Department Of Occupational Safety And Health
Ministry Of Human Resources
Malaysia

GUIDELINES ON OCCUPATIONAL SAFETY AND HEALTH FOR LIGHTING AT WORKPLACE 2018

PREFACE

These guidelines may be cited as the Guidelines on Occupational Safety and Health for Lighting at Workplace.

The purpose of the guidelines is to provide a guidance to achieve visual environments which are comfortable and suited to the function of the interior. It is largely concerned with artificial lighting at workplaces generally and excludes specialised activities such as underground mining, diving and offshore operations, certain types of entertainment and photographic processing.

All employers are expected to adopt and adapt these guidelines as a source of reference in managing lighting at workplace. It is a general duty under the Occupational Safety and Health Act 1994 and the Factories and Machinery Act 1967 to ensure not only the safety, health and welfare of employees at work but also the visitors and passers-by. As part of these, they should provide lighting which is appropriate to the workplace and its activities, as inadequate or unsuitable lighting can cause accidents or ill health.

These guidelines will be reviewed from time to time. Employers, employees and occupational safety and health practitioners are encouraged to give their comments in writing to the Department of Occupational Safety and Health, Malaysia so that these guidelines can be continuously improved.

I would like to thank and acknowledge those who have contributed in the development of these guidelines.

Director General
Department of Occupational Safety and Health,
Malaysia
2018

ABBREVIATION

BS : British Standard
CIE : International Commission on Illumination
CRI : Colour Rendering Index
DIN ; Deutsches Institute Für Normung
F : Fluorescent
HID : High Intensity Discharge
HSE : Health And Safety Executive
HSG : Health And Safety Guidance
Hz : Hertz
IES : Illuminating Engineering Society
IR : Infrared
IRR : Infrared Radiation
LED : Light Emitting Diode
lm : Lumen
lx : Lux
UK : United Kingdom
UV : Ultra-Violet
UVR : Ultra-Violet Radiation

ACKNOWLEDGEMENT

The Department of Occupational Safety and Health Malaysia would like to thank the following individuals for their most valuable contributions during the drafting of these guidelines. The Guidelines on Occupational Safety and Health for Lighting at Workplace has been prepared by the drafting committee comprising of:

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Special thanks are extended to Ir. Dr. Majahar bin Abd Rahman (DOSH), Ir. Haji Anuar bin Mohd Mokhtar (OSHChem Consultancy) and Safial Eqbal bin Zakaria (Open University Malaysia) who also contributed to the success of these guidelines.

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Good lighting contributes to the safety and health at workplace by enabling employees to perform their work comfortably and efficiently. The quicker and easier it is to see a hazard, the more easily it is avoided. The types of hazards present at work therefore determine the lighting requirements for safe operation.

There must be sufficient light in the workplace to ensure the safety and health of every employee. The lighting in the workplace should enable employees to comfortably see what they need to do their tasks. Good lighting also creates a pleasant atmosphere and gives employees a sense of well-being. This can improve their productivity and efficiency.

Poor lighting makes it hard for employees to see and can lead to visual fatigue and discomfort. It can affect the health of people at work causing symptoms like eyestrain, migraine and headaches. Other than that, poor lighting at work can represent a significant cost to business in the form of time off work as a result of accidents and injuries, increased absenteeism and also can reduced staff efficiency and productivity.

These guidelines deal mainly with lighting at work and how it affects the safety, health and welfare at the workplace.

1.1 Purpose

The purpose of the guidelines is to provide a guidance on how :

i) To identify the potential hazards arising from the work activity under the current lighting condition;

ii) To evaluate the risks; and

iii) To decide improvement measures needed to protect the employees.

1.2 Scope and Application

These guidelines cover issues related to interior lighting in the workplaces under the purview of Occupational Safety and Health Act 1994 [Act 514]. It may be used by any employer, employee, occupational safety and health practitioner and personnel who design, install and maintain lighting installations. These guidelines apply principally to artificial lighting but recommendations relating to the use of natural lighting are also included.

2.0 LEGAL REQUIREMENT

The guidelines provide practical guidance and advice on how to comply with the provisions of these Acts:

2.1 Factories and Machinery Act (FMA) 1967

Section 22(1)(e) of the Factories and Machinery Act, 1967 stipulates effective provision shall be made for securing and maintaining sufficient and suitable lighting, whether natural or artificial, in every part of a factory in which persons are working or passing.

2.2 Factories and Machinery (Safety, Health and Welfare) Regulations, 1970

Regulation 29 of the Factories and Machinery (Safety, Health and Welfare) Regulations, 1970 prescribed the responsibility of occupier with regards to lighting provisions. The responsibilities include:

i) Specifying the intensity of lighting required;
ii) Adequate measures to prevent the formation on shadows; and
iii) Provision of emergency lighting.

2.3 Occupational Safety and Health Act (OSHA) 1994

Under Section 15 of the Occupational Safety and Health Act 1994, duties and responsibilities of employers and the self employed persons are clearly stated. The responsibilities include:

i) Provision and maintenance of plant and system of work to ensure safety and without risk to health;
ii) Make arrangement to ensure safety and absence of risks to health in connection with the use or operation, handling, storage and transport of plant and substance;
iii) Provision of necessary information, instruction and training to and supervision of employees to enable them to perform their work safely;

iv) Provision and maintenance of working environment that is safe and without risk to health and adequate welfare facilities; and

v) Providing good visual environment is in conformance to these requirements.

3.0 DEFINITIONS

3. 1 Luminous Flux

Luminous flux is the quantity of the energy of the light emitted per second in all directions. The unit of luminous flux is a lumen (lm). One lumen is a luminous flux of the uniform point light source that has luminous intensity of 1 candela and is contained in one unit on spatial angle (or 1 steradian). The steradian is the spatial angle that limits a surface area of the sphere equal to the square of the radius (r^2).

3.2 Luminous Intensity

Luminous intensity is the ability to emit light into a given direction, or it is the luminous flux that is radiated by the light source in a given direction within the unit of the spatial angel. If the point light source emits Ø lumens into a small spatial angel β, the luminous intensity is I=Ø/β.

The unit of luminous intensity is candela. There is a standard that details the candela definition. This includes the standard light source and the physical conditions of the measurement.

3.3 Illuminance

Illuminance is the measurement of the amount of light falling onto (illuminating) and spreading over a given surface area. Illuminance also correlates with how humans perceive the brightness of an illuminated area. The SI unit for illuminance is lux (lx) and the non SI unit is foot-candle. The term “foot-candle” means “the illuminance on a surface by a candela source one foot away”. One foot-candle is equivalent to one lumen per square foot which is approximately 10 lux.

3.4 Luminaire

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

3.5 General Lighting

Lighting designed to illuminate an area without special provision for local requirements within that area. Normally this is provided by an arrangement of luminaires which produce approximately uniform illuminance throughout an interior.

3.6 Local Lighting

Lighting designed to illuminate a particular small area which usually does not extent far outside the visual task (e.g. a desk light).

3.7 Working Plane

The horizontal, vertical or inclined plane in which the visual task lies, unless otherwise indicated, the plane is assumed to be horizontal and 0.85 meter above floor.

3.8 Reflectance

The ratio of the luminous flux reflected from a surface to the incident luminous flux. It is usually expressed as a percentage.

3.9 Glare

The discomfort or impairment of vision experienced when parts of the visual field are excessively bright in relation to the general surroundings.

4.0 LIGHTING IN VIEW OF SAFETY AND HEALTH

Good lighting whether natural or artificial plays an important role in promoting safety and health at place of work. It helps employees to see hazards and it can reduce the likelihood of visual fatigue and discomfort.

To ensure workplace have a good lighting, the lighting system shall be designed and installed properly to provide a safe and comfortable visual working environment. For example, the lighting requirement recommended for offices range between 200 lux to 750 lux depending on types of task. For other rooms and activities, the lighting requirement is recommended in **Appendix 1**.

The benefits of good lighting are:

i) It allows employees to comfortably see what they are doing, without straining their eyes or their bodies;
ii) It makes work easier and more productive;
iii) It draws attention to hazardous operations and equipments; and
iv) It helps prevent costly errors and accidents.

4.1 Safety Aspects of Lighting

In general, safety behaviour is influenced markedly by prompt and correct identification and evaluation of workplace hazards. The faster and easier a hazard can be seen or identified, the easier it can be avoided. The nature of the hazard present at work thus determines the lighting needed for safety.

In all working and accessible areas, a person must be able to see in order to move about without tripping, falling or walking into obstacles. In addition, some jobs may require the ability to see fine details. For example machines operators may need to see the work pieces from a distance or to read gauges and displays accurately.

The level and type of lighting needed for safety in working areas therefore depends on:

i) The type of work being carried out or effectively reveals the task;

ii) The hazard associated with it; and

iii) Safe and comfortable visual working environment

4.1.1 Illuminance and Planes

The amount of light on a surface affects our ability to see. The finer the detail, the higher the illuminance required. Of equal importance is the illuminance in adjacent areas. It is not sufficient to illuminate one area if an adjacent area through which movement occurs is inadequately lit. This is often the case on construction sites and in storage areas.

