# Guidelines for Interior Lighting Using the Lumen Method

## 1.0 Introduction

In lighting design, the DE has to ascertain that his design provides adequate lighting. Drawings showing the plan and cross section of each room including the proposed constructional detail of the ceiling and wall, furniture and equipment or machinery layout are required in lighting design. In order to make necessary detailed calculation concerning the type and quantity of lighting equipment, additional information on the surface reflectance of walls, ceiling and floors is required. The level of illumination obtained must conform to the IES Code or in our case, to JKR Standards (See Appendix 1).

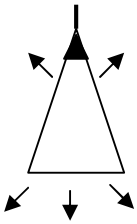
## 2.0 Basic information on lighting

## 2.1 Classification of Fittings

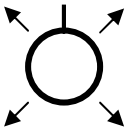
The precise definitions can be formulated in terms of percentage of upward light (to total light output) as illustrated below:-

- Direct - 0 – 10%

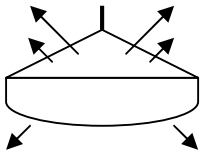
- Semi direct - 10 – 40%



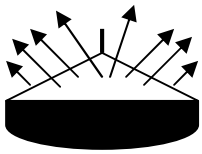
- General diffusing - 40 – 60%



- Semi indirect - 60 – 90%



- Indirect - 90 – 100%



## 2.2 Selection of light source

The choice of lamp type is clearly of importance in any lighting design. Among the lamp characteristics which have to be taken into account are efficiency, heat output, size, life, robustness, colour properties and maintainability.

## 2.3 Efficiency

Efficiency is measured in lumen per watt. Generally discharge and fluorescent types have much higher efficiencies than the tungsten filament lamps. Efficiency of tungsten filament lamp is in the range of 10 to 15 lumen / watt, for high pressure mercury the range is 40 to 50 and tubular fluorescent lamps is between 30 to 60.

## 2.4 Heat Output

Less heat is produced in mercury of fluorescent scheme as compared to a tungsten scheme due to the lower wattage necessary to produce the same lumen output. (Every watt of electrical energy put into an interior lighting system ultimately appears as heat).

## 2.5 Size

The small size of the filament lamp is valuable whenever precise light control is needed, e.g. when a definite beam of light is called for. Directional control of the output from a fluorescent tube is very limited because of its considerable length. The size of the luminaire selected is important so as to blend with the internal decoration of the room or the room's function.

## 2.6 Lamp Life

The lifetime of a tungsten lamp is dependent on its light output, as one designed for a long life will have a low light output and vice versa. BS 161 quotes a life of 1,000 hours of tungsten lamp, representing an optimum compromise based on the

principle of getting the most light per unit cost. In contrast the life to fail of a mercury lamp or fluorescent tube is less important as the lamp life is long.

However the light output falls progressively with time and a stage will be reached where replacement is worthy so as get a greater light output for the same consumption of electricity.

## 2.7 Effect of Vibration of life-time

Vibration while the lamp is in used can cause premature failure of filament lamps. Fluorescent & mercury type are less affected by vibration. However, if the design calls for filament lamps, robust type luminaire may be used.

## 2.8 Lamp Colour Temperature

Filament lamps produce a warm effect, which is different from daylight. 'Natural' colour is similar to daylight.

Mercury lamps are bluish-white in appearance and in their colour corrected form, have an effect on colour which is acceptable in many industrial interiors.

Fluorescent tubes offer an extensive colour choice. They fall into two groups, namely 'high efficiency' and 'de-luxe'. The former produces some 50 to over 60 lumens per watt but with some sacrifice of colour quality (however the colour rendering is still better than that of colour corrected mercury lamp). The de-luxe colour is nearly to those of 'natural' colour but with lower efficiency (30 to 40 lumens per watt).

## 2.9 Comparison between tungsten and fluorescent schemes

In broad terms a tungsten filament scheme is relatively cheap to install but expensive to run. It would be recommended for low initial expenses cases. Low usage or it is used intermittently with frequent switching.

Initial cost of a fluorescent scheme is higher but the extra cost been compensated with higher efficiency lamps.

In a great deal of lighting for effect, in display and in prestige interiors, the precise control possible with the small tungsten source makes it the immediate choice. Normally the fluorescent scheme is the choice for the general lighting of an interior.

## 2.10 Comparison between colour corrected mercury and fluorescent scheme.

For many commercial and some industrial situations the colour performance of mercury discharge lamps is inadequate but it can still be accepted.

The limitation of the tubular fluorescent lamp appears in the loading possible per fitting. In heavy industry, the presence of a traveling crane high mounting of fluorescent fitting is necessary. Thus in large industrial interiors it is possible to concentrate the lighting into a relatively small number of high loaded points with resultant economics and materials in both installation and maintenance.

## 2.11 Glare

Glare is experienced if a source of light (be it a window, a luminaire or a reflecting shiny surface) is too bright compared with the general brightness of the surrounding. Glare will makes it more difficult to see detail or contrast in an object and it is known as disability glare. Discomfort glare is the more common type of glare experienced in interiors. It causes visual discomfort, though this may not be apparent but the effect is sense of tiredness, especially towards the end of a working day. This discomfort will also have an effect on working efficiency.

## 2.12 Glare Index

The level of discomfort glare can be expressed numerically as a glare index. (The method of calculating glare index is a bit too details to be included in this manual, however the reader can consult the references mentioned to learn the method). The glare index worked out for a particular interior should not be more than the limiting value found in the IES Code for that particular activity.

## 2.13 Controlling glare

(1) One way of reducing glare is to direct visual task away from the line of sight of a bright luminaire.

(2) When luminaries are mounted in regular pattern, the glare index should be calculated and if it is greater than the limiting value then the following changes might be necessary:-

(a) a change in the orientation of the luminaire
(b) a change in the type of luminaire
(c) a change in the room surface reflectance

(3) Open luminaries should be fitted with louvers whose cut off angle is sufficient to prevent the lamp being seen at normal angle of view.

(4) Unscreened fluorescent lamps should be mounted in line with the normal direction of view and not across it.

(5) Other guidelines.

## 2.14 Reducing Fire Hazards

Chokes in fluorescent fittings are a fire hazard due to the high temperatures ($130^{o}$ C – $160^{o}$) when they are in operation.

Fluorescent fittings should be separated from the ceiling (Using insulation blocks) by an air gap to reduce fire hazards.

Mineral-insulated copper-sheathed cable should be used for wring in places that are constantly exposed to heat, oil or moisture.

Arc-free (sparkles) switches and fire-proof fittings should be employed in environments where explosive gas mixtures might be present.

## 2.15 Flicker

The 50Hz flicker in discharge lamps can prove distracting to some people. For fluorescent tube, the 50Hz flicker occurs mainly at the lamp ends, and the effect is more apparent in 5 ft. 80W tubes than the lower rated current tubes. Flicker can be reduced in these fluorescent lamps of high rated current (5 ft., 6 ft., and 8 ft., tubes) by employing the shielded electrode type.

Confusing stroboscopic patterns seen when moving objects are illuminated by discharge lamps (as experienced in workshops) can be diminished by supplementing the light over the task areas with light from local incandescent lamps.

## 2.16 Lighting and Noise

The induction coil (part of the control of discharge lamps) is usually a source of noise. The fitting housing may become a resonator for this noise especially if it has loose fitting parts which are free to vibrate. Thus special precautions must be taken when lighting equipment is installed in very quiet interiors, such as libraries and places of worship.

