THE REPUBLIC OF THE UNION OF MYANMAR

MINISTRY OF CONSTRUCTION

MYANMAR

NATIONAL

BUILDING

CODE

2025

PART 5 BUILDING SERVICES

PART 5A - LIGHTING

PART 5B - ELECTRICAL AND ALLIED INSTALLATIONS

PART 5C - INSTALLATION OF LIFTS AND ESCALATORS

PART 5E - HEATING, MECHANICAL VENTILATION AND AIR-CONDITIONING SERVICES

PART 5F - FIRE SAFETY, FIRE PROTECTION SYSTEMS AND MEANS OF ESCAPE

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JUNE, 2025

MINISTRY OF CONSTRUCTION
FOREWORD

In 2008, Cyclone Nargis, which hit Myanmar, caused extensive damage and necessitated the development of a Building Code to ensure the safety of buildings. The Ministry of Construction formed Technical Working Groups, in collaboration with United Nations Human Settlements Programme (UN-Habitat), the Myanmar Engineering Society, the Association of Myanmar Architects, related ministries, technological universities, and government organizations to develop the Myanmar National Building Code - 2012 (Provisional) (English Version) and distributed it to government departments and organizations.

In 2016, comments and advices sent from government departments and organizations were further incorporated and the directive was issued to follow Myanmar National Building Code - 2016 (English Version) in carrying out construction activities.

In 2020, the Technical Working Groups revised and modified the Building Code in accordance with the updated international standards. The Ministry of Construction distributed Myanmar National Building Code - 2020 [English and Myanmar Version] to the Union-level organizations, Union Ministries, Region and State governments and relevant organization to refer and follow them, and further issued the directive to the Myanmar Engineering Council, the Myanmar Architectural Council and the High-Rise and Public Building Projects Committee to follow them starting from 1st November, 2020.

In order to publish the Myanmar National Building Code (Updated Version) in line with the improved international standards, the Ministry of Construction has formed the Myanmar National Building Code Implementation Steering Committee, Implementation Working Committee, Drafting Sub-committee and Technical Working Groups (TWGs) in 2024. The publication of the Myanmar National Building Code – 2025 was made possible by joint efforts of the Ministry of Construction, the Ministry of Science and Technology and other related ministries, the Myanmar Engineering Council, the Myanmar Architect Council, the High-Rise and Public Building Projects Committee, the Federation of Myanmar Engineering Societies and its partner organizations, namely the Myanmar Earthquake Committee, the Myanmar Society of Civil Engineers, the Myanmar Society of Mechanical Engineers, the Myanmar Society of Welding Engineering, the Myanmar Green Building Society, the Myanmar International Consulting Engineers Group and the Environmental Conservation Consulting Engineers Association.

Following the Mandalay earthquake struck on 28th March, 2025, the Myanmar Earthquake Committee and the Myanmar Geoscience Association have undertaken the necessary preparations to build earthquake-resistant buildings.

Therefore, the Ministry of Construction acknowledged the contributions of the Ministries, the Myanmar Engineering Council, the Myanmar Architect Council, the High-rise and Public Building Projects Committee, the Federation of Myanmar Engineering Societies and partner organizations, the Myanmar Earthquake Committee, the Myanmar Geoscience Association and to those who have provided advice and assistance from various sectors to develop and publish the Myanmar National Building Code - 2025.

Ministry of Construction

MYANMAR

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PART 5A

BUILDING SERVICES

(LIGHTING)

MYANMAR NATIONAL BUILDING CODE - 2025

PART - 5A BUILDING SERVICES

LIGHTING

CONTENTS

MYANMAR NATIONAL BUILDING CODE - 2025

PART 5A BUILDING SERVICES

LIGHTING

5A.1 SCOPE

This Section covers requirements and methods for lighting of buildings.