One further and often neglected aspect of illuminance is the plane on which it is provided. In most circumstances where there is little obstruction and surface reflectance is high illuminance should be provided primarily on the horizontal plane, for example in office and electronic factories where the work is small in scale. However, where the predominant tasks are on vertical planes as in warehouse or where there is considerable obstruction to lighting, illuminance should be provided on other planes as necessary.

4.1.2 Glare Effects

Glare is a contrast in brightness between different objects in one's field of vision. It occurs when one part of the visual field is brighter than the average brightness to which the visual system is adapted.

There are two main types of glare: direct and reflected (or indirect).

i) Direct glare is caused by bright areas, such as luminaire ceiling and windows that are directly in the field of view. Refer **Figure 1a**.

ii) Reflected glare is caused by light that bounces off nearby surfaces into the employee's eyes. Dark coloured or glossy surfaces such as desk tops, glass table tops, and computer monitors are especially problematic because they intensify the glare. Reflected glare causes the employee more visual fatigue because it is closer to the line of vision than direct glare. Refer **Figure 1b**.

Both types of glare may arise from the same source.

To check for glare, place a mirror on the work surface. Any bright light that reflects in the mirror is a source of glare.

Where there is direct interference with vision, the condition is known as disability glare. It is relevant to safety because it affects the sensitivity of the visual system.

Driving at night with its headlights on full beam towards a car is a common example of how glare reduces the visibility of objects beside and beyond the oncoming car. The most common sources of disability glare at work are vehicle headlights, light fittings and the sun and sky see-through windows or roof lights. It occurs only when a person tries to look at something close to the light source.

Where vision is not directly impaired but there is discomfort, annoyance, irritability or distraction, the condition is called discomfort glare and it is related to symptoms of visual fatigue.

Figure 1a: Direct glare

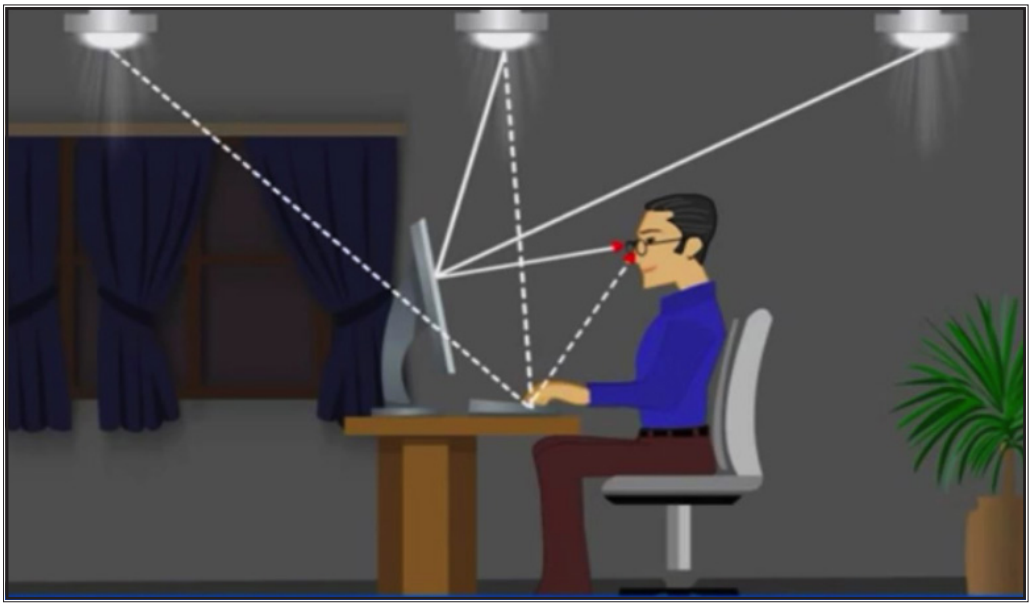


Figure 1b: Reflected glare

4.1.3 Colour Effects

A surface lit by different artificial light sources or by daylight under changing sky conditions, may appear to vary in colour. Where colour judgement is required (e.g. for electrical work), this may affect safety but with most light sources, the change in colour appearance is insufficient to create problems. Under monochromatic light sources, such as low pressure sodium discharge lamps, colours will not be identifiable and a hazard may go unnoticed. At very low illuminances, colour vision fails and all colours are seen as shades of grey. The recommended illuminances in **Appendix 1** are sufficient to ensure that this stage is not reached, and that hazard colours or building service colours can be easily identified.

4.1.4 Stroboscopic Effects

All lamps that operate from an alternating electricity supply may produce oscillations in light output. When the magnitude of these oscillations is great and their frequency is a multiple or sub multiple of the frequency of movement of machinery, that machinery will appear to be stationary or moving in a different manner. This is called the stroboscopic effect. It is not common with modern lighting systems but where it does occur it can be dangerous, so appropriate action should be taken to avoid it.

4.1.5 Flicker

Light flicker refers to quick, repeated changes in light intensity - light that appears to flutter and be unsteady. It is caused when the voltage supplied to a light source changes or when the power line voltage itself fluctuates. The severity of the flicker depends on several factors such as:

i) How often and regularly the voltage fluctuates;

ii) How much of a voltage change occurs;

iii) The kind of light (incandescent, fluorescent or high intensity discharge lighting systems (HID));

vi) The gain factor of the lamp [gain factor is a measure of how much the light intensity changes when the voltage fluctuates - (% relative change in light levels) divided by (% relative fluctuation in voltage)]; or

v) The amount of light in the lighted area (ambient light levels).

4.1.6 Veiling Reflections

Veiling reflections may be sharp-edged or vague in outline, but regardless of form they can affect task performance and cause discomfort. Veiling reflections are high luminance reflections which overlay the detail of the task. Refer **Figure 2**.

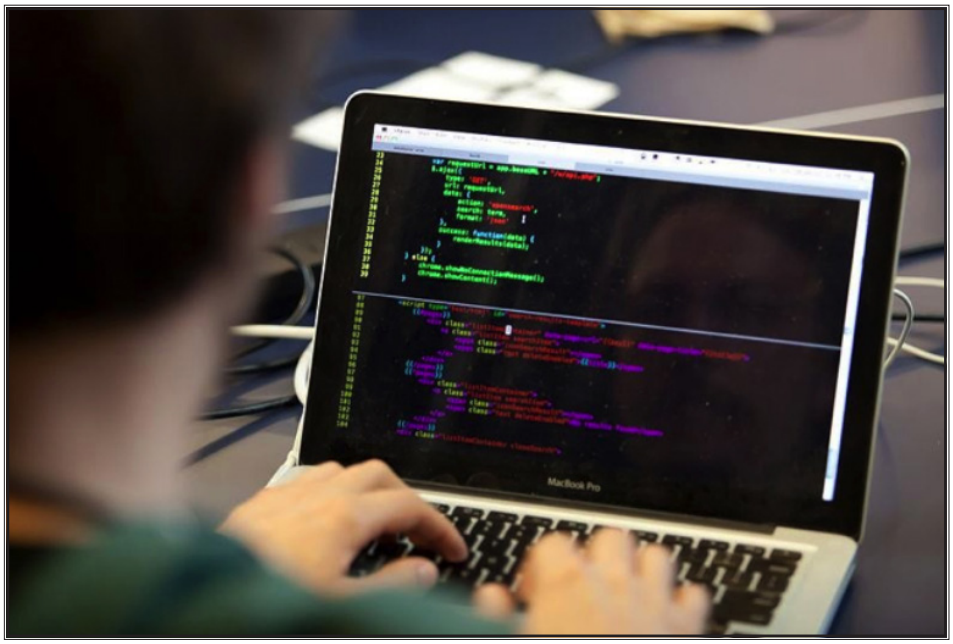


Figure 2: Veiling reflections

4.2 Health Aspects Of Lighting

Poor lighting that makes the visual system work harder, may lead to visual fatigue or eyestrain because the normal healthy eyes cannot be strained by overuse. In sufficient quantities, light can also cause tissue damage or specific sight damage.

4.2.1 Visual Fatigue

Visual fatigue comprises all those symptoms that arise after excessive stress on any of the functions of the eye. The symptoms of visual fatigue vary according to the lighting condition and the task being carried out. The symptoms are likely to occur whenever the visual system has to act at the limits of its capabilities for any length of time. Poor lighting is not the only cause; the inadequacies of a person's visual system can also create problems.

Among the symptoms are:

i) Painful irritation (burning) accompanied by lachrymation, reddening of the eyes and conjunctivitis;

ii) Breakdown of vision e.g. blurred or double vision;

iii) Reduced powers of accommodation and convergence;

iv) Reduced visual acuity, sensitivity to contrast, and speed of perception; and

v) Referred symptoms e.g. headaches, fatigue and giddiness.