## 3.0 Interior Lighting Design Work Sheet

Calculation may be made more quickly and efficiently using a well designed format as follows:

## INTERIOR LIGHTING DESIGN WORK SHEET

**Project:** _____ **Room :** _____
**Date :** _____ **Designed by:** _____

### Room Data

| | | | |
|---|---|---|---|
| Room Dimensions | Length | **1.** | m |
| | Width | **2.** | m |
| | Floor Area | **3.** | m² |
| | Ceiling ht. | **4.** | m |
| Surface Reflectance | Ceiling | **5.** | % |
| | Wall | **6.** | % |
| | Floor | **7.** | % |
| Work plane height | | **8.** | m |
| Luminance mounting height | | **9.** | m |
| Room Index (Kr) | | **10.** | |

### Lamp & Luminaire Data

| | |
|---|---|
| Manufacturer | **11.** |
| Catalogue Reference | **12.** |
| Lamps per luminaire | **13.** |
| Lumen per lamp | **14.** |
| Coefficient of Utilization | **15.** |
| Maintenance Factor | **16.** |
| Design Factor | **17.** |
| Spacing / Mounting ht. Ratio | **18.** |

### Illuminance

| | | |
|---|---|---|
| **No. of luminaires required to produce desired illumination in LUX** | | |
| Desired illuminance | **19.** | lux |
| No. of luminaires | **20.** | |
| **Illuminance achieved for No. of luminaires installed by considering spacing / mounting ht. Ratio** | | |
| No. of luminaires installed | **21.** | |
| Illuminance achieved | **22.** | lux |

### Calculation Room Index

(Line 10) Room Index (Kr)

$$= \frac{\text{Length x Width}}{\text{Hm x (Length + Width)}}$$

$$= \frac{\text{Line 1 x Line 2}}{\text{(Line 9 – Line 8) (Line 1 + Line 2)}}$$

= _____

= _____

### Calculating No. of Luminaires

$$\text{No. of Lum.} = \frac{\text{L x W x Desired illuminance}}{\text{Lamp per Luminaire x Lumen lamp x C.O.U. x M.F. x D.F.}}$$

$$= \frac{\text{Line 3 x Line 19}}{\text{Line 13 x Line 14 x Line 15 x Line 16 x Line 17}}$$

Line 20 = _____

### Calculating Illuminance Achieved

$$\text{Illu. achieved In lux} = \frac{\text{No. of Lum. x Lamps per Lum. x Lumens per lamp x C.O.U. x M.F. x D.F.}}{\text{Floor Area}}$$

$$= \frac{\text{Line 21 x Line 13 x Line 14 x Line 15 x Line 16 x Line 17}}{\text{Line 3}}$$

Line 22 = _____

### 3.1 Room Data

This is physical data obtained from blue print or by actual measurement. Inside dimension should be used.

### 3.2 Lamp and Luminaire Data

A wide range of luminaires are available from various manufacturers for various application like commercial, industrial, decorative, high bay, etc. for light sources – halogen lamp, CFL, fluorescent tube, HPMV, etc. Refer to Appendix 2 (Lamp – Lumen table) and Appendix 3 (Luminaire – Coefficient of Utilization table)

### 3.3 Coefficient of Utilization, (C of U)

Coefficient of Utilization is the ratio of the actual flux received on a working plane to the installed flux. It is a measure of the degree to which the installed lamps has been use fully applied. The ratio depends on the proportions of the room, the design of the fitting, and the reflection factors of the rooms' surfaces. Illumination (E) thus can be expressed as:

E = C of U × Installed flux per unit area.

Note: This formula holds only if the lighting installation is perfectly clean.

### 3.4 Practical Example on Average Illumination

This is the measure of the average concentration of light on a surface. The unit of illumination is the lux (lumen/sq. metre) where lumen is the unit of light. Thus if 50% of the light output of 1 x 18 watt fluorescent lamps ultimately fall on a working plane measuring 2m by 3m. What is the average illumination?

The lighting design Lumens (LDL) of the lamps is given by Appendix 2 to be 1130 lumens (lm).

Total light output = 4 × 1130 lm

Light reaching surface $= \frac{50}{100} \times 4 \times 1130$

= 2260 lm

Area = 2 × 3 m²

Average illumination $= \frac{\text{incident light}}{\text{Area}}$

$= \frac{2260}{2 \times 3} = 416.66 = 376.67$

### 3.5 Installed Flux (Lumen)

If we take the light output of the luminaire (light fitting) and multiply by their number, the product represents the installed flux.

A room is fit by 2 x 18 watt fluorescent lamps and tungsten bulb 100 watt lamp. What is the installed flux?

Installed flux = 2 × 1130 + 1 × 1160

= 3420 lm.

### 3.6 Maintenance Factor

Dirt of the fitting has the effect of reducing its light output from it. The conventional assumption is that on average, lighting installation delivers 80% of the light it would do if it were perfectly clean. Thus the average maintenance factor = 0.8. A higher maintenance factor, say 0.9 can be assumed if the fittings are cleaned regularly or it could be as low as 0.5 in a foundry. Taking dirt into account, the modified illumination (E), formula achieved is:

E = C of U × Maintenance Factor × Installed flux per unit area.

## 4.0 Practical Design Example

The DE usually knows the illumination desired. He also has a prior knowledge of the luminaire he wishes to use. He has to calculate the installed flux and thus number of fittings needed.

Consider the following general office of floor dimension 12m (L) by 6m (W) and ceiling height 3m. JKR illuminations standards recommended an illumination of 500 lux. How many lamps are needed to attain this illumination level?

By using the previous Interior Lighting Design Work Sheet, the calculation now will be as follow:

## INTERIOR LIGHTING DESIGN WORK SHEET

**Project: ABC Office** **Room : General Office**
**Date : 25 / 10 /2005** **Designed by: DV**

### Room Data

| | | | | |
|---|---|---|---|---|
| Room Dimensions | Length: | **1.** | 12 | m |
| | Width: | **2.** | 6 | m |
| | Floor Area: | **3.** | 72 | m² |
| | Ceiling ht.: | **4.** | 3 | m |
| Surface Reflectance | Ceiling: | **5.** | 50 | % |
| | Wall: | **6.** | 50 | % |
| | Floor: | **7.** | 10 | % |
| Work plane height | | **8.** | 0.85 | m |
| Luminance mounting height | | **9.** | 3.0 | m |
| Room Index (Kr) | | **10.** | 1.86 | |

### Lamp & Luminaire Data

| | | |
|---|---|---|
| Manufacturer | **11.** | XYZ Sdn. Bhd. |
| Catalogue Reference | **12.** | Mirror Optics |
| Lamps per luminaire | **13.** | 2 |
| Lumen per lamp | **14.** | 3250 |
| Coefficient of Utilization | **15.** | 0.58 |
| Maintenance Factor | **16.** | 0.8 |
| Design Factor | **17.** | 0.95 |
| Spacing / Mounting ht. Ratio | **18.** | 1.5 |

### Illuminance

| | | | |
|---|---|---|---|
| **No. of luminaires required to produce desired illumination in LUX** | | | |
| Desired illuminance | **19.** | 500 | lux |
| No. of luminaires | **20.** | 13 | |
| **Illuminance achieved for No. of luminaires installed by considering spacing / mounting ht. Ratio** | | | |
| No. of luminaires installed | **21.** | 12 | |
| Illuminance achieved | **22.** | 477 | lux |

### Calculation Room Index

(Line 10) Room Index (Kr)

$$= \frac{\text{Length x Width}}{\text{Hm x (Length + Width)}}$$

$$= \frac{\text{Line 1 x Line 2}}{\text{(Line 9 – Line 8) (Line 1 + Line 2)}}$$

$$= \frac{(12 \times 6)}{(3 - 0.85)(12 + 6)}$$

$$= 1.86$$

### Calculating No. of Luminaires

$$\text{No. of Lum.} = \frac{\text{L x W x Desired illuminance}}{\text{Lamp per Luminaire x Lumen lamp x C.O.U. x M.F. x D.F.}}$$

$$= \frac{\text{Line 3 x Line 19}}{\text{Line 13 x Line 14 x Line 15 x Line 16 x Line 17}} = 12.56$$

Line 20 = 13 nos.