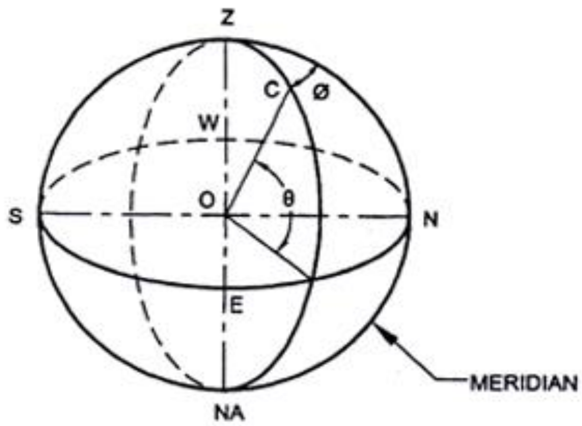
5A.2 TERMINOLOGY

5A.2.0 For the purpose of this Section, the following definitions shall apply.

5A.2.1 Lighting

5A.2.1.1 *Altitude (θ)* — The angular distance of any point of celestial sphere, measured from the horizon, on the great circle passing through the body and the zenith *(see* Figure 1).

5A.2.1.2 *Azimuth (Ø)* — The angle measured between meridians passing through the north point and the point in question (point C in Figure 1).



REFERENCES

O	-	Observer's station	S	-	Geographical south
C	-	Celestial body	E	-	Geographical east
Z	-	Zenith	W	-	Geographical west
NA	-	Nadir	N	-	Geographical north

Figure 1: Altitude and Azimuth of a Celestial Body

5A.2.1.3 *Brightness Ratio or Contrast* — The variations or contrast in brightness of the details of a visual task, such as white print on blackboard.

5A.2.1.4 *Candela (cd)* —The SI unit of luminous intensity.

Candela = 1 lumen per steradian

5A.2.1.5 *Central Field* — The area of circle round the point of fixation and its diameter, subtending an angle of about 2° at the eye. Objects within this area are most critically seen in both their details and colour.

5A.2.1.6 *Clear Design Sky* — The distribution of luminance of such a sky is non-uniform; the horizon is brighter than the zenith, and when L_z is the brightness at zenith, the brightness at an altitude (θ) in the region away from the sun, is given by the expression:

$$L_\theta = L_z \operatorname{cosec} \theta$$

When θ lies between 15° and 90°, and L_θ is constant when θ lies between 0° and 15°.

5A.2.1.7 *Colour Rendering Index (CRI)* — Measure of the degree to which the psychophysical colour of an object illuminated by the test illuminant conforms to that of the same object illuminated by the reference illuminant, suitable allowance having been made for the state of chromatic adaptation.

5A.2.1.8 *Correlated Colour Temperature (CCT) (Unit: K)* — The temperature of the Planckian radiator whose perceived colour most closely resembles that of a given stimulus at the same brightness and under specified viewing conditions.

5A.2.1.9 *Daylight Area* — The superficial area on the working plane illuminated to not less than a specified daylight factor, that is, the area within the relevant contour.

5A.2.1.10 *Daylight Factor* — The measure of total daylight illuminance at a point on a given plane expressed as the ratio (or percentage) which the illuminance at the point on the given plane bears to the simultaneous illuminance on a horizontal plane due to clear design sky at an exterior point open to the whole sky vault, direct sunlight being excluded.

5A.2.1.11 *Daylight Penetration* — The maximum distance to which a given daylight factor contour penetrates into a room.

5A.2.1.12 *Direct Solar Illuminance* — The illuminance from the sun without taking into account the light from the sky.

5A.2.1.13 *External Reflected Component (ERC)*— The ratio (or percentage) of that part of the daylight illuminance at a point on a given plane which is received by direct reflection from external surfaces as compared to the simultaneous exterior illuminance on a horizontal plane from the entire hemisphere of an unobstructed clear design sky.

5A.2.1.14 *Glare* — A condition of vision in which there is discomfort or a reduction in the ability to see significant objects or both due to an unsuitable distribution or range of luminance or due to extreme contrasts in space and time.

5A.2.1.15 *Illuminance*— At a point on a surface, the ratio of the luminous flux incident on an infinitesimal element of the surface containing the point under consideration to the area of the element.