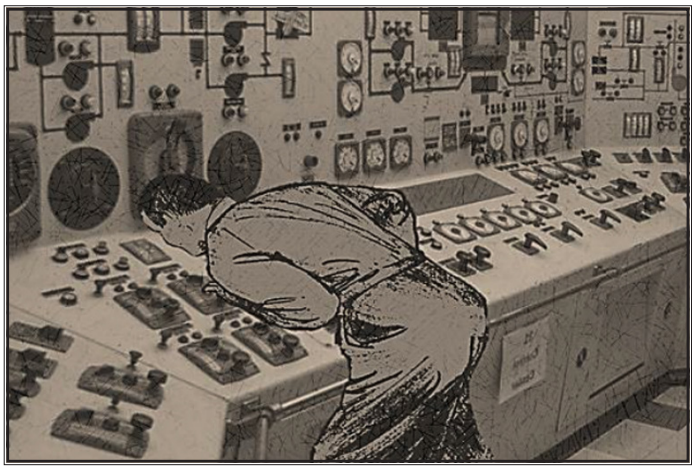


Figure 3: Awkward posture due to insufficient lighting

Poor lighting can also cause other indirect effects of the natural response to insufficient luminance or veiling reflections. For example by getting closer to the task or to look at it from a different direction can mean adopting unusual postures that lead to other forms of strain, such as backache. Refer **Figure 3**.

4.2.2 Tissue Damage

Light sources produce optical radiation in the infrared (IR), visible and ultra-violet (UV) arts of the spectrum. The amount of radiation emitted in each depends on the nature of the source. In sufficient quantities, each type can damage human tissue. There are two main ways in which this can happen;

i) Radiation induces a chemical reaction in the tissue (photochemical); and

ii) Radiation heats or burns exposed tissue (thermal).

4.2.2.1 Infrared Radiation (IRR)

Visible and near IR radiation between the range of IR-A: 700-1400 nanometres are transmitted through the eyes and focused onto the retina. If the temperature of the retina rises, thermal injury or burns may result. Even if there is no appreciable temperature rise, photochemical injury can be caused by the shorter wavelength towards the blue end of the spectrum. Severe over-exposure can lead to permanent disability such as cataract and scotoma, but because light sources capable of causing permanent damage are uncomfortably bright, and the natural tendency to look away from them usually provides protection from accidental exposure. Whoever exposed to such bright source such as glass blower and furnace man should not try to overrule this natural response. If people must look at uncomfortable bright sources, they should wear eye protection with the appropriate filters or shade to reduce the intensity of the luminance.

Longer IR radiation wavelength is not transmitted through the eyes, but is absorbed by the cornea, the humours and the lens. When the lens absorbs such radiation, thermal injury may result which shows up as opacities and cataracts, e.g. glass employees cataract.

Exposure of the skin to longer IR radiation wavelength raises its temperature, and could lead to heat stress and less commonly, to local burns. Discomfort should provide adequate warning.

4.2.2.2 Ultra-Violet Radiation (UVR)

The effects of UV radiation are mainly photochemical. When the shorter UVR wavelength is absorbed by the eye, the conjunctive and cornea may become painfully inflamed. Common examples are ‘arc-eye’ and ‘snow- blindness’.Unless exposure is grossly excessive, this condition is temporary and clears within two days. Longer UVR wavelength is absorbed mainly by the lens of the eye and is thought to contribute to the development of cataracts.

If applied to the skin, UVR causes reddening (erythema). When this happens gradually over a period of days, it may lead to a tan, but excessive UVR wavelength can cause the symptoms associated with sunburn. Prolonged exposure to the high levels of shortwave UVR present in intense sunlight is associated with an increased risk of skin cancers.

Figure 4 shows the normal structure of human eyes.

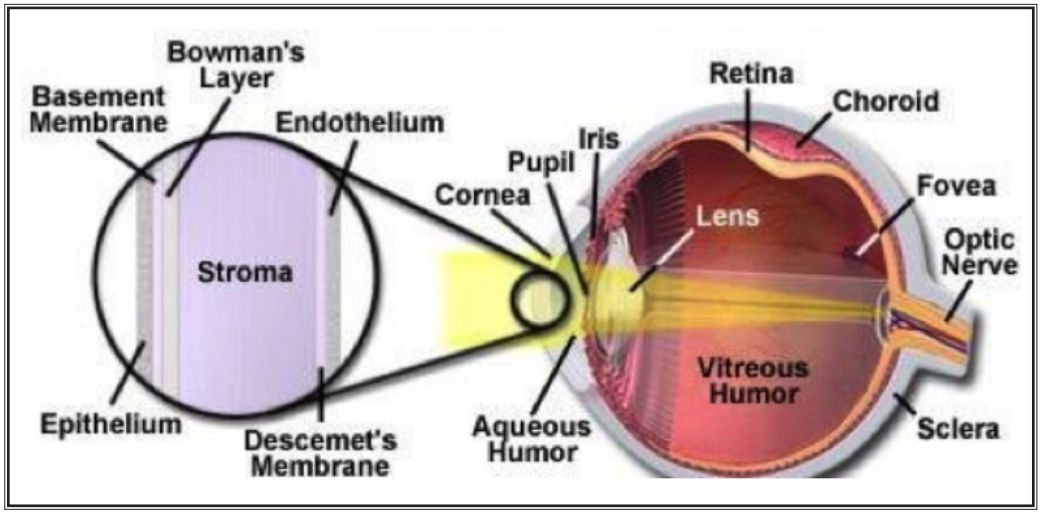


Figure 4: Tissue and structure of the human cornea

5.0 LIGHTING EQUIPMENTS

Lighting equipment should be comprised of lamps, lighting fittings and control system for lighting installation.

5.1 Lamps

A wide range of lamp types is commercially available. Examples for types of lamp are incandescent (tungsten), fluorescent, LED (light emitting diode) and others. Examples for types of lamp is as follow:

Figure 5: Tungsten

Figure 6: Fluorescent

Figure 7: LED

Different lamp types produce light in different ways and hence different properties. Characteristics of lamps widely used for lighting at work are summarized below, and for further detailed information should be available from lamp manufacturers.

5.1.1 Lamp Prefix Letters

These may be found marked on the lamp or on its packing and in our country there are widely used as a means of identification. Additional letters may be added to the end of the prefix according to the construction of the specific lamp, e.g. “F” for a fluorescent coating.

5.1.2 Construction and Appearance

To describe the method of light production and the physical appearance of the lamp, e.g. for tungsten, a tungsten filament heated to incandescence in a glass envelope.

5.1.3 Luminous Efficacy

This is a measure of how efficiently the lamp converts electrical power (measured in watts) to light (measured in lumens). The higher the value of the luminous efficacy, the more efficient the lamp. A range of values is given for each lamp type because luminous efficacy varies with power. These values do not include the power consumed by any control gear that may be required. For example, luminous efficacy for tubular fluorescent is 37 - 90 lm/W.

5.1.4 Life

A lamp can be considered to have reached the end of its life not only when it fails, but also when it flickers markedly or when its efficiency has fallen to an uneconomic level. A range is given for each lamp type as life will depend on the lamp rating, the switching cycle and other operating conditions. For example, tungsten halogen has 2000 – 4000 hours life.

5.1.5 Apparent Colour

The apparent colour of the light emitted by each lamp type, e.g. for tungsten, its apparent colour is warm white light.

5.1.6 Colour Rendering

The extent to which a lamp type will give surface colours the same appearance as they have under a reference light source, usually daylight. Excellent colour rendering implies no distortion of surface colours. The measure is called colour rendering index (CRI). Low CRI indicates an object appears unnatural under the light source, while a light with a high CRI will allow an object's colour to appear more natural.

5.1.7 Run-up Time

Small light sources, for examples from tungsten, tungsten halogen and tubular fluorescent lamps produce light immediately when switched on. All the other lamp types require several minutes to approach full light output, this may be important where installations have to be used at unexpected times.

5.2 Light Fittings

All light fitting must support and protect the lamp, provide electrical connection and be safe during installation and operation. Using incorrect fittings in such circumstances can be dangerous, and they may deteriorate rapidly unless they are frequently maintained. The following are examples for types of light fittings.

Figure 8: Ceiling mounted

Figure 9: Wall mounted

Figure 10: Pole mounted

Refer to **Chapter 6.0** for details about installation of light fitting.

5.3 Control Systems

A control system may be anything from a simple mechanical switch to a sophisticated automatic control system capable of responding to the amount of daylight present or to whether or not a space is occupied.

The following are examples for types of control system.

Figure 11: Switches

Figure 12: Dimmers

Figure 13: Timers

Figure: 14 Sensors

Mechanical switches should not be positioned so that a person has to reach past machinery or cross an unlit area to operate them. Similar consideration applies to automatic control system. If the control system fails, an occupied area may be plunged into darkness, so at least part of the lighting installation should be separated from the automatic control system and all such control system should incorporate a manual override. A further consideration is the extent to which users need to have some form of individual control over light levels and possible sources of glare.

6.0 LIGHTING INSTALLATION

When assessing an existing lighting installation or designing a new one it is essential to establish:

i) The purpose of the installation - e.g. to light task requiring the perception of detail, to light movement areas such as passages;

ii) The conditions in which it will operate - e.g. corrosive, explosive; and

iii) Any constraints imposed by the workplace or the task to be performed - e.g. large plant may obstruct light distribution and restrict the mounting of fittings.