### Calculating Illuminance Achieved

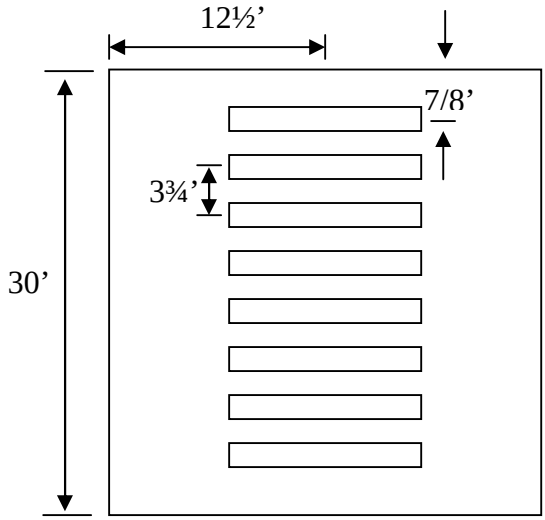
$$\text{Illu. achieved In lux} = \frac{\text{No. of Lum. x Lamps per Lum. x Lumens per lamp x C.O.U. x M.F. x D.F.}}{\text{Floor Area}}$$

$$= \frac{\text{Line 21 x Line 13 x Line 14 x Line 15 x Line 16 x Line 17}}{\text{Line 3}}$$

Line 22 = 477 lux

## 5.0 Arrangement of fittings

Possibly the simplest way of arranging the 8 fitting of luminaires would be to space them equally in a line down the middle of the room.

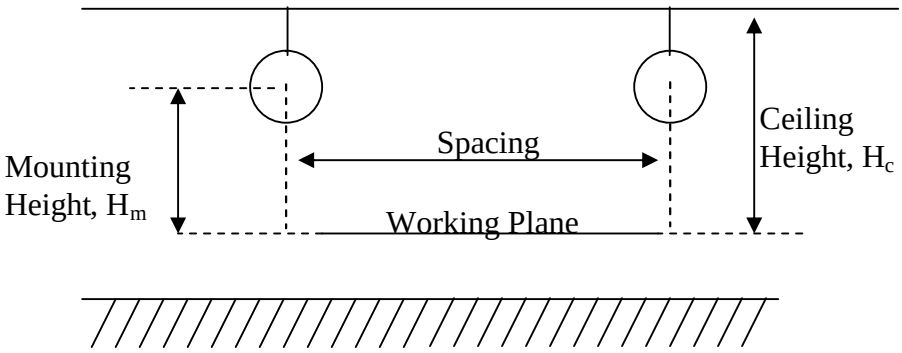



It is clear that the illumination in the middle would be much higher than that at the sides.

## 6.0 Spacing for Uniform Illumination

Besides appearance design, the aim of lighting design is to have uniformity in illumination over the working plane. Complete uniformity is impossible in practice, but an acceptable standard is for the minimum to be at least 70% of the maximum (IES Recommended figure).

## 7.0 Spacing / Mounting-height ratio



| Fittings | Max. spacing | Max. spacing between fitting and wall. (Generally) | Working positions next to wall |
|---|---|---|---|
| 1. a) Indirect fittings<br>b) Semi-indirect fittings (Fittings generally between ¼ Hc and ⅓ Hc below ceiling). | 1½ Hc | ¼ Hc | ½ Hc |
| 2. a) Generally diffusing fitting<br>b) Opal (or similar) base fitting<br>c) Open direct fittings (unlouvred) but other diffusing materials reflectors. | 1½ Hm | ½ Hm | 1 Hm |
| 3. a) Optically designed prismatic control of down drop light fitting<br>b) Louvred fittings | 1¼ Hm | ¾ Hm | ½ Hm |
| 4. a) Concentrating fittings<br>b) Optically designed specular reflector fittings | 1 Hm | ½ Hm | |

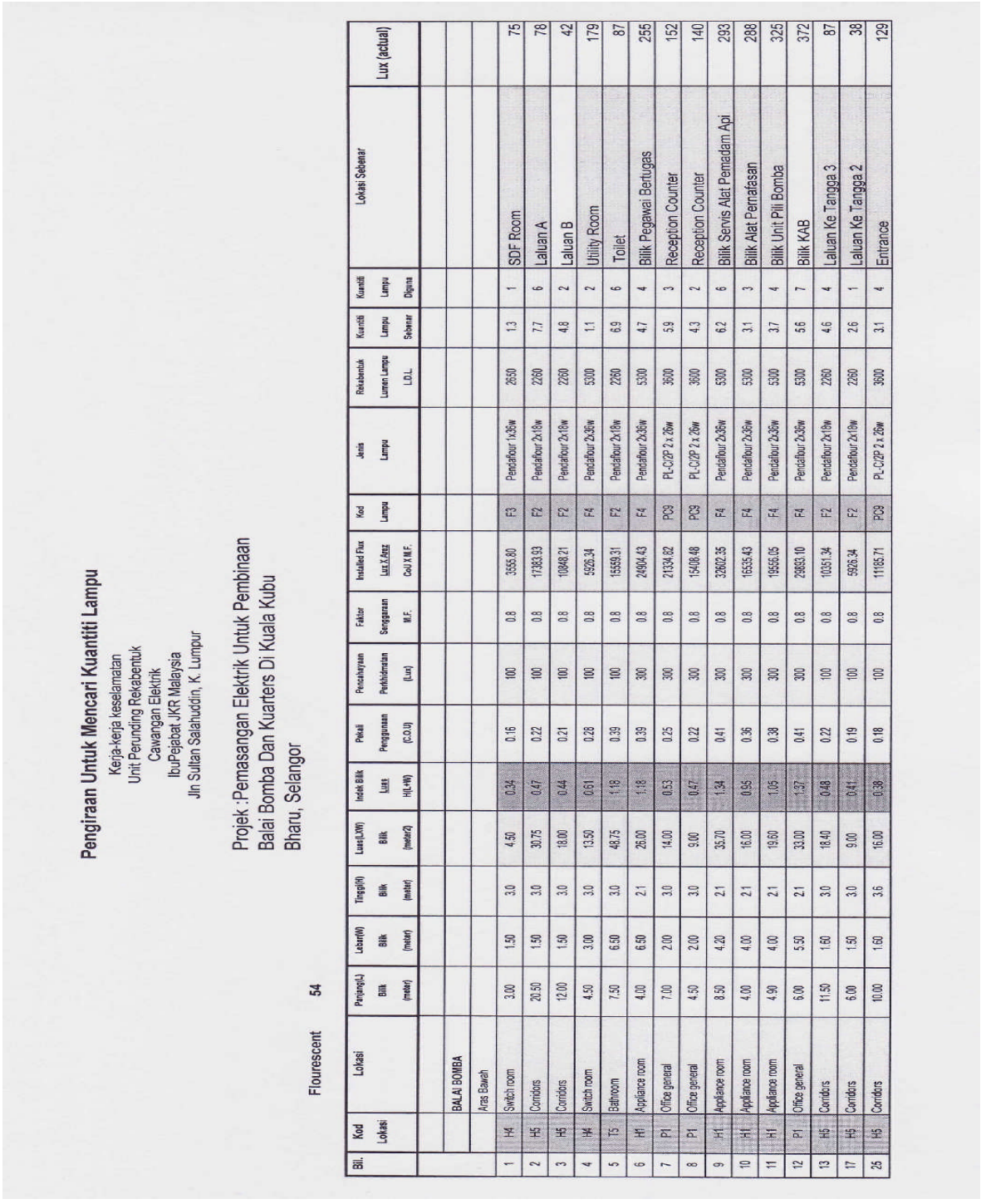
Where: Hc = Ceiling height above the working plane
Hm = Fitting height above the working plane

Table 7: Maximum permissible spacing/mounting height ratio for the following type of fittings.

## Practical Design Example

### Example Calculation on Lux Level and Quantity of Fitting.

Nowadays, the use of computer program such as Excel is widely practiced to expedite the electrical calculations. For example, in lux level calculations, the DE only need to get all the related information / data of the rooms i.e. width, length, height, etc. and insert them into the formula. The below diagram shows the example of the calculation using Excel computer program.