NOTE — The unit of illuminance (the measurement of illumination) is lux which is 1 lumen per square metre.

5A.2.1.16 *Internal Reflected Component (IRC)* **—** The ratio (or percentage) of that part of the daylight illuminance at a point in a given plane which is received by direct reflection or inter-reflection from the internal surfaces as compared to the simultaneous exterior illuminance on a horizontal plane due to the entire hemisphere of an unobstructed clear design sky.

5A.2.1.17 *Light Output Ratio (LOR) or Efficiency (η)* — The ratio of the luminous flux emitted from the luminaire to that emitted from the lamp(s) (nominal luminous flux). It is expressed in percent.

5A.2.1.18 *Lumen (lm)* — SI unit of luminous flux. The luminous flux emitted within unit solid angle (one steradian) by a point source having a uniform intensity of one candela.

5A.2.1.19 *Luminance (At a point of a Surface in a Given Direction) (Brightness)* — The quotient of the luminous intensity in the given direction of an infinitesimal element of the surface containing the point under consideration by the orthogonally projected area of the element on a plane perpendicular to the given direction. The unit is candela per square meter (cd/m^2).

5A.2.1.20 *Luminous Flux (Ø)*—The quantity characteristic of radiant flux which expresses its capacity to produce visual sensation evaluated according to the values of relative luminous efficiency for the light adapted eye:

(a) *Effective luminous flux* ($Ø_n$) — Total luminous flux which reaches the working plane.

Nominal luminous flux ($Ø_0$)— Total luminous flux of the light sources in the interior.

5A.2.1.21 *Maintenance Factor (d)* **—** The ratio of the average illuminance on the working plane after a certain period of use of a lighting installation to the average illuminance obtained under the same conditions for a new installation.

5A.2.1.22 *Meridian***—** It is the great circle passing through the zenith and nadir for a given point of observation.

5A.2.1.23 *North and South Points* — The point in the respective directions where the meridian cuts the horizon.

5A.2.1.24 *Orientation of Buildings* — In the case of non- square buildings, orientation refers to the direction of the normal to the long axis. For example, if the length of the building is east-west, its orientation is north- south.

5A.2.1.25 *Peripheral Field* — It is the rest of the visual field which enables the observer to be aware of the spatial framework surrounding the object seen.

NOTE **—** A central part of the peripheral field , subtending an angle of about 30° on either side of the point of fixation, is chiefly involved in the perception of glare.

5A.2.1.26 *Reflected Glare* — The variety of ill effects on visual efficiency and comfort produced by unwanted reflections in and around the task area.

5A.2.1.27 *Reflection Factor (Reflectance*) — The ratio of the luminous flux reflected by a body (with or without diffusion) to the flux it receives. Some symbols used for reflection factor are:

r_c= Reflection factor of ceiling.

r_w= Reflection factor of parts of the wall between the working surface andthe luminaires.

r_f= Reflection factor of floor.

5A.2.1.28 *Reveal***—**The side of an opening for a window.

5A.2.1.29 *Room Index (k_r)***—** An index relating to the shape of a rectangular interior, according to the formula:

$$k_r = \frac{L.W}{(L+W)\,H_m}$$ where *L* and *W* are the length and width respectively of the interior, and H_m is the mounting height, that is, height of the fittings above the working plane.

NOTES

1 For rooms where the length exceeds 5 times the width, *L* shall be taken as *L* = 5W.

2 If the reflection factor of the upper stretch of the walls is less than half the reflection factor of the ceiling, for indirect or for the greater part of indirect lighting, the value H_m is measured between the ceiling and the working plane.

5A.2.1.30 *Sky Component (SC)*—The ratio (or percentage) of that part of the daylight illuminance at a point on a given plane which is received directly from the sky as compared to the simultaneous exterior illuminance on a horizontal plane from the entire hemisphere of an unobstructed clear design sky.

5A.2.1.31 *Solar Load* — The amount of heat received into a building due to solar radiation which is affected by orientation, materials of construction and reflection of external finishes and colour.