6.1 Interior Lighting

The design of an interior lighting installation will depend on the relationship between use of daylight and artificial lighting. There are three possible courses of action;

i) To rely on daylight during daylight hours and to use artificial lighting only during hours of darkness;

ii) To use available daylight supplemented by artificial lighting; or

iii) To ignore daylight and depend entirely on artificial lighting.

There are three type/broad classes of interior lighting used in workplaces;

i) General lighting - which provides uniform illumination over the whole working area and does not limit the positioning of the work;

Figure 15: General lighting

ii) Localised lighting - which provides different levels of illumination in different parts of the same working areas and it matches the level of illumination to the location of the task;

Figure 16: Localised lighting

iii) Local lighting - which is usually a combination of background lighting and a light fitting close to the actual work area. It is used;

a) When a high level of illumination is needed in small area;

b) When flexible directional lighting is required; and

c) When general lighting is unnecessary or impossible to install because of the layout of the work area.

Figure 17: Local lighting

Which type to choose is a matter of judgement, there is no single best approach. However the lamps and light fitting should always be chosen as a package because each fitting is designed for a limited range lamps. If lamps are put into the wrong fittings, glare control may be poor and lamp life and operating efficiency may be reduced. When replacing lamps in existing fittings, care should be taken to ensure that the lamp and the control system are electrically and physically compatible; if they are not the lamp may become damaged, or the lamp, light fitting or control gear may overheat giving risk to a fire risk.

When a regular array of fittings is to be used, the spacing between fittings needs to be considered. Manufacturers publish maximum spacing per mounting height ratios for each fitting. If these are exceeded, there will be excessive variation in illuminance across the working plane.

Where illuminance on vertical planes is important, it may be useful to space the fittings closer together than the maximum spacing/mounting height ratio allows. This makes the illuminance on vertical surfaces more uniform, but notes that it does not apply where there is a regularly arranged obstruction, as for example, in work stores. Where linear fittings with tubular fluorescent lamps are used, the orientation of the fitting must be considered as well as the spacing. Such fitting are less glaring if viewed end on rather than sideways on. A regular array of fittings should therefore be orientated so that they are end on to the viewing direction with the longest dimension. Corridors are an extreme example; it is generally better to align linear light fittings along the corridor rather than across it.

For installations using local lighting, the positioning of the fitting is important, because it will determine both the illuminance on the task and the degree of glare. Adjustable fitting in particular, need considerable care because what constitutes glare-free lighting for one person may be very glaring for other. Positioning also affects the likelihood of veiling reflections.

The choice of colour in a room is important because dark surfaces reflect very little light. Light reflected off wall, ceiling and other surfaces is distributed much more uniformly than direct lighting, softens shadows created by the installation, diminishes the effect of any veiling reflections and reduces the degree of glare, so high reflectance's are desirable for interior surfaces and for large pieces of machinery.

6.2 Exterior Lighting

The type of exterior lighting installation chosen will depend on:

i) The size of the area to be covered; and

ii) The purpose for which it will be used (e.g. for work, security, or means of access)

In general, all exterior installations should:

i) Achieve a reasonable uniform illuminance on all relevant, working area. The illuminances provided should be consistent with those recommended in **Appendix 1** (Recommended Illuminance)

ii) Avoid glare to the users of those areas and to occupants of nearby areas. Glare is determined by the light distribution of the fittings, the mounting height and, for floodlights, the direction of aiming. For entrance areas, it is possible to use wall mounted, pole mounted or bollard-type fittings. Once again, spacing and light distribution determine the uniformity of illuminance, large spacing and narrow light distribution leading to considerable variation of illuminance. Fitting must be carefully chosen and positioned to avoid glare to those entering or leaving the building.

Many outside workplaces (especially construction sites) have temporary installations and portable lighting including hand lamps is often used. The lighting objectives for these should be the same as for permanent installations although their temporary nature will have implications for the choice of equipment, the means of fixing and the source of electricity.

6.3 Lighting Maintenance

Lighting installations should be designed with maintenance in mind. How often maintenance will have to be carried out depends on the equipment in use and the environment in which it has to operate. It is important to choose light fittings which resist to dirty and corrosive environment. Ease of maintenance will depend on ease of access to the fittings. Fittings that are difficult to reach will not be properly maintained.

In practice, it is best to have a planned maintenance procedure so that:

i) It does not interfere with other activities;

ii) Proper safety procedures are followed; and

iii) The right equipment is available to do job.

7. 0 LIGHTING ASSESSMENT

Lighting assessment is an evaluation of the lighting condition and level of lighting in the work environment for the purpose of:

i) Identifying the potential hazards arising from the work activity under the current lighting condition in the workplace, such as insufficient illumination, excessive contrast, glare or flicker;

ii) Identifying employee who may be harmed; and

iii) Evaluating the risks and decide whether improvement measures are needed to protect the employees, including but not limited to the lighting provision.

Lighting assessment can be conducted in two approaches which are:

i) Walkthrough inspection

ii) Lighting measurement.

7.1 Lighting Assessment Step

These guidelines focus on the measurement of lighting and compare them with the recommended values in **Appendix 1**. A flow chart of lighting assessment is shown in **Figure 18**.

Figure 18: Lighting assessment flow chart

7.2 Walkthrough Inspection

Walkthrough inspection is a process to identify the existing lighting condition in the work area. The person carry out the inspection can identify most lighting problems such as dim work environment, defective lamps, strong glare and reflections. The locations and numbers of point to be measured should be identified clearly. Light bulbs and tubes which have blown or are reduced in brightness should be replaced before conduct lighting measurement. Lighting Checklist in **Appendix 2** can be used as a guidance.

7.3 Lighting Measurement

Lighting measurement is conducted for the purpose of determining or verifying lighting or illuminance level for tasks or activities involved in the related work area. Illuminance is measured using a light meter (Lux meter) which is a handy instrument equipped with sensor for light detection. The measured illuminance is directly displayed in lux (lx). Lux (lx) is the SI unit of illuminance and luminous emittance, measuring luminous flux per unit area (refer **Figure 19:** Illustration of lux and footcandle). In general, lux meters conforming to internationally recognised specifications, such as BS 667: 2005[1], DIN 5032-7:1985[2] or CIE Publication No. 69 (1987)[3], should be used. There should be regular calibration, typically once a year, to ensure accurate measurement. A good lux meter with error less than 10% is available in the market. Measurement data should be recorded.

[1] British Standard, *BS 667:2005 Illuminance Meters – Requirements and Test Methods, 2005.*

[2] German Standard, *DIN 5032-7:1985 Photometry; Classification of Illuminance Meters and Luminance Meters.*

[3] International Commission on Illumination Publication, *CIE Publication No. 69 (1987) Methods of Characterizing Illuminance Meters and Luminance Meters: Performance, Characteristics and Specifications.*

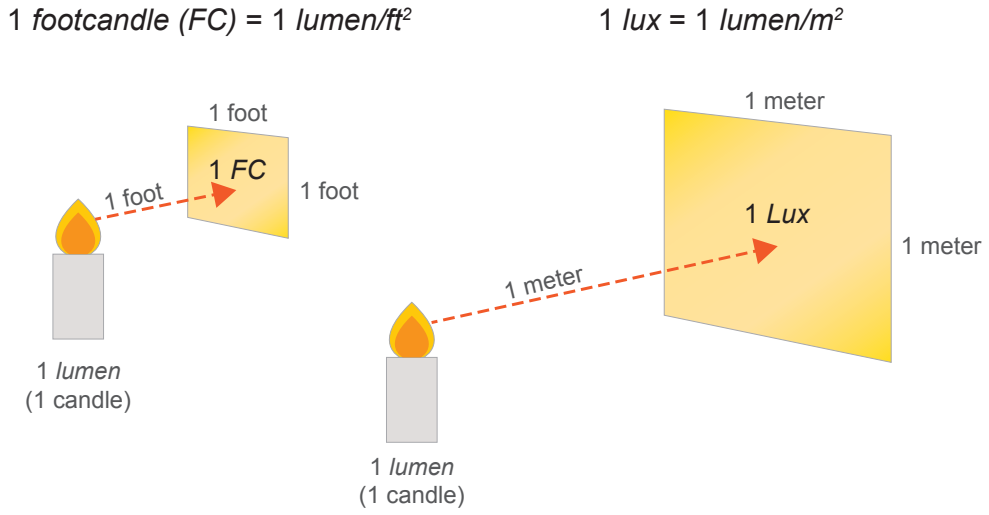


Figure 19: Illustration of lux and footcandle

Precaution steps to be taken to obtain accurate lighting measurements are:

i) Before any reading is taken, the lux meter should be exposed to the lighting for at least 3 - 5 minutes to allow it to reach equilibrium;

ii) The lamp in the installation should be lit for a period of time to allow them to reach a stable condition before measurement is taken;

iii) The zero reading of the lux meter should be checked and adjusted as necessary; and

iv) The voltage applied to the lighting installation should be checked to ensure that it is at an appropriate level.