**Pengiraan Untuk Mencari Kuantiti Lampu**

Kerja-kerja keselamatan
Unit Perunding Rekabentuk
Cawangan Elektrik
IbuPejabat JKR Malaysia
Jln Sultan Salahuddin, K. Lumpur

Projek :Pemasangan Elektrik Untuk Pembinaan
Balai Bomba Dan Kuarters Di Kuala Kubu
Bharu, Selangor

Flourescent 54

| Bil. | Kod Lokasi | Lokasi | Panjang(L) Bilik (meter) | Lebar(W) Bilik (meter) | Tinggi(H) Bilik (meter) | Luas(LXW) Bilik (meter2) | Indek Bilik Luas H(L+W) | Pekali Penggunaan (C.O.U) | Penyelenggaraan Pemeliharaan (Lux) | Faktor Penggunaan M.F. | Installed Flux Lux X Area Coul X M.F. | Kod Lampu | Jenis Lampu | Rekabentuk Lumen Lampu L.D.L. | Kuantiti Lampu Sebenar | Kuantiti Lampu Diguna | Lokasi Sebenar | Lux (actual) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BALAI BOMBA | | | | | | | | | | | | | | | | |
| | | Aras Bawah | | | | | | | | | | | | | | | | |
| 1 | H4 | Switch room | 3.00 | 1.50 | 3.0 | 4.50 | 0.34 | 0.16 | 100 | 0.8 | 3555.80 | F3 | Pendaflour 1x36w | 2650 | 1.3 | 1 | SDF Room | 75 |
| 2 | H5 | Corridors | 20.50 | 1.50 | 3.0 | 30.75 | 0.47 | 0.22 | 100 | 0.8 | 17383.93 | F2 | Pendaflour 2x18w | 2260 | 7.7 | 6 | Laluan A | 78 |
| 3 | H5 | Corridors | 12.00 | 1.50 | 3.0 | 18.00 | 0.44 | 0.21 | 100 | 0.8 | 10948.21 | F2 | Pendaflour 2x18w | 2260 | 4.8 | 2 | Laluan B | 42 |
| 4 | H4 | Switch room | 4.50 | 3.00 | 3.0 | 13.50 | 0.61 | 0.28 | 100 | 0.8 | 5926.34 | F4 | Pendaflour 2x36w | 5300 | 1.1 | 2 | Utility Room | 179 |
| 5 | T5 | Bathroom | 7.50 | 6.50 | 3.0 | 48.75 | 1.18 | 0.39 | 100 | 0.8 | 15559.31 | F2 | Pendaflour 2x18w | 2260 | 6.9 | 6 | Toilet | 87 |
| 6 | H1 | Appliance room | 4.00 | 6.50 | 2.1 | 26.00 | 1.18 | 0.39 | 300 | 0.8 | 24904.43 | F4 | Pendaflour 2x36w | 5300 | 4.7 | 4 | Bilik Pegawai Bertugas | 255 |
| 7 | P1 | Office general | 7.00 | 2.00 | 3.0 | 14.00 | 0.53 | 0.25 | 300 | 0.8 | 21334.82 | PC3 | PL-C/2P 2 x 26w | 3600 | 5.9 | 3 | Reception Counter | 152 |
| 8 | P1 | Office general | 4.50 | 2.00 | 3.0 | 9.00 | 0.47 | 0.22 | 300 | 0.8 | 15408.48 | PC3 | PL-C/2P 2 x 26w | 3600 | 4.3 | 2 | Reception Counter | 140 |
| 9 | H1 | Appliance room | 8.50 | 4.20 | 2.1 | 35.70 | 1.34 | 0.41 | 300 | 0.8 | 32602.35 | F4 | Pendaflour 2x36w | 5300 | 6.2 | 6 | Bilik Servis Alat Pemadam Api | 293 |
| 10 | H1 | Appliance room | 4.00 | 4.00 | 2.1 | 16.00 | 0.95 | 0.36 | 300 | 0.8 | 16535.43 | F4 | Pendaflour 2x36w | 5300 | 3.1 | 3 | Bilik Alat Pernafasan | 288 |
| 11 | H1 | Appliance room | 4.90 | 4.00 | 2.1 | 19.60 | 1.05 | 0.38 | 300 | 0.8 | 19656.05 | F4 | Pendaflour 2x36w | 5300 | 3.7 | 4 | Bilik Unit Pili Bomba | 325 |
| 12 | P1 | Office general | 6.00 | 5.50 | 2.1 | 33.00 | 1.37 | 0.41 | 300 | 0.8 | 29693.10 | F4 | Pendaflour 2x36w | 5300 | 5.6 | 7 | Bilik KAB | 372 |
| 13 | H5 | Corridors | 11.50 | 1.60 | 3.0 | 18.40 | 0.48 | 0.22 | 100 | 0.8 | 10351.34 | F2 | Pendaflour 2x18w | 2260 | 4.6 | 4 | Laluan Ke Tangga 3 | 87 |
| 17 | H5 | Corridors | 6.00 | 1.50 | 3.0 | 9.00 | 0.41 | 0.19 | 100 | 0.8 | 5926.34 | F2 | Pendaflour 2x18w | 2260 | 2.6 | 1 | Laluan Ke Tangga 2 | 38 |
| 25 | H5 | Corridors | 10.00 | 1.60 | 3.6 | 16.00 | 0.38 | 0.18 | 100 | 0.8 | 11185.71 | PC3 | PL-C/2P 2 x 26w | 3600 | 3.1 | 4 | Entrance | 129 |

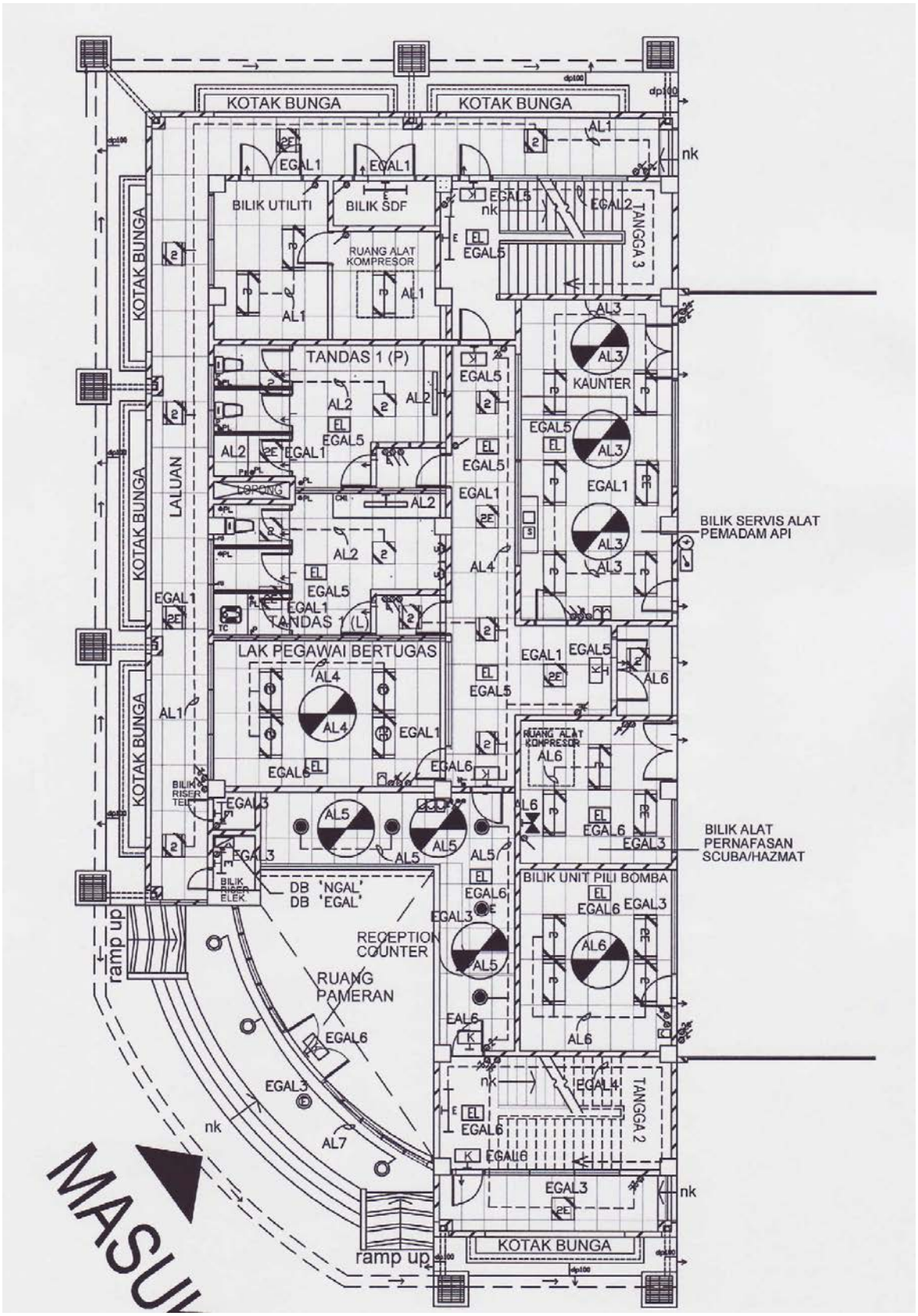

KOTAK BUNGA
KOTAK BUNGA
BILIK UTILITI
BILIK SDF
RUANG ALAT KOMPRESOR
TANGGA 3
TANDAS 1 (P)
KAUNTER
LALUAN
LORONG
BILIK SERVIS ALAT PEMADAM API
TANDAS 1 (L)
LAK PEGAWAI BERTUGAS
RUANG ALAT KOMPRESOR
BILIK ALAT PERNAFASAN SCUBA/HAZMAT
BILIK UNIT PILI BOMBA
BILIK RISER TEL
BILIK RISER ELEK
DB 'NGAL'
DB 'EGAL'
RECEPTION COUNTER
RUANG PAMERAN
TANGGA 2
ramp up
ramp up
MASUK
KOTAK BUNGA