5A.2.1.32 *Utilization Factor (Coefficient of Utilizaiton) (μ)***—** The ratio of the total luminous flux which reaches the working plane (effective luminous flux, $Ø_n$) to the total luminous flux of the light sources in the interior (nominal luminous flux, $Ø_0$).

5A.2.1.33 *Visual Field*—The visual field in the binocular which includes an area approximately 120° vertically and 160° horizontally centering on the point to which the eyes are directed. The line joining the point of fixation and the centre of the pupil of each eye is called its primary line of sight.

5A.2.1.34 *Working Plane* **—** A horizontal plane at a level at which work will normally be done *(see* **5A.3.1.3.3** and **5A.3..1.3.4**),

5A.2.1.35 Light Pipe — A conduit made of a highly reflective material, which is capable of channeling light from one end to the other through successive internal reflections. Such a pipe may be flexible or rigid.

5A.2.1.36 Light Shelf— A daylighting system based on sun path geometry used to bounce the light off a ceiling, project it deeper into a space, distribute it from above, and diffuse it to produce a uniform light level below.

5A.3 LIGHTING

5A.3.1 Principles of Lighting

5A.3.1.1*Aims of Good Lighting*

Good lighting is necessary for all buildings and has three primary aims. The first aim is to promote work and other activities carried out within the building; the second aim is to promote the safety of the people using the building; and the third aim is to create, in conjunction with the structure and decoration, a pleasing environment conducive to interest of the occupants and a sense of their well-being.

5A.3.1.1.1*Realization of these aims involves:*

careful planning of the brightness and colour pattern within both the working areas and the surroundings so that attention is drawn naturally to the important areas, detail is seen quickly and accurately and the room is free from any sense of gloom or monotony *(see* **5A.3.1.3**);

using directional lighting where appropriate to assist perception of task detail and to give good modeling;

controlling direct and reflected glare from light sources to eliminate visual discomfort;

in artificial lighting installations, minimizing flicker from certain types of lamps and paying attention to the colour rendering properties of the light;

correlating lighting throughout the building to prevent excessive differences between adjacent areas so as to reduce the risk of accidents; and

installation of emergency lighting systems, where necessary.

5A.3.1.2 *Planning the Brightness Pattern*

The brightness pattern seen within an interior may be considered as composed of three main parts — the task itself, immediate background of the task and the general surroundings of walls, ceiling, floor, equipment and furnishings.

5A.3.1.2.1 In occupations where the visual demands are small, the levels of illumination derived from a criterion of visual performance alone may be too low to satisfy the other requirements. For such situations, therefore, illuminance recommendations are based on standards of welfare, safety and amenity judged appropriate to the occupations; they are also sufficient to give these tasks brightness which ensured that the visual performance exceeds the specified minimum. Unless there are special circumstances associated with the occupation, it is recommended that the illuminance of all working areas within a building should generally be 150 lux, even though the visual demands of the occupation might be satisfied by lower values.

5A.3.1.2.2 Where work takes place over the whole utilizable area of room, the illumination over that area should be reasonably uniform and it is recommended that the uniformity ratio (minimum illuminance divided by average illuminance levels) should be not less than 0.7 for the working area.

5A.3.1.2.3 When the task brightness appropriate to an occupation has been determined, the brightness of the other parts of the room should be planned to give a proper emphasis to visual comfort and interest.

A general guide for the brightness relationship within the normal field of vision should be as follows:

(a)	For high task brightness (above 100 cd/m^2)	Maximum
	1) Between the visual task and the adjacent areas like table tops	3 to 1
	2) Between the visual task and the remote areas of the room	10 to 1

(b) For low and medium task brightness (below 100 cd/m^2): The task should be brighter than both the background and the surroundings; the lower the task brightness, the less critical is the relationship.