There are two types of lighting measurement:

i) General lighting at general area; and

ii) Specific task or activity at workstation area

7.3.1 Measurement for General Lighting

General lighting is provided to give uniform illumination over the work area to meet the lighting requirement for a particular type of work activity, e.g. office, reception or storage. Measurement of illuminance level for general lighting is required to determine the adequacy of lighting in the work area.

Steps to do measurement for general lighting are as follows:

i) Measure length and width of the room, and height of lighting above the working plane.

ii) Calculate the room index to determine the number of measurement points in particular work area.

$$Room\ Index = \frac{L \times W}{H_m(L+W)}$$

where:

L : Length of room (m)

W : Wide of room (m)

Hm : Height of lighting above the working plane (m)

iii) Refer to **Table 1** for the number of measurement points required. The number of measurement points given is the minimum requirement.

Table 1: Minimum number of measurement points for measuring average illuminance in rooms of different proportion

Room Index	Number of measurement points
Below 1	4
1 and below 2	9
2 and below 3	16
Above 3	25

Note:

- It may be necessary to increase the number of points to obtain a symmetrical grid (as nearly square as possible) to suit a particular room shape.
- If the grid of squares matches the layout of the light fitting, the minimum number of measurement points should be increased until they no longer match.

iv) After setting the small squares, measure the illuminance at the centre of each square using a lux meter (refer **Figure 20**). The results indicate whether the lighting is evenly distributed. In addition, the average values of these measurements represent the average illuminance level for that work area. To evaluate whether the illuminance is adequate, the average illuminance is compared to the recommended illuminance in **Appendix 1**. When making a number of measurements at a fixed height and inclination, a portable stand or tripod is useful to support the meter.

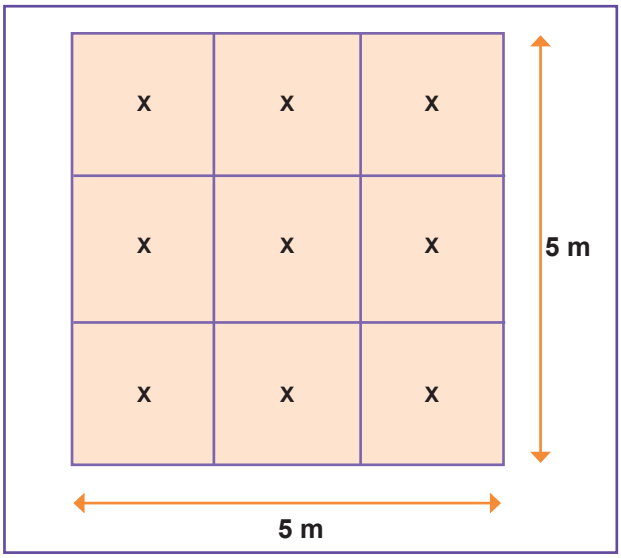


Figure 20: Lighting measurement at the centre of equally divided squares

Note:

- Two work areas with two different work activities should be separately evaluated. In other words, the office and the storage room of a work place should be separately measured and assessed.
- The path between the lighting source and the point of measurement should be clear as far as practicable. Avoid obstructing the normal light path, and move sideways, back and forth to ascertain no blocking of the light falling on the light sensor of the lux meter.
- Select the lowest measurement range of the lux meter as appropriate to give more precise reading.
- The measurement points should not be too close to walls or obstructions. Daylight should be shielded by blinds or curtains when assessing artificial lighting only.

7.3.2 Measurement for Specific Task or Activity

In some workplaces, there may be visually demanding task or work activities which required more illumination than the surrounding work area. In these circumstances, local lighting may be provided in the vicinity of the task or installed close to the work location. To assess whether lighting for an individual task is adequate, the lighting measurement should be at the task position.

Step to conduct measurement for specific task or activity:

i) Select four (4) representative points on the work plane. For example, if the task position is mostly at the central front area of an ordinary writing desk or a counter, this area may be divided into 4 equal areas (refer to **Figure 21**).

Figure 21: Four equally divided areas of the major task area

ii) Measure the illuminance level at the centre of each area. Lighting measurement should be taken at the height of the work plane. In case there is no specified plane for the task, the measurement should be taken at approximately 0.8 meter above the floor.

The light sensor of the lux meter should be place on the work plane which is normally a horizontal plane but is an inclined plane if the object is to be read on such a plane e.g. an easel (refer to **Figure 22**). Similarly, the work plane is a vertical plane if the object is to be read vertically (**Figure 23**).

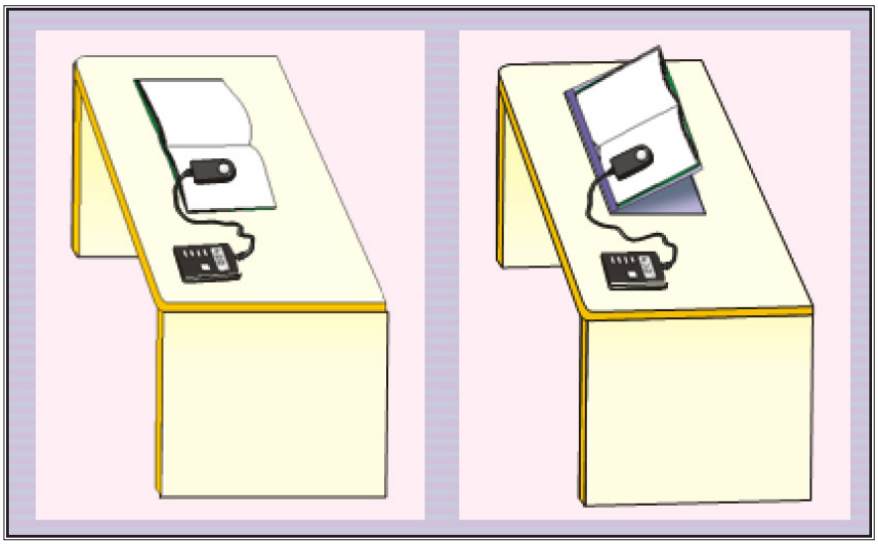


Figure 22: The light sensor of the lux meter should be placed on the work plane

Figure 23: The light sensor of the lux meter should be placed vertically if the object is read vertically

iii) However, if the task position is at a computer workstation, the illuminance is measured in a slightly different manner. Two measurement points are taken at the keyboard position which is 20 cm apart and two others points on the top of the screen, 10 cm apart, as shown in **Figure 24**. The sensor of the lux meter should be placed horizontally when taking the measurements.

Figure 24: Measurement point (x) for a computer workstation

iv) The average of these measurements is then calculated as the average illuminance at the task position. To evaluate whether the illuminance is adequate, the average illuminance is compared to the recommended illuminance in **Appendix 1**.

7.3.3 Uniformity of Illuminance

The uniformity of the illuminance is the ratio of the minimum to average value. Using only the average illuminance may result in lower illuminance in certain areas which may endanger the safety of employees. The uniformity of the illuminance measured should be:

i) not less than 0.5 for general lighting; and

ii) not less than 0.7 for task or activity

7.3.4 Illuminance Ratios

The relationship between the lighting of the work area and adjacent areas is important. Large differences in illuminance between them may cause visual discomfort or even affect safety in places where there is frequent movement. This problem arises most often where local or localized lighting in an interior exposes a person to a range of illuminances for a long time, or where there is movement between interior and exterior working areas exposing a person to a sudden change of illuminance. To guard against danger and discomfort the recommendations in **Table 2** should be followed.

Table 2: Maximum ratio of illuminance for adjacent areas

Situations to which recommendation applies	Typical location	Maximum ratio of illumineces	
		Working areas	Adjacent areas
Where each task is individually lit and the area around the task is lit to a lower illuminannce	Local lighting in an office	5	1
Where two working area are adjacent, but one is lit to a lower illuminance then the other	Localized lighting in a work store	5	1
Where two working areas are lit to different illuminances and are separated by a barrier but there is frequent movement between them.	A storage area inside a factory and a loading bay outside	10	1

7. 4 Improvement Measures

These following factors should be considered to improve lighting condition in the workplace;

i) Human factors;

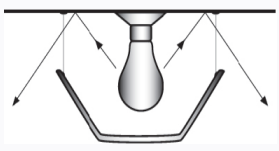
ii) Area to be lit;

iii) Tasks to be done; and

iv) Equipment and furniture used in tasks.

The details of improvement measures are shown in **Table 3**.