**Diagram 1**

## LEGEND (NON-ESSENTIAL)

| SYMBOL | DESCRIPTION |
|---|---|
| | 1 X 18W (F) WALL MOUNTED CHANNEL LUMINAIRE |
| | 1 X 36W (F) WALL MOUNTED CHANNEL LUMINAIRE |
| | 1 X 36W (F) MIRROR LIGHT LUMINAIRE |
| 2 | 2 X 18W (F) SURFACE MOUNTED LUMINAIRE C/W ALUMINIUM LOUVERS (TOILET) |
| 2 | 2 X 18W (F) RECESSED LUMINAIRE C/W ALUMINIUM LOUVERS |
| 2 | 2 X 36W (F) SURFACE MOUNTED LUMINAIRE C/W LOUVERS |
| 2 | 2 X 36W (F) RECESSED LUMINAIRE C/W ALUMINIUM LOUVERS |
| | 1500mm DIA. CEILING FAN |
| N | SWITCH PANEL |
| | 2X18W PLC SURFACE MOUNTED DOWNLIGHT |
| | 2X18W PLC RECESSED MOUNTED DOWNLIGHT |

## LEGEND (ESSENTIAL)

| SYMBOL | DESCRIPTION |
|---|---|
| E | 1 X 18W (F) ESSENTIAL WALL MOUNTED CHANNEL LUMINAIRE |
| E | 1 X 36W (F) ESSENTIAL WALL MOUNTED CHANNEL LUMINAIRE |
| 2E | 2 X 36W (F) ESSENTIAL RECESSED LUMINAIRE C/W ALUMINIUM LOUVERS |
| 2E | 2 X 18W (F) ESSENTIAL SURFACE MOUNTED LUMINAIRE C/W ALUMINIUM LOUVERS (TOILET) |
| 2E | 2 X 18W (F) ESSENTIAL RECESSED PLASTER LUMINAIRE C/W ALUMINIUM LOUVERS |
| K | 2 X 8W (F) KELUAR SIGN LUMINAIRE |
| EL | 1 X 8W (F) EMERGENCY LIGHT LUMINAIRE |
| 2E | 2 X 36W (F) ESSENTIAL SURFACE MOUNTED LUMINAIRE C/W LOUVERS |
| E | 2X18W PLC SURFACE MOUNTED DOWNLIGHT |
| E | 2X18W PLC RECESSED MOUNTED DOWNLIGHT |

## Appendix 1: Room Illumination Level

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| **Circulation Area** | | | |
| | | | |
| Corridors, Passageway | 100 | 50 | 100 |
| | | | |
| Lift | 150 | 100 | 100 |
| | | | |
| Stairs | 150 | 100 | 100 |
| | | | |
| Escalator | 150 | 150 | 100 |
| | | | |
| External Covered Ways | 30 | 50 | 30 |
| | | | |
| **Entrances** | | | |
| | | | |
| Entrance halls, lobbies, waiting rooms | 150 | 100 | 100 |
| | | | |
| Enquiry desk | 500 | 300 | 300 |
| | | | |
| Gate houses | 300 | 200 | 200 |
| | | | |
| **Kitchens** | | | |
| | | | |
| Food stores | 150 | 150 - 300 | 100 |
| | | | |
| General | 500 | 150 - 300 | 300 |
| | | | |
| **Outdoor** | | | |
| | | | |
| Controlled entrance halls or exit gate | 150 | 100 | 150 |
| | | | |
| Entrance and exit car park | 30 | 50 | 30 |
| | | | |
| Stores, stockyards | 30 | 50 | 30 |
| | | | |
| Industrial covered ways | 50 | 50 | 50 |
| | | | |
| **Staff Restaurants** | | | |
| | | | |
| Centre cafeterias, dining room | 300 | 200 | 300 |
| | | | |
| **Medical and First Aids Centres** | | | |
| | | | |
| Consultant room, treatment areas | 500 | | 400 |
| | | | |
| Medical stores | 100 | | 100 |
| | | | |

## Appendix 1: Room Illumination Level (continue)

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| | | | |
| Rest room | 150 | 150 | 100 |
| | | | |
| **Staff Room** | | | |
| | | | |
| Changing locker and cleaner's room, cloakrooms lavatories | 150 | 100 | 150 |
| | | | |
| Rest rooms | 150 | 150 | 150 |
| | | | |
| **Store and Stock Rooms** | | | |
| | | | |
| Telecommunication board, switchboard rooms | | | 500 |
| | | | |
| Cordless switchboard | 300 | | 300 |
| | | | |
| Apparatus rooms | 150 | | 150 |
| | | | |
| Teteprinter rooms | 500 | | 500 |
| | | | |
| **Aircraft Maintenance Hangers** | | | |
| | | | |
| Aircraft engine testing | 750 | | 600 |
| | | | |
| Inspection and repairs (hanger) | 500 | | 500 |
| | | | |
| **Boiler House General** | 150 | | 150 |
| | | | |
| **Fire Stations** | | | |
| | | | |
| Appliance room | 300 | | 300 |
| | | | |
| External apron | 30 | | 30 |
| | | | |
| **Garages** | | | |
| | | | |
| External apron general | 50 | | 50 |
| | | | |
| Pumps | 300 | | 200 |
| | | | |
| Parking areas (interior) general repairs servicing | 30 | | 30 |
| | | | |
| Greasing, pits washing polishing | 500 | | 300 |

## Appendix 1: Room Illumination Level (continue)

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| | | | |
| **Gas Works** | | | |
| | | | |
| Exterior walkways and platforms | 50 | | 50 |
| | | | |
| Exterior stairs and ladders | 100 | | 50 |
| | | | |
| Retort house, oil gas plants, water gas plant purifier, indoor coke, screening and handling plants | 100 | | 100 |
| | | | |
| Booster and exhauster houses | 150 | | 150 |
| | | | |
| **Gauge Tools Rooms** | | | |
| | 1000 | | 600 |
| General | | | |
| | | | |
| **Inspection and Testing shop** | | | |
| | | | |
| Rough work e.g. counting rough Checking of stock parts | 300 | | 200 |
| | | | |
| Medium work e.g. ‘go’ & ‘no go’ gauges sub-assemblies | 500 | | 400 |
| | | | |
| Fine work e.g. radio and telecommunication equipment, calibrated scales, precision mechanism, instruments | 1000 | | 600 |
| | | | |
| Very fine work e.g. gauging and inspections of small intricate parts | 1500 | | 750 |
| | | | |
| Minute work e.g. very small instruments | 3000 | | 1000 |
| | | | |
| **Laboratories** | | | |
| | | | |
| General | 750 | | 500 |
| | | | |
| **Laundries & Dry Cleaning Works** | | | |
| | | | |
| Receiving, sorting, washing, drying, ironing (clending) dispatch, drying cleaning, bulk machine work | 300 | | 200 |
| | | | |
| Hand ironing, pressing, inspection, | | | 300 |

| | | | |
|---|---|---|---|
| mending, spotting | | | |

## Appendix 1: Room Illumination Level (continue)

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| | | | |
| **Machine & Fitting Shop** | | | |
| | | | |
| Rough bench and machine work | 300 | | 200 |
| | | | |
| Medium bench and machine work, ordinary automatic machines, rough grinding, medium buffing, polishing | 500 | | 400 |
| | | | |
| Fine bench and machine work, ordinary automatic machines, rough grinding, medium buffing, polishing | 1000 | | 500 |
| | | | |
| **Pharmaceutical & Fine Chemical Works Pharmaceutical Manufacture** | | | |
| | | | |
| Grinding, granulating mixing and drying, tableting, sterilizing and washing, preparation of solutions and filling, labeling capping, cartooning, warping | 500 | | 300 |
| | | | |
| Inspection | 750 | | 400 |
| | | | |
| Fine chemical manufacture, plant processing | 300 | | 200 |
| | | | |
| Fine chemical finishing | 500 | | 400 |
| | | | |
| Raw material store | 300 | | 200 |
| | | | |
| Inspection | 750 | | 300 |
| | | | |
| **Printing Works Type Foundries** | | | |
| | | | |
| Matrix making, dressing type hand and machine casting | 300 | | 300 |
| | | | |
| Front assembly sorting | 750 | | 400 |