5A.3.1.3 *Recommended Values of Illuminance*

Table 1 gives recommended values of illuminance commensurate with the general standards of lighting described in this section and related to many occupations and buildings; These are valid under most of the conditions whether the illumination is by daylighting, artificial lighting or a combination of the two. The great variety of visual tasks makes it impossible to list them all and those given should be regarded as representing types of task.

5A.3.1.3.1 The different locations and tasks are grouped within the following four sections:

a) Industrial buildings and process;

b) Offices, schools and public buildings;

c) Surgeries and hospitals; and

d) Hotels, restaurants, shops and homes.

5A.3.1.3.2 The illumination levels recommended in Table 1 are those to be maintained at all time on the task. As circumstances may be significantly different for different interiors used for the same application or for different conditions for the same kind of activity, a range of illuminances is recommended for each type of interior or activity instead of a single value of illuminance. Each range consists of three successive steps of the recommended scale of illuminances. For working interiors the middle value of each range represents the recommended service illuminance that would be used unless one or more of the factors mentioned below apply.

5A.3.1.3.2.1 The higher value of the range should be used when**:**

(a) unusually low reflectances or contrasts are present in the task;

(b) errors are costly to rectify;

(c) visual work is critical;

(d) accuracy or higher productivity is of great importance; and

(e) the visual capacity of the worker makes it necessary.

5A.3.1.3.2.2 The lower value of the range may be used when:

(a) reflectances or contrast are unusually high;
(b) speed and accuracy is not important; and
(c) the task is executed only occasionally.

5A.3.1.3.3 Where a visual task is required to be carried out throughout an interior, general illumination level to the recommended value on the working plane is necessary; where the precise height and location of the task are not known or cannot be easily specified, the recommended value is that on horizontal plane 850 mm above floor level.

NOTE — For an industrial task, working plane for the purpose of general illumination levels is that on a work place which is generally 750 mm above the floor level. For certain purposes, such as viewing the objects of arts, the illumination levels recommended are for the vertical plane at which the art pieces are placed.

5A.3.1.3.4 Where the task is localized, the recommended value is that for the task only; it need not, and sometimes should not, be the general level of illumination used throughout the interior. Some processes, such as industrial inspection process, call for lighting of specialized design, in which case the level of illumination is only one of the several factors to be taken into account.

5A.3.1.4 *Glare*

Excessive contrast or abrupt and large changes in brightness produce the effect of glare. When glare is present, the efficiency of visionis reduced and small details or subtle changes in scene cannot be perceived. It may be

(a) direct glare due to light sources within the field of vision,

(b) reflected glare due to reflections from light sources or surfaces of excessive brightness,

(c) veiling glare where the peripheral field is comparatively very bright.

5A.3.1.4.1 An example of glare sources in day lighting is the view of the bright sky through a window or skylight, especially when the surrounding wall or ceiling is comparatively dark or weakly illuminated. Glare can be minimized in this case either by shielding the open sky from direct sight by louvers, external hoods or deep reveals, curtains or other shading devices or by cross lighting the surroundings to a comparable level. A gradual transition of brightness from one portion to the other within the field of vision always avoids or minimizes the glare discomfort.

5A.3.1.5 *Lighting for Movement about a Building*

Most buildings are complexes of working areas and other areas, such as passages, corridors, stairways, lobbies and entrances. The lighting of all these areas should be properly correlated to give safe movement within the building at all times.

5A.3.1.5.1*Corridors, passages and stairways*

Accidents may result if people leave a well-lighted working area and pass immediately into corridors or on to stairways where the lighting is inadequate, as the time needed for adaptation to the lower level may be too long to permit obstacles or the threads of stairs to be seen sufficiently quickly.