Table 3: Improvement measures

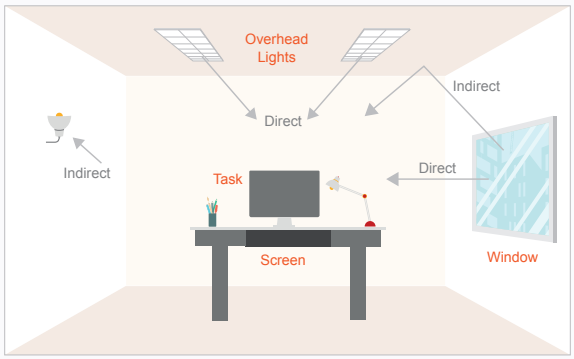
Factor	Improvement measures
Human factor	
Where each task is individually lit and the area around the task is lit to a lower illuminannce	• Increase the lighting to a comfortable level by providing lighting with adjustable intensity. It also helps to increase the viewing time and the brightness of the work piece. • Provide local lighting if necessary.
Area to be lit	
• Consider the size and shape of the work area and how it is used.	• Avoid barriers such as furniture and partitions because it can block general lighting
• Inappropriate lighting, such as using only overhead lights, can create shadows. Shadows can make work difficult and even dangerous by hiding sharp edges and other potential or actual hazards (for example, steps, torn carpet, or spills).	• Provide light from various sources and directions. • Lighting units should have low-brightness lenses and glare control louvers that evenly distribute the light. • Light the tasks, ceilings, and walls independently.
• Indirect lighting sends 90-100% of the light up to the ceiling and walls where it then reflects to the work area. Indirect lighting provides soft, even lighting with minimal shadows and glare.  **Figure 25: Direct lighting**  **Figure 26: Indirect lighting**	• Use indirect lighting on clean, highly reflective surfaces so that the light reaches the work area. • Use light colours and matte finishes on walls, ceilings and floors to reflect light and enhance the output of the lighting system. Keep these surfaces clean.

<table>
<tr><th>Factor</th><th>Improvement measures</th></tr>
<tr><td colspan="2">Task To Be Done</td></tr>
<tr><td>i) Size of object
The bigger the object, the easier it is to see. Small objects and details are not as easy to see.</td><td>• Increase the size of critical visual details, if possible.
• Move the task closer to the employee.
• Increase the light.</td></tr>
<tr><td>ii) Contrast between object and background
• Low contrast makes it difficult to distinguish an object from its background.
• Colour can also help to improve contrast.
• The background at the workstation is important, especially for visual tasks that demand close and continuous attention. A simple background will allow for more accuracy and an increase in production whereas a complex background may disturb the work and increase the workload.</td><td>• To increase contrast, make the work itself brightest, with the light decreasing as you move away from the work.
• Paint stationary and moving parts of machinery with contrasting colours, such as black and orange. With print materials, use black type against a white or light-coloured background.
• To obtain an optimum visual task background:
i. Eliminate potential sources of distraction, such as posted papers, forms or schedules on walls;
ii. Use light-coloured partitions and screens to eliminate or screen sources of distraction;
iii. Select an appropriate colour for the work background.

The following table provides some guidance for making the selection:

<table><tr><th>Material</th><th>Appropriate Background Colour</th></tr><tr><td>Steel, Cast Iron</td><td>Cream Coloured</td></tr><tr><td>Bronze, Copper</td><td>Grey-blue</td></tr><tr><td>Light-coloured Wood</td><td>Dark</td></tr><tr><td>Aluminium, Tin</td><td>Cream Coloured</td></tr><tr><td>Dark Wood</td><td>Grey-Blue</td></tr></table></td></tr>
</table>

Factor	Improvement measures
iii) Time available to view the object • It takes time for the eyes to focus on and evaluate an object. • Visibility is even more difficult if the object is moving.	• More time should be given to employees who work with small objects or work pieces with low contrast. • If a task requires a employee to quickly view an object (such as inspecting products on a conveyor belt), increase the light. • A task that requires a employee to move from a well lit to a low lit area or the opposite must be designed to allow enough time for the employee's eyes to adapt.
iv) Brightness • Brightness refers to the amount of light that appears to come from an object. In general, the brighter an object is, the easier it is to see. Brightness is often the most controllable factor.	• Increasing light on the workplace will improve visibility and help to compensate for any deficiencies in the other factors.
v) Glare • The amount of light should not be excessively brighter than the general level of brightness to avoid causing glare for the employee and others working nearby.	• Keep the glare source as far as possible from direct view. • Decrease the intensity of the lighting. • Avoid using extremely bright lights. • Position the work so that the employee's side or back faces the window. • Block very bright light sources with partitions or furniture. • Use anti-glare screens on computer monitors. (Glass or plastic screens are best because they're easy to clean.) • Use non-glossy paper and ink. • Change the position of light sources; • Change the position of the workstation; • Use multiple light sources by mixing direct and reflected light;

Factor	Improvement measures
 *(Adapted from: Computer Ergonomics: Workstation Layout and Lighting, 2004, p. 10.)* **Figure 27: Reducing glare**	• Use lamp shades which reflect light upwards, since reflected light from ceilings provides the best visibility; • Use lamps with a movable stand or a flexible arm to easily change the direction of light; • Construct skylights and windows on the non-sunny side to obtain an evenly lit working area; • Provide blinds, curtains, louvers, trees and vines to shade the building; • Use matte paint or darker colours for all surfaces (for example, tables, machines, tools); • Install screens, covers or partitions for shielding strong light which produces glare; • Combine daylight from windows and skylights with ceiling and local lights to reduce sharp shadows and glares and to achieve optimum lighting conditions.
Equipment and furniture used in tasks	
Flickering light is dangerous in work areas with rotating or oscillating machinery. It may create the illusion that the machine is going slower than it really is, or that it has stopped when it hasn't.	• Using lamps with a long after-glow. • Use different source of electricity for lamps and machine, so that they are not subject to the same electrical variation.

7.5 Reporting the Assessment

Recording of an assessment is important because it will be useful for the purpose of follow-up action, review and compliance with legal requirements. The information to be recorded in the report includes:

i) Introduction of the assessment:
   - Name and address of the workplaces; and
   - Particular of person conducting the assessment, date and time of assessment

ii) Purpose of the assessment

iii) Equipment:
   - Identification of the lux meter, such as the model number and serial number; and
   - Date of equipment calibration

iv) Methodology:
   - Description of the work area and the task / activity;
   - Position of the measurement points; and
   - Details of the lighting fixtures including their position, type and size.

v) Result:
   - Detail of the assessment data for each work area and task; and
   - Compare to the recommended lighting requirement

vi) Recommendations for further action:
   - Propose immediate action; and
   - Propose short term and long term action if necessary

vii) Conclusions

8.0 EMERGENCY LIGHTING

Emergency lighting can be used either standby or escape lighting when the normal installation fails. Standby lighting enables essential work to continue. Escape lighting enables a building to be evacuated.

Emergency lighting is normally required to operate fully automatically and give illumination of a sufficiently high level to enable all occupants to evacuate the premises safely. Most new buildings now have emergency lighting installed during construction; the design and type of equipment being specified by the architect in accordance with current Building Regulations and any local authority requirements.

8.1 Standby Lighting

The illuminance needed for standby lighting depend on what work has to be done. It may be between 5% and 100% of the illuminance produced by the normal installation. The recommended lighting requirement given in **Appendix 1** can be taken as a guide.

8.2 Escape Lighting

The illuminance for escape lighting should reach the required illuminance within five seconds of the failure of the main lighting system, although if the occupants are familiar with the buildings this time may be increased to 15 seconds. Battery powered escape lighting is usually designed to operate for between one and three hours according to the size of the building and the likely problems of evacuation. Escape lighting installations powered by a generator will operate for as long as the generator runs, which should at least match the operating times of battery powered installations.

Emergency escape lighting is itself sub-divided into escape route lighting, open area lighting and high-risk task area lighting.

8.2.1 Escape Route Lighting

An emergency escape lighting system provided to ensure the means of escape can be effectively identified and safely used by occupants of the building.

Figure 28: Emergency exit light

8.2.2 Open Area Lighting/Anti-Panic Lighting

An emergency escape lighting system provided to minimise panic and ensure there is sufficient illumination to allow the occupants of a building to reach a place where an escape route can be identified.

Figure 29: Bulkhead emergency lighting

8.2.3 High Risk Task Area Lighting

An emergency escape lighting system provides illumination for the safety of people involved in a potentially dangerous process or situation and to enable proper shut-down procedures for the safety of the operator and other occupants of the premises.

8.3 Emergency Lighting Design

The equipment used for emergency lighting is the same as for normal lighting, subject to two constraints which are:

i) The need for immediate light output when the normal main supply fails for examples tungsten, tungsten halogen, tubular fluorescent and LED lamps are suitable for emergency lighting. Other lamp types take too long to reach full light output.

ii) Some mechanism is needed for connecting the lamp to the alternative supply when the normal supply fails. A wide choice of systems is available ranging from fitting with their own battery packs to centralised systems where the lamps are supplied from a central generator or batteries via protected wiring. The choice system will depend on the size and nature of the installation. Whichever system is chosen, emergency lighting should be tested and maintained regularly.

The positioning of equipment is largely a matter of common sense. A suitable procedure is to:

i) Define the exits and emergency exits;

ii) Identify the escape routes and any areas that require special treatment e.g., plant rooms, escalators direction signs, fire alarm points and fire-fighting equipment;

iii) Locate light fitting so that recommended lighting requirement along the escape routes are met paying particular attention to stairs, obstruction and change in direction;

iv) Ensure that specific items that need to be seen are clearly lit, e.g. direction and exit signs; and

v) Ensure that the lighting outside the building is adequate for evacuation.