## Appendix 1: Room Illumination Level (continue)

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| | | | |
| **Composing Press** | | | |
| | | | |
| Hand composing, imposition and distribution | 750 | | 500 |
| | | | |
| Machine, composition-key board | 750 | | 500 |
| | | | |
| Machine, composition casting | 300 | | 200 |
| | | | |
| Proof press | 500 | | 300 |
| | | | |
| Illuminated tables general lighting | 300 | | 200 |
| | | | |
| **Printing Machine Room** | | | |
| | | | |
| Presses | 500 | | 300 |
| | | | |
| Premake ready | 500 | | 300 |
| | | | |
| Printed-sheet inspection | 1000 | | 500 |
| | | | |
| **Graphic Reproduction** | | | |
| | | | |
| General | 500 | | 300 |
| | | | |
| Precision proofing, retouching, etching | 1000 | | 500 |
| | | | |
| **Rubber Processing Factories** | | | |
| | | | |
| Preparation needs, dipping molding, compounding calendaring | 300 | | 200 |
| | | | |
| Tyre and tube making | 500 | | 300 |
| | | | |
| **Sheet Metal Works** | | | |
| | | | |
| Benchwork, scribing, inspection | 750 | | 400 |
| | | | |
| Pressing, punching, shearing stamping, spinning, folding | 500 | | 300 |

## Appendix 1: Room Illumination Level (continue)

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| | | | |
| **Slaughter House** | | | |
| | | | |
| General | 500 | | 300 |
| | | | |
| Inspection | 750 | | 400 |
| | | | |
| **Welding & Soldering Shop** | | | |
| | | | |
| Gas and arc welding rough spot welding | 300 | | 200 |
| | | | |
| Medium soldering, brazing spot welding e.g. domestic hand ware | 500 | | 300 |
| | | | |
| Fine soldering, spot welding e.g. instrument | 1000 | | 500 |
| | | | |
| Very fine soldering, spot welding e.g. radio valves | 1500 | | 750 |
| | | | |
| **Woodworking Shop** | | | |
| | | | |
| Rough sawing, benchwork | 300 | | 200 |
| | | | |
| Sizing, planning, rough sanding medium and bench work gluing cooperage | 500 | | 300 |
| | | | |
| Fine bench and machine work fine sanding, finishing | 750 | | 400 |
| | | | |
| **Office** | | | |
| | | | |
| General office with mainly clerical task and typing office | 500 | 300 - 400 | 500 |
| | | | |
| Deep plan general offices | 750 | 300 - 400 | 300 |
| | | | |
| Business machine and typing | 750 | 300 - 400 | 300 |
| | | | |
| Filling room | 300 | 200 | 300 |
| | | | |
| Conference rooms | 750 | 300 - 400 | 300 |

## Appendix 1: Room Illumination Level (continue)

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| | | | |
| **Offices & Shop** | | | |
| | | | |
| Executive office | 500 | 300 - 400 | 300 |
| | | | |
| Computer rooms | 500 | 300 - 400 | 500 |
| | | | |
| Punch card rooms | 750 | 300 - 400 | 600 |
| | | | |
| Drawing offices drawing boards | 750 | 300 - 400 | 600 |
| | | | |
| Reference table and general | 500 | 300 - 400 | 300 |
| | | | |
| Print room | 300 | 300 - 400 | 300 |
| | | | |
| **Shop** | | | |
| | | | |
| Conventional with counters | 500 | 200 - 750 | 500 |
| | | | |
| Conventional with wall display | 500 | 200 - 750 | 500 |
| | | | |
| **Shop** | | | |
| | | | |
| Self service | 500 | 200 - 750 | 500 |
| | | | |
| Supermarkets | 500 | 200 - 750 | 500 |
| | | | |
| Hypermarkets | 500 | 200 - 750 | 500 |
| | | | |
| General | 500 | 200 - 750 | 500 |
| | | | |
| **Public and Educational Building Assembly and Concert Halls** | | | |
| | | | |
| Theatre and concert halls | 100 | | 100 |
| | | | |
| Cinemas | 50 | | 50 |
| | | | |
| Multipurpose | 500 | | 300 |
| | | | |
| **Further Education Establishment** | | | |
| | | | |
| Lecture theatres general | 500 | 300 -500 | 300 |
| | | | |
| Chalkboard | 500 | 300 -500 | 300 |
| | | | |
| Demonstration benches | 500 | 300 -500 | 300 |

## Appendix 1: Room Illumination Level (continue)

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| | | | |
| Examination halls, seminar rooms, teaching spaces | 500 | 300 -500 | 300 |
| | | | |
| Laboratories | 500 | 300 -500 | 300 |
| | | | |
| **Further Education Establishment** | | | |
| | | | |
| Workshop | 300 | | 300 |
| | | | |
| Staff rooms, student rooms / students hostels etc | | | |
| | | | |
| Gymnasium | | | |
| | | | |
| **Libraries** | | | |
| | | | |
| Shelves, book stack | 150 | 300 - 500 | 150 |
| | | | |
| Reading table | 500 | 300 - 500 | 500 |
| | | | |
| Reading rooms, newspaper and magazines | 500 | 300 - 500 | 500 |
| | | | |
| Reference libraries | 500 | 300 - 500 | 500 |
| | | | |
| Counters | 500 | 300 - 500 | 500 |
| | | | |
| Cataloging and sorting | 500 | 300 - 500 | 500 |
| | | | |
| Binding | 500 | 300 - 500 | 500 |
| | | | |
| Closed book store | 100 | | 100 |
| | | | |
| **Museum & Art Galleries General** | | | |
| | | | |
| Exhibits insensitive to light | 300 | 300 | 300 |
| | | | |
| Light sensitive exhibit | 150 | | 150 |
| | | | |
| Specially light sensitive exhibit | 50 | | 50 |

## Appendix 1: Room Illumination Level (continue)

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| | | | |
| **School** | | | |
| | | | |
| Assembly hall general | special lighting | special lighting | special lighting |
| | | | |
| Platform and stage | 300 | 300 | 200 |
| | | | |
| Teaching spaces general | 300 | 300 | 200 |
| | | | |
| General where also used for further education | 500 | 300 | 300 |
| | | | |
| Chalkboard | 500 | 300 | 300 |
| | | | |
| Beedlework rooms | 500 | 300 | 300 |
| | | | |
| Art rooms | | | |
| | | | |
| Laboratories | 500 | 300 | 300 |
| | | | |
| Workshop | 300 | 300 | 200 |
| | | | |
| Gymnasium | 300 | 300 | 200 |
| | | | |
| Music practice rooms | 300 | 300 | 200 |
| | | | |
| **Transport Terminal Building** | | | |
| | | | |
| Airport coach and railway station | | | |
| | | | |
| Reception areas (desk) customs and immigration halls | 500 | | 300 |
| | | | |
| Railway stations booking offices | 500 | | 300 |
| | | | |
| Railway station parcel and left luggage offices counters | 300 | | 200 |
| | | | |
| Circulation area | 150 | | 100 |
| | | | |
| Waiting area | 300 | | 200 |