Table 1: Recommended Values of Illuminance

(*Clauses* 5A.3.1.3, 5A.3.1.3.2 and 5A.3.3.2)

Sr No.	Type of Interior or Activity	Range of Service Illuminance (See Note) in Lux	Quality Class of Direct Glare Limitation (See Note)	Remarks
(1)	(2)	(3)	(4)	(5)
1	**AGRICULTURE AND HORTICULTURE**			
1.1	Inspection of Farm Product where Colour is Important	300-500-750	1	Local lighting may be appropriate
	Other Important Tasks	200-300-500	2	Local lighting may be appropriate
1.2	Farm Workshops			
1.2.1	General	50-100-150	3	
1.2.2	Workbench or machine	200-300-500	2	Local or portable lighting may be appropriate
1.3	Milk Premises	50-100-150	3	
1.4	Sick Animal Pets, Calf Nurseries	30-50-100	3	
1.5	Other Firm and Horticultural Buildings	20-30-50	3	
2	**COAL MINING (SURFACE BUILDINGS**)			
2.1	Coal Preparation Plant			
2.1.1	Walkways, floors under conveyors	30-50-100	3	
2.1.2	Wagon loading, bunkers	30-50-100	3	
2.1.3	Elevators, chute transfer pits, wash box area	50-100-150	3	
2.1.4	Drum filters, screen, rotating shafts	100-150-200	3	
2.1.5	Picking belts	150-200-300	3	Directional and colour properties of lighting may be important for easy recognition of coal and rock
2.2	Lamp Rooms			
2.2.1	Repair section	200-300-500	2	
2.2.2	Other areas	100-150-200	3	
2.3	Weight Cabins, Fan Houses	100-150-200	3	
2.4	Winding Houses	100-150-200	3	

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
3	**ELECTRICITY GENERATION, TRANSMISSION AND DISTRIBUTION**			
3.1	General Plant			
3.1.1	Turbine houses (operating floor)	150-200-300	2	
3.1.2	Boiler and turbine house basements	50-100-150	3	
3.1.3	Boiler houses, platforms, areas around burners	50-100-150	3	
3.1.4	Switch rooms, meter rooms, oil plant rooms, HV substations (indoor)	100-150-200	2	
3.1.5	Control rooms	200-300-500	1	Localized lighting of control display and the control desks may be appropriate
3.1.6	Relay and telecommunication rooms	200-300-500	2	
3.1.7	Diesel generator rooms, compressor rooms	100-150-200	3	
3.1.8	Pump houses, water treatment plant houses	100-150-200	3	
3.1.9	Battery rooms, chargers, rectifiers	50-100-150	3	
3.1.10	Precipitator chambers, platforms, etc	50-100-150	3	
3.1.11	Cable tunnels and basements, circulating water culverts and screen chambers, storage tanks (indoor), operating areas and filling points at outdoor tanks	30-50-100	3	
3.2	Coal Plant			
3.2.1	Conveyors, gantries, junction towers, unloading hoppers, ash handling plants, settling pits, dust hoppers outlets	50-100-150	3	
3.2.2	Other areas where operators may be in attendance	100-150-200	3	
3.3	Nuclear Plants			
	Gas circulation bays, reactor area, boiler platform, reactor charges and discharge face	100-150-200	2	
4	**METAL MANUFACTURE**			
4.1	Iron Making			

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
4.1.1	Sinter plant:			
	Plant floor	150-200-300	3	
	mixer drum, fan house, screen houses, coolers transfer stations	100-150-200	3	
4.1.2	Furnaces, cupola:			
	General	100-150-200	3	
	Control platforms	200-300-500	2	Local Lighting may be appropriate
	Conveyor galleries, walkways	30-50-100	3	
4.2	Steel Making			
4.2.1	Electric melting shops	150-200-300	3	
4.2.2	Basic oxygen steel making plants			
4.2.2.1	General	100-150-200	3	
4.2.2.2	Convertor floor, teeming bay	150-200-300	3	
4.2.2.3	Control platforms	200-300-500	2	Local Lighting may be appropriate
4.2.2.4	Scrap bays	100-150-200	3	
4.3	Metal Forming and Treatment			
4.3.1	Ingot stripping, soaking pits, annealing and heat treatment bays ,acid recovery plant Picking and cleaning bays, roughing mills, cold mills, finishing mills, tinning and galvanizing lines, cut up and rewind lines	150-200-300	3	
4.3.2	General	100-150-200	3	
4.3.3	Control platforms	200-300-500	2	Local Lighting may be appropriate
4.3.4	Wire mills, product finishing, steel inspection and treatment	200-300-500	3	
4.3.5	Plate/strip inspection	300-500-700	2	
4.3.6	Inspection of tin plate, stainless steel, etc;	-	-	Special lighting to reveal faults in the specular surface of the material will be required
4.4	Foundries			
4.4.1	Automatic Plant			
4.4.1.1	Without manual operation	30-50-100	3	