This procedure should ensure that the necessary illuminance is provided in appropriate places. As for glare, a simple rule to follow is to mount the emergency fitting at least two metres above the floor but not much higher because there is always a risk of smoke drastically reducing the illuminance on the escape route.

Specific locations where a luminaire should be provided are shown in **Figure 30**.

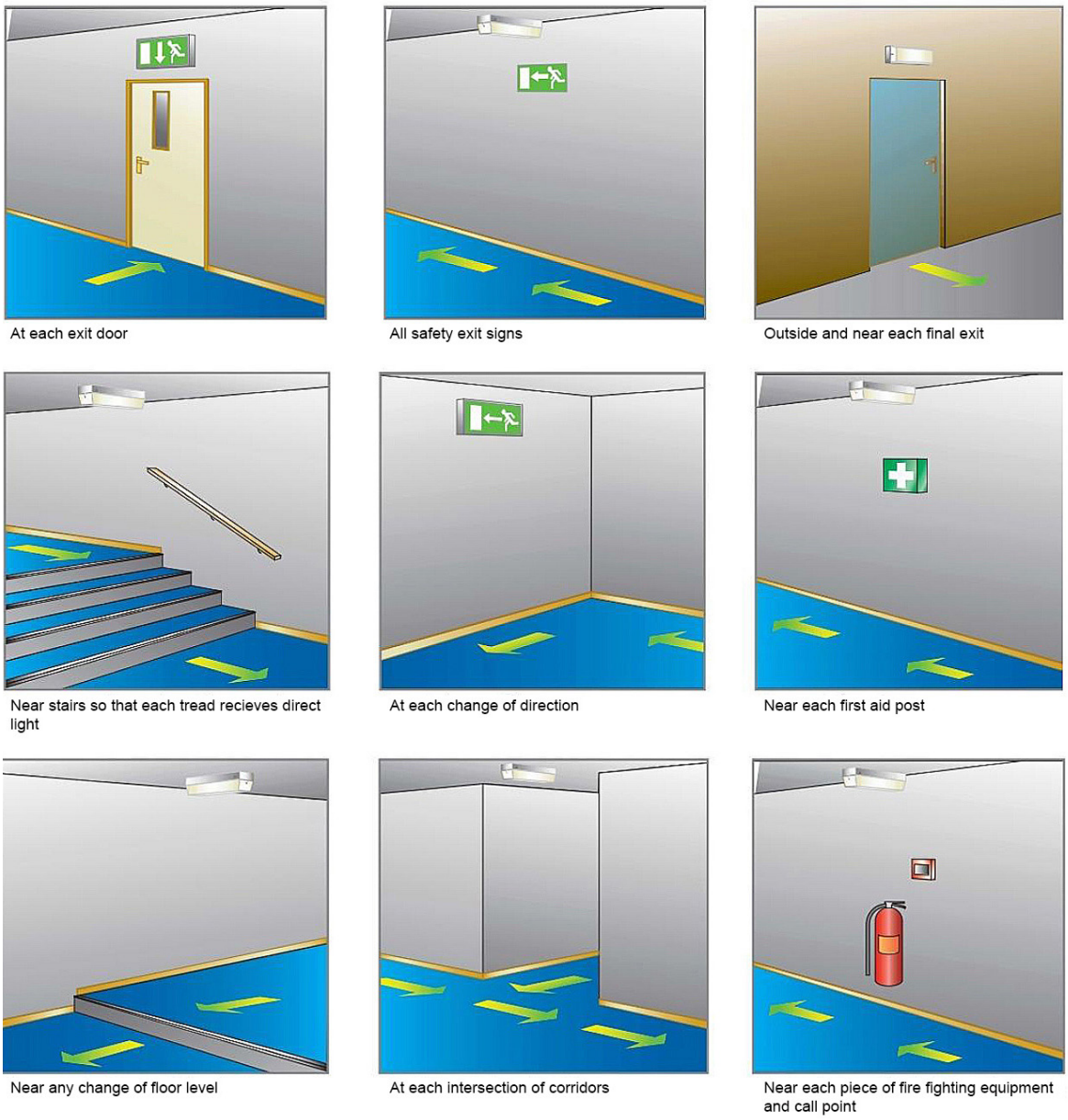


Figure 30: Specific locations where a luminaire should be provided
(source: BS 5266:1999 Part 7: Emergency Lighting Design)

Note:

1. BS 5266-1:2011 Emergency Lighting-Part 1: Code of Practice for The Emergency Escape Lighting of Premises, recommends the provision of horizontal illumination at floor level along the centre line of a defined escape route (permanently unobstructed) not less than 1 lux, and 0.5 lux for anti-panic areas, to exclude a 0.5m border around the route.

2. The term near means within two meters measured horizontally.

9.0 REFERENCES

1. BS 5266-1:2011 Emergency Lighting-Part 1: Code of Practice for the Emergency Escape Lighting of Premises.
2. BS 5266:1999 Part 7: Emergency Lighting Design Guide.
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10.0 APPENDICES

Appendix 1: The Lighting Requirement Recommended for Various Rooms and Activities

Type of interior, task or activity	Lux
1. General building areas	
Entrance halls	100
Lounges	200
Circulation areas and corridors	100
Stairs, escalators, travelators	150
Loading ramp/bays	150
Canteens	200
Rest rooms	100
Rooms for physical exercise	300
Cloakrooms, washrooms, bathrooms, toilets	200
Sick bay	500
Rooms for medical attention	500
Plant rooms, switch gear rooms	200
Post room, switchboard	500
Store, stockrooms, cold store	100
Dispatch packing handling areas	300
Control station	150
2. Agriculture building	
Loading and operating of goods handling equipment and machinery	200
Building for livestock	50
Sick animal pens, calving stalls	200
Feed preparation, dairy, utensil washing	200
3. Bakeries	
Preparation and baking	300
Finishing, glazing, decorating	500
4. Cement, concrete , & bricks industry	
Drying	50
Preparation of materials, work on kilns and mixers	200
General machine work	300
Rough forms	300

Type of interior, task or activity	Lux
5. Ceramics and glass industry	
Drying	50
Preparation, general machine work	300
Enameling, rolling, pressing, shaping simple parts, glazing, glass blowing	300
Grinding, engraving, glass polishing, shaping precision parts, manufacture of glass instruments	750
Decorative work	500
Grinding of optical glass, crystal hand grinding and engraving, work on average goods	750
Precision work e.g. decorative grinding, hand painting	1000
Manufacture of synthetic precious stones	1500
6. Chemicals , plastics and rubber industry	
Remote operated processing installations	50
Processing installations with limited manual intervention	150
Constantly manned work places in processing installations	300
Precision measuring rooms, laboratories	500
Pharmaceutical production	500
Tyre production	500
Colour inspection	1000
Cutting, finishing, inspection	750
7. Electrical industry	
Cable and wire manufacture	300
Winding:	
• large coils	300
• medium-sized coils	500
• small coils	750
Coil impregnating	300
Galvanising	300
Assembly work:	
• rough e.g. large transformers	300
• medium e.g. switchboards	500
• fine e.g. telephones	750
• precision e.g. measuring equipm.	1000
Electronic workshops, testing, adjusting	1500

Type of interior, task or activity	Lux
8. Food industry	
Workplaces and zones in breweries, malting floor, for washing, barrel filling, cleaning, sieving, peeling, cooking in preserve and chocolate factories, work places and zones in sugar factories, for drying and fermenting raw tobacco, fermentation cellar	200
Sorting and washing of products, milling, mixing, packing	300
Work places and zones in slaughter houses, butchers, dairies mills, on filtering floor, in sugar refineries	500
Cutting and sorting of fruit and vegetables	300
Manufacture of delicatessen foods, kitchen	500
Manufacture work of cigars and cigarettes	500
Inspection of glasses and bottles, product control, trimming, sorting decoration	500
Laboratories	1000
Colour inspection	
9. Foundries and metal casting plants	
Mansize under floor tunnels, cellars etc.	50
Platforms	100
Sand preparation	200
Dressing room	200
Workplaces at cupola and mixer	200
Casting bay	200
Shake out areas	200
Machine moulding	200
Hand and core moulding	300
Die casting	300
Model building	500
10. Hairdressers	
Hairdressing	500
11. Jewellery manufacturing	
Working with precious stones	1500
Manufacture of jewellery	1000
Watch making (manual)	1500
Watch making (automatic)	500