## Appendix 1: Room Illumination Level (continue)

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| | | | |
| **Hospital** | | | |
| | | | |
| Ward unit bed heads general | 30 - 50 | | 50 |
| | | | |
| General | 150 | | local lighting |
| | | | |
| Night | 0.1 | | |
| | | | |
| Nurse station evening | 300 | | 300 |
| | | | |
| Pharmacies dispensing bench | 500 | | 300 |
| | | | |
| Shelves | 150 | | |
| | | | |
| Reception general | 300 | | 200 |
| | | | |
| Enquiry desk | 500 | | 300 |
| | | | |
| Laboratories | 500 | | 300 |
| | | | |
| Operating theatre suits general | 400 | | 500 |
| | | | |
| Operating area | | | |
| | | | |
| Recovery room and intensive care units | 30 50 | | bedhead |
| | | | |
| X-ray department radio-diagnostic and rooms fluoroscopy | 500 | | 500 |
| | | | |
| Dental surgeries | | | |
| | | | |
| **Homes** | | | |
| | | | |
| Living rooms general | 50 | | 50 |
| | | | |
| Casual reading | 150 | | 150 |
| | | | |
| Sewing darningsrudies desk and protuged | 300 | | 300 |
| | | | |
| Bedroom general | 50 | | 50 |
| | | | |
| Bedlead kitchen | 150 | | 150 |
| | | | |
| Kitchen working area | | | |

## Appendix 1: Room Illumination Level (continue)

| General Building Areas | IES Standards Illumination Level | MS 1525 Recommendation | Panduan Teknik JKR |
|---|---|---|---|
| | | | |
| Bathrooms | 100 | | 100 |
| | | | |
| Halls and landings | 150 | | 150 |
| | | | |
| Stairs | 100 | | 100 |
| | | | |
| Workshops | 300 | | 200 |
| | | | |
| Garages | 50 | | 50 |
| | | | |
| **Indoor Sports & Recreational Building** | | | |
| | | | |
| **Multipurpose Sports Halls** | | | |
| | | | |
| Athletics, basketball, bowls, judo | 300 | | 200 |
| | | | |
| Hockey | 700 | | 500 |
| | | | |
| **Badminton Courts** | 300 | | 300 |
| | | | |
| **Billiard Rooms** | | | |
| | | | |
| General | 100 | | 150 |
| | | | |
| Table | special lighting | | |
| | | | |
| **Card Rooms** | 300 | | 300 |
| | | | |
| **Gymnasia General** | 500 | | 300 |
| | | | |
| **Swimming Pool** | | | |
| | | | |
| Top pool | 500 | | 300 |
| | | | |
| Spectator areas | 150 | | 150 |
| | | | |
| Club recreational | 300 | | 200 |
| | | | |
| **General** | | | |
| | | | |
| Changing rooms showers lockers rooms | 150 | 150 | 150 |
| | | | |
| **Table Tennis** | | | |
| | | | |
| Club | 300 | | 200 |

| | | | |
|---|---|---|---|
| Recreational | 200 | | 200 |

**Appendix 2: Lamp Lumen Table**

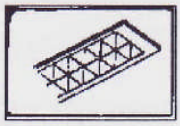
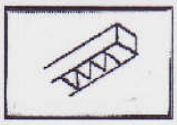
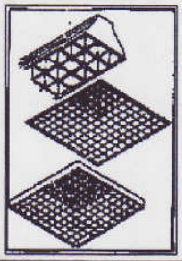
| Jenis Lampu | Lumen (LDL) |
|---|---|
| Pendaflour 1x18w | 1130 |
| Pendaflour 2x18w | 2260 |
| Pendaflour 3x18w | 3390 |
| Pendaflour 1x36w | 2650 |
| Pendaflour 2x36w | 5300 |
| Pendaflour 3x36w | 7950 |
| Pendaflour 4x36w | 10600 |
| Tungsten Bulb 40W | 325 |
| Tungsten Bulb 60W | 576 |
| Tungsten Bulb 100W | 1160 |
| Mercury 80W | 2500 |
| Mercury 125W | 4600 |
| Mercury 250W | 10400 |
| Mercury 400W | 18000 |
| Mercury 700W | 32000 |
| Metal Halide 70W | 5500 |
| Metal Halide 150W | 12500 |
| Metal Halide 400W | 22000 |
| Metal Halide 1000W | 70000 |
| Metal Halide 250W | 18000 |
| Down Light SL16 | 1000 |
| PL-L/4P 18w | 1200 |
| PL-L/4P 24w | 1800 |
| PL-L/4P 36w | 2900 |
| PL-L/4P 40w HF | 3500 |
| PL-L/4P 55w HF | 4800 |
| PL-S/2P 5w | 250 |
| PL-S/2P 7w | 400 |
| PL-S/2P 9w | 600 |
| PL-S/2P 11w | 900 |
| PL-S/4P 5w | 250 |
| PL-S/4P 7w | 400 |
| PL-S/4P 9w | 600 |
| PL-S/4P 11w | 900 |
| PL-C/2P 10w | 600 |
| PL-C/2P 13w | 900 |
| PL-C/2P 18w | 1200 |
| PL-C/2P 26w | 1800 |
| PL-C/4P 10w | 600 |
| PL-C/4P 13w | 900 |
| PL-C/4P 18w | 1200 |
| PL-C/4P 26w | 1800 |
| PL-C/2P 2 x 26w | 3600 |
| PL-E/C 9w 230-240V | 400 |

| | |
|---|---|
| PL-E/C 11w 230-240V | 600 |

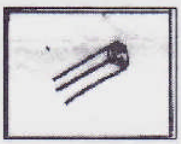
**Appendix 2: Lamp Lumen Table (continue)**

| | |
|---|---|
| PL-E/C 15w 230-240V | 900 |
| PL-E/C 20w 230-240V | 1200 |
| PL-E/C 23w 230-240V | 5000 |
| SL Comfort 9w | 350 |
| SL Comfort 13w | 550 |
| SL Comfort 18w | 800 |
| SL Comfort 25w | 1050 |
| SL Prismat 9w | 400 |
| SL Prismat 13w | 600 |
| SL Prismat 18w | 900 |
| SL Prismat 25w | 1200 |
| SON 50w Standard | 3400 |
| SON 70w Standard | 5600 |
| SON 1000w Standard | 130000 |
| SON PLUS 100w | 10000 |
| SON PLUS 150w | 16000 |
| SON PLUS 250w | 30000 |
| SON PLUS 400w | 54000 |
| SON COMFORT 150w | 12500 |
| SON COMFORT 250w | 22000 |
| SON COMFORT 400w | 37000 |
| QL 55w | 3500 |
| QL 85w | 6000 |
| High-Bay | 150 |

