressure sodium lamps having an internal starting device

 Luminaire suitable for direct mounting on flammable surface

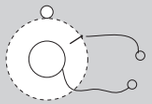
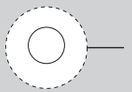
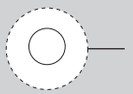
Symbol	Type (W)	Wattage (V)	Voltage	Base intensity(cd)	Luminous (lm)	Light out put (hr)	Average life (mm)	Diameter (mm)	Length
	GLS	25-100	220-240	E27	–	220-1380	100	60	105
	P45	40	–	E27	400	–	–	–	–
	MR 16	50	12	GX/GU 5.3	3100(24)	–	3500	50	46
	a4 a8 a24 a8 AR111 a24 a45 a8 a24 a45	50 75 100	12	G53	45000 20000 4000 30000 5300 1700 48000 8500 2800	–	3000	 111 44 49 48	46 44 49 44 49 48 44 49 48
	SPa10 PAR 20 FLa 30	50	220-240	E27	3000 1000	–	2000	65	65
	SPa 10 PAR25 FLa 30	75	220-240	E27	5500 1100		2000	81	81
	FLa 30 PAR 30 SPa10 FLa 30	75 100	220-240	E27	2200 6900 3500	–	2000 2500	97	91
	PAR 38	100W 10° 100W 30°		E27 E27	10000 3000				
	HID Elliptical shape	75 100 150	220-240	E27		5500 8500 13000	15000	54	138
	35 HCI-T 70 150	39 72 147	220-240	G12		3400 6600 14000	2000 5000	25	84
	HCI-TS	75 150	220-240	RX7S		55000 13500	4000	21 24	114 132
	QT32 QT32 QT-DE12	60 100 150	220-240	E27 E27 R7s		840 1550 2600			
	QT9 QT12	10 50		G4 GY6.35		140 950			

Symbol	Type	Wattage (W)	Voltage (V)	Base	Luminous	Light out put intensity(cd)	Average life (lm)	Diameter (hr)	Length
	TC-S	5 7 9 11	220-240	G23	–	250 400 600 900	8000	12	108 137 137 237
	TC-D	10 13 18 26	220-240	G24d-1 G24d-2 G24d-3		600 900 1200 1800	8000	12	110 138 153 172
	TC-TEL	18 26 32 42	220-240	G24q-2 G24q-3 G24q-4		1200 1800 2400 3200	8000	56/61 49	123/118 138/133 153
	TC-L	18 24 36 18 24 36 40 55	220-240	2G-11	–	1200 1800 2900 1140 1750 2800 3500 4800	8000 10000	17	225 320 415 225 320 145 535 535
	PLE-U	11 15 20 23	220-240	E27		540 900 1200 1500	12000	49	126 149 149 170
	PLE-T	23	220-240	E27		1500	15000	58	173
	T-5	14 28	220-240	G5		1270 2720	16000	16	549 1149
	T-8	18 36	220-240	tG-13		1000 2350	T10000	26	590 1200

INGRESS PROTECTION

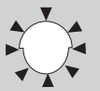
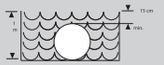
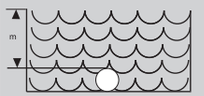
The IP (level of protection) is a two digit number which indicates the protection level provided by the housing of the lighting appliance. The first digit indicates the protection level against dust and the second against water.

1st digit protection against solid bodies

IP	tests	
0		Unprotected
1		Protected from solid bodies more than 50mm (eg. accidental contact with a hand)
2		Protected from solid bodies more than 12mm (eg.fingers)
3		Protected from solid bodies more than 2.5 mm (eg. tools,wires or similar)
4		Protected from solid bodies more than 1mm (eg.small tools, fine wires...)
5		Protected from dust (without harmful deposits)
6		Total protection from dust

The two first digits are defined by the norms UTE C 20 010, IEC 144 and 525 and DIN 40 050

2nd digit protection against liquids

IP	Tests	
0		Unprotected
1		Protected from vertically falling drops of water (condensation)
2		protected from water falling at an angle up to 15˚ from the vertical
3		Protected from rain water falling at an angle upto 60˚ from the vertical
4		Protected from water sprayed in all directions
5		Protected from water getting in all directions
6		Protected from heaving water similar to heavy seas
7		Protected from immersion in water
8		Protected from prolonged immersion in water at a specified pressure.

The two digits are defined by the norms UTE C 20 010, IEC 144 and 525 and DIN 40 050