Type of interior, task or activity	Lux
12. Laundries and dry cleaning	
Goods in, marking and sorting	300
Washing and dry cleaning	300
Ironing, pressing	300
Inspection and repairs	750
13. Leather industry	
Work on vats, barrels, pits	200
Fleshing, skiving, rubbing, tumbling of skins	300
Saddlery work, shoe manufacture stitching, sewing, polishing, shaping, cutting, punching	500
Sorting	500
Leather dyeing machine	500
Quality control	1000
Colour inspection	1000
Shoe making	500
Glove making	500
14. Metal working and processing	
Open die forging	200
Drop forging, welding, cold forming	300
Rough and average machining: tolerances > 0.1 mm	300
Precision machining: grinding: tolerances < 0.1 mm	500
Scribing; inspection	750
Wire & pipe drawing shapes	300
Plate machining >5mm	200
Sheet metalwork <5mm	300
Tool making; cutting equipment manufacture	750
Assembly:	
• rough	200
• medium	300
• fine	500
• precision	750
Galvanizing	300
Surface preparation and painting	750
Tool, template and jig making, precision mechanics, micromechanics	1000

Type of interior, task or activity	Lux
15. Paper industry	
Pulp mills, edge runners	200
Paper manufacture and processing, paper and corrugating machines, cardboard manufacture	300
Standard book binding work, e.g. folding, sorting, gluing, cutting, embossing, sewing	500
16. Power stations	
Fuel supply plant	50
Boiler house	100
Machine halls	200
Auxiliary rooms, e.g pump rooms,condenser rooms, switchboard,etc.	200
Control rooms	500
17. Printers	
Cutting, gilding, embossing, block engraving, work on stones and platens, printing machines, matrix making	500
Paper sorting and hand printing	500
Type setting. retouching, lithography	1000
Colour inspection in multi-coloured printing	1500
Steel and copper engraving	2000
18. Iron and steel works	
Production plants without manual Intervention	50
Production plants with occasional manual operation	150
Production plants with continuous manual operation	200
Slab store	50
Furnaces	200
Mill train, coiler, shear line	300
Control platforms, control panels	300
Test, measurement and inspection	500
Underfloor man sized tunnels belt sections, cellars etc.	50

Type of interior, task or activity	Lux
19. Textile industry	
Workplace and zones in baths, bale opening	200
Carding, washing, ironing, drawing,combing, sizing, card cutting, prespinning, jute and hemp spinning	300
Spinning, plying, reeling, winding warping, weaving, braiding, knitting	500
Sewing, fine knitting, taking up stitches	750
Manual design, drawing patterns	750
Finishing, dyeing	500
Drying room	100
Automatic fabric printing	500
Burling, picking, trimming	1000
Colour inspection, fabric control	1000
Invisible mending	1500
Hat manufacturing	500
20. Vehicle construction	
Body work and assembly	500
Painting, spraying chamber, polishing chamber	750
Painting: touch-up, inspection	1000
Upholstery manufacture (manned)	1000
Final inspection	1000
21. Wood working & furniture industry	
Automatic processing e.g. drying plywood manufacturing	50
Steam pits	150
Saw frame	300
Work at joiner's bench, gluing, assembly	300
Polishing, painting, fancy joinery	750
Work on wood working machines e.g. turning, fluting, dressing, rebating, grooving, cutting, sawing, sinking	500
Selection of veneer woods, maquetry, inlay work	750
Quality control	100

Type of interior, task or activity	Lux
22. Offices	
Filing, copying, circulation, etc.	300
Writing, typing, reading, data processing	500
Technical drawing	750
CAD workstation	500
Conference and meeting rooms	500
Reception desk	300
Archives	200
23. Retailing	
Sales area small	300
Sales area large	500
Till area	500
Wrapper table	500
24. Restaurants and hotels	
Reception/cashier desk, porters desk	300
Kitchen	500
Restaurant, dining room, function room	200
Self-service restaurant	200
Buffet	300
Conference rooms	500
Corridors	100
25. Places of entertainment	
Theatres & concert halls	200
Multipurpose halls	300
Practice rooms, dressing rooms	300
Museums (general)	300
26. Libraries	
Bookshelves	200
Reading area	500
Counters	500

Type of interior, task or activity	Lux
27. Public car parks (indoor)	
In/out ramps (during the day)	300
In/out ramps (at night)	75
Traffic lanes	75
Parking areas	75
Ticket office	300
28. Educational buildings	
Play school room	300
Nursery class	300
Nursery craft room	300
Classrooms, tutorial rooms	300
Classroom for evening classes and adults education	500
Lecture hall	500
Black board	500
Demonstration table	500
Art and craft rooms	500
Art rooms in art schools	750
Technical drawing rooms	750
Practical rooms and laboratories	500
Teaching workshop	500
Music practice rooms	300
Computer practice rooms	500
Langauge laboratory	300
Preparation rooms and workshops	500
Student common rooms and assembly halls	200
Teachers rooms	300
Sports halls, gymnasiums and swimming pools	300

Type of interior, task or activity	Lux
29. Health care premises	
Waiting rooms	200
Corridors: during the day	200
Corridors: during the night	50
Day rooms	200
Staff office	500
Staff rooms	300
Wards:	
• General lighting	100
• Reading lighting	300
• Simple examination	300
Examination and treatment	1000
Night lighting, observation lighting	5
Bathrooms and toilets for patients	200
Examination room general	500
Ear and eye examination	1000
Reading and colour vision test with vision charts	500
Scanners with image enhancers and television systems	50
Dialysis rooms	500
Dermatology rooms	500
Endoscopy rooms	300
Plaster rooms	500
Medical baths	300
Massage and radiotherapy	300
Pre-op and recovery rooms	500
Operating theatre	1000
Operating cavity	Special lighting
Intensive care:	
• General lighting	100
• Simple examinations	300
• Examination and treatment	1000
• Night watch	20

Type of interior, task or activity	Lux
Dentists:	
• General lighting	500
• At the patient	1000
• Operating cavity	5000
• White teeth matching	5000
Colour inspection (laboratories)	1000
Sterilisation rooms	300
Disinfection rooms	300
Autopsy rooms and mortuaries	500
Autopsy table and dissecting table	5000
30. Airports	
Arrival and departure halls, baggage claim areas	200
Connecting areas, escalators,travelators	150
Information desks, check-in desks	500
Customs and passport control desks	500
Waiting areas	200
Luggage store rooms	200
Security check areas	300
Air traffic control tower	500
Air traffic rooms	500
Testing and repair hangars	500
Engine test areas	500
Measuring areas in hangars	500
Platforms and passenger subways (underpasses)	50
Ticket hall and concourse	200
Ticket and luggage offices and counters	300
Waiting rooms	200
31. Mosques, churches, synagogues and temples	
Body of church	100
Chair, altar, pulpit	300

Appendix 2: Lighting Checklist

How to use the checklist

1. Ask the employer any questions you have. You should learn about the main products and production methods, the number of employees (male and female), the hours of work (including breaks and overtime) and any important occupational safety and health problems.

2. Define the work area to be checked. In the case of a small enterprise the whole production area can be checked. In the case of a larger enterprise, particular work areas can be defined for separate checking.

3. Read through the checklist and spend a few minutes walking around the work area before starting to check.

4. Read each measures in the checklist meticulously. Look for a way to apply the measure. If necessary, ask the manager or employees questions. If the measure has already been applied or it is not needed, mark NO under “Do You Propose Action?” If you think the measure would be worthwhile, mark YES. Use the space under REMARKS to put a description of your suggestion or its location.

5. After you have finished, look again at the measures you have marked YES. Choose a few where the benefits seem likely to be the most important. Mark PRIORITY for these measures.

6. Before finishing, make sure that for each measures you have marked either NO or YES, and that for some measures marked YES you have marked PRIORITY.

No.	Measures	Do you propose action?			Remarks
		Yes	No	Priority	
1	Skylights or windows are used to take advantage of day light				
2	Workstations are arranged so that work requiring strong light is done near windows or under skylights.				
3	Ceilings and walls are painted white or in a light colour.				
4	Multiple light sources are used at workstations.				
5	Lamps, windows and workstations are positioned to prevent glare.				
6	Lighting fixtures are placed at a high position or lamp shades provided to prevent direct glare.				
7	Blinds, curtains, louvers, shades, trees and vines are used to prevent or diminish direct glare from the sun.				
8	Light sources, machines or other objects reflecting light are relocated to prevent indirect glare.				
9	Lamps are placed high to provide evenly distributed general lighting.				
10	Local lamps are used to provide adequate light required for detailed work				
11	Moveable local lamps with flexible arms are provided				
12	Direction of light sources is selected considering the type of task.				
13	General and local lighting are combined to provide necessary light and prevent large contrasts in brightness.				

No.	Measures	Do you propose action?			Remarks
		Yes	No	Priority	
14	Work is avoided in an isolated area of strong light surrounded by a poorly lit background				
15	Screens or curtains are used to avoid a complex background.				
16	Appropriate colours are used for work backgrounds.				
17	Light-coloured screens or partitions are used to improve visibility of objects.				
18	Each lamp or each group of lamps has its own electrical switch.				
19	Individual plugs and sockets are provided at workstations to reduce use of extension cords.				
20	Lamps, skylights, windows, ceilings, walls and partitions are cleaned periodically.				
21	Light bulbs and tubes which have blown or are reduced in brightness are replaced.				
Checked by:			**Date:**		

(Adapted from "Lighting at work" HSG38, Health and Safety Executive (HSE UK, 2002))

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ISBN 978-983-2014-91-1

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