## Appendix 3: Coefficient of Utilization Table

| | Description of Fitting and Typical Downward Light Output Ratio % | Typical Outline | Basic Downward L.O.R. % | Ceilling | | 70 | |
|---|---|---|---|---|---|---|---|
| | | | | Walls | 50 | 30 | 10 |
| | | | | Room Index | | | |
| (M) | Aluminium industrial reflector (72-76) .. .. |  | 70 | 0.6 | 0.39 | 0.36 | 0.33 |
| | | | | 0.8 | 0.48 | 0.43 | 0.4 |
| (T) | High-bay reflector, aluminium (72) or enamel (66) .. .. | | | 1 | 0.52 | 0.49 | 0.45 |
| | | | | 1.25 | 0.56 | 0.53 | 0.5 |
| | | | | 1.5 | 0.6 | 0.57 | 0.54 |
| | | | | 2 | 0.66 | 0.62 | 0.59 |
| | | | | 2.5 | 0.67 | 0.64 | 0.62 |
| | | | | 3 | 0.69 | 0.66 | 0.64 |
| | | | | 4 | 0.71 | 0.68 | 0.67 |
| | | | | 5 | 0.72 | 0.7 | 0.69 |
| (F) | Recessed louvered trough with optically designed reflecting surfaces (50) .. .. |  | 50 | 0.6 | 0.28 | 0.25 | 0.23 |
| | | | | 0.8 | 0.34 | 0.31 | 0.28 |
| | | | | 1 | 0.37 | 0.35 | 0.32 |
| | | | | 1.25 | 0.4 | 0.38 | 0.35 |
| | | | | 1.5 | 0.43 | 0.41 | 0.38 |
| | | | | 2 | 0.46 | 0.44 | 0.42 |
| | | | | 2.5 | 0.48 | 0.46 | 0.44 |
| | | | | 3 | 0.49 | 0.478 | 0.46 |
| | | | | 4 | 0.5 | 0.49 | 0.48 |
| | | | | 5 | 0.51 | 0.5 | 0.49 |
| (F) | Suspended louvered metal trough, upward and downward light, optically designed reflecting surfaces (47-54) .. .. |  | 50 | 0.6 | 0.35 | 0.32 | 0.29 |
| | | | | 0.8 | 0.41 | 0.38 | 0.35 |
| | | | | 1 | 0.46 | 0.42 | 0.4 |
| | | | | 1.25 | 0.49 | 0.46 | 0.43 |
| | | | | 1.5 | 0.52 | 0.49 | 0.46 |
| | | | | 2 | 0.56 | 0.53 | 0.51 |
| | | | | 2.5 | 0.58 | 0.55 | 0.53 |
| | | | | 3 | 0.59 | 0.57 | 0.55 |
| | | | | 4 | 0.61 | 0.59 | 0.57 |
| | | | | 5 | 0.63 | 0.6 | 0.59 |
| (M) | Reflectorised colour-corrected mercury lamp MBFR/U (80-90) .. .. .. |  | 85 | 0.6 | 0.4 | 0.34 | 0.3 |
| | | | | 0.8 | 0.53 | 0.46 | 0.41 |
| | | | | 1 | 0.62 | 0.55 | 0.49 |
| | | | | 1.25 | 0.68 | 0.6 | 0.55 |
| | | | | 1.5 | 0.72 | 0.65 | 0.59 |
| | | | | 2 | 0.81 | 0.73 | 0.67 |
| | | | | 2.5 | 0.85 | 0.78 | 0.72 |
| | | | | 3 | 0.9 | 0.83 | 0.78 |
| | | | | 4 | 0.94 | 0.89 | 0.84 |
| | | | | 5 | 0.97 | 0.92 | 0.89 |
| (F) | Enamel slotted trough, louvered (45-55) .. |  | 50 | 0.6 | 0.27 | 0.24 | 0.22 |
| (F) | Louvered recessed (module) fitting (40-50) .. .. .. | | | 0.8 | 0.32 | 0.3 | 0.27 |
| (F) | Shallow ceilling-mounted louver panel (40-50) .. .. .. | | | 1 | 0.35 | 0.32 | 0.3 |
| | | | | 1.25 | 0.38 | 0.35 | 0.32 |
| | | | | 1.5 | 0.41 | 0.38 | 0.36 |
| | | | | 2 | 0.45 | 0.42 | 0.4 |
| | | | | 2.5 | 0.47 | 0.44 | 0.42 |
| | | | | 3 | 0.48 | 0.45 | 0.44 |
| | | | | 4 | 0.49 | 0.47 | 0.46 |
| | | | | 5 | 0.5 | 0.49 | 0.48 |

## Appendix 3: Coefficient of Utilization Table (continue)

| | Description of Fitting and Typical Downward Light Output Ratio % | Typical Outline | Basic Downward L.O.R. % . | Ceilling | | 70 | |
|---|---|---|---|---|---|---|---|
| | | | | Walls | 50 | 30 | 10 |
| | | | | Room Index | | | |
| (F) | Suspended opaquesided fitting, upward and downward light, diffuser or louver beneath (40-50) .. .. |  | 45 | 0.6 | 0.28 | 0.24 | 0.2 |
| | | | | 0.8 | 0.36 | 0.3 | 0.28 |
| | | | | 1 | 0.41 | 0.36 | 0.32 |
| | | | | 1.25 | 0.45 | 0.41 | 0.36 |
| | | | | 1.5 | 0.49 | 0.45 | 0.4 |
| | | | | 2 | 0.55 | 0.5 | 0.46 |
| | | | | 2.5 | 0.58 | 0.53 | 0.5 |
| | | | | 3 | 0.6 | 0.56 | 0.53 |
| | | | | 4 | 0.63 | 0.59 | 0.57 |
| | | | | 5 | 0.65 | 0.62 | 0.6 |
| (F) | Plastic trough, louvered (45-55) .. .. .. |  | 50 | 0.6 | 0.26 | 0.22 | 0.19 |
| | | | | 0.8 | 0.34 | 0.29 | 0.26 |
| | | | | 1 | 0.39 | 0.34 | 0.3 |
| | | | | 1.25 | 0.43 | 0.38 | 0.34 |
| | | | | 1.5 | 0.46 | 0.41 | 0.37 |
| | | | | 2 | 0.5 | 0.46 | 0.43 |
| | | | | 2.5 | 0.53 | 0.49 | 0.46 |
| | | | | 3 | 0.55 | 0.51 | 0.49 |
| | | | | 4 | 0.58 | 0.54 | 0.52 |
| | | | | 5 | 0.6 | 0.57 | 0.55 |
| (F) | Plastic trough, unlouvered (60-70) .. .. |  | 70 | 0.6 | 0.33 | 0.28 | 0.25 |
| | | | | 0.8 | 0.42 | 0.37 | 0.33 |
| | | | | 1 | 0.48 | 0.43 | 0.38 |
| | | | | 1.25 | 0.52 | 0.47 | 0.43 |
| | | | | 1.5 | 0.56 | 0.51 | 0.47 |
| | | | | 2 | 0.62 | 0.56 | 0.53 |
| | | | | 2.5 | 0.65 | 0.6 | 0.57 |
| | | | | 3 | 0.67 | 0.63 | 0.6 |
| | | | | 4 | 0.7 | 0.66 | 0.64 |
| | | | | 5 | 0.73 | 0.69 | 0.67 |
| (T) | Near-spherical diffuser, open beneath (50) .. .. .. |  | 50 | 0.6 | 0.28 | 0.22 | 0.18 |
| | | | | 0.8 | 0.39 | 0.3 | 0.26 |
| | | | | 1 | 0.43 | 0.36 | 0.32 |
| | | | | 1.25 | 0.48 | 0.41 | 0.37 |
| | | | | 1.5 | 0.52 | 0.46 | 0.41 |
| | | | | 2 | 0.58 | 0.52 | 0.47 |
| | | | | 2.5 | 0.62 | 0.56 | 0.52 |
| | | | | 3 | 0.65 | 0.6 | 0.56 |
| | | | | 4 | 0.68 | 0.64 | 0.61 |
| | | | | 5 | 0.71 | 0.68 | 0.65 |
| (F) (F) | Bare lamp on celling Batten fitting (60-70) |  | 65 | 0.6 | 0.29 | 0.24 | 0.19 |
| | | | | 0.8 | 0.37 | 0.31 | 0.27 |
| | | | | 1 | 0.44 | 0.37 | 0.33 |
| | | | | 1.25 | 0.49 | 0.42 | 0.38 |
| | | | | 1.5 | 0.54 | 0.47 | 0.42 |
| | | | | 2 | 0.6 | 0.52 | 0.49 |
| | | | | 2.5 | 0.64 | 0.57 | 0.53 |
| | | | | 3 | 0.67 | 0.61 | 0.57 |
| | | | | 4 | 0.71 | 0.66 | 0.62 |
| | | | | 5 | 0.74 | 0.7 | 0.66 |
| (F) | Enclosed plastic diffuser (45-55) .. .. .. |  | 50 | 0.6 | 0.27 | 0.21 | 0.18 |
| | | | | 0.8 | 0.34 | 0.29 | 0.26 |
| | | | | 1 | 0.4 | 0.35 | 0.31 |
| | | | | 1.25 | 0.44 | 0.39 | 0.35 |
| | | | | 1.5 | 0.47 | 0.42 | 0.38 |
| | | | | 2 | 0.52 | 0.47 | 0.44 |
| | | | | 2.5 | 0.55 | 0.51 | 0.48 |
| | | | | 3 | 0.58 | 0.54 | 0.51 |
| | | | | 4 | 0.61 | 0.57 | 0.54 |
| | | | | 5 | 0.63 | 0.59 | 0.57 |