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
4.4.1.2	With occasional manual operation	100-150-200	3	
4.4.1.3	With continuous manual operation	150-200-300	3	
4.4.1.4	Control room	200-300-500	1	Localized lighting of the control display and the control desks may be appropriate
4.4.1.5	Control platforms	200-300-500	2	
4.4.2	Non-automatic plants			
4.4.2.1	Charging floor, pouring, shaking out, cleaning, grinding fettling	200-300-500	3	
4.4.2.2	Rough moulding, rough core making	200-300-500	3	
4.4.2.3	Fine moulding, fine core making	300-500-750	2	
4.4.2.4	Inspection	300-500-750	2	
4.5	Forges (Severe vibration is likely to occur)			
4.5.1	General	200-300-500	2	
4.5.2	Inspection	300-500-750	2	
5	**CERAMICS**			
5.1	Concrete products			
	Mixing, casting, cleaning	150-200-300	3	
5.2	Potteries			
5.2.1	Grinding, moulding, pressing, cleaning, trimming, glazing, firing	200-300-500	3	
5.2.2	Enamelling, colouring	500-750-1000	1	
5.3	Glass Works			
5.3.1	Furnace rooms, bending ,annealing	100-150-200	3	
5.3.2	Mixing rooms, forming, cutting, grinding polishing, toughening	200-300-500	3	
5.3.3	Beveling, decorative cutting, etching, silvering	300-500-750	2	
5.3.4	Inspection	300-500-750	2	
6	**CHEMICALS**			
6.1	Petroleum, Chemical and Petrochemical Works			
6.1.1	Exterior walkways, platforms, stairs and ladders	30-50-100	3	
6.1.2	Exterior pump and valve areas	50-100-150	3	

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
6.1.3	Pump and compressor houses	100-150-200	3	
6.1.4	Process plant with remote control	30-50-100	3	
6.1.5	Process plant requiring occasional manual intervention	50-100-150	3	
6.1.6	Permanently occupied work stations in process plant	150-200-300	3	
6.1.7	Control rooms for process plant	200-300-500	1	
6.2	Pharmaceutia l Manufacturer and Fine Chemicals Manufacturer			
6.2.1	Pharmaceutical manufacturer Grinding, granulating, mixing, drying, tableting, sterilizing, washing, preparation of solutions, filling, capping, wrapping, hardening	300-500-750	2	
6.2.2	Fine chemical manufacture			
6.2.2.1	Exterior walkways, platforms, stairs and ladders	30-50-100	3	
6.2.2.2	Process plant	50-100-150	3	
6.2.2.3	Fine chemical finishing	300-500-750	2	
6.2.2.4	Inspection	300-500-750	1	Local lighting may be appropriate
6.3	Soap Manufacture			
6.3.1	General area	200-300-500	2	
6.3.2	Automatic processes	100-200-300	2	
6.3.3	Control panels	200-300-500	1	Local lighting may be appropriate
6.3.4	Machines	200-300-500	2	
6.4	Paint Works			
6.4.1	General	200-300-500	2	
6.4.2	Automatic processes	150-200-300	2	
6.4.3	Control panels	200-300-500	2	
6.4.4	Special batch mixing	500-750-1000	2	
6.4.5	Colour matching	750-1000-1500	1	
7	**MECHANICAL ENGINEERING**			
7.1	Structural Steel Fabrication			
7.1.1	General	200-300-500	3	

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
7.1.2	Marking off	300-500-750	3	Local lighting may be appropriate
7.2	Sheet Metal Works			
7.2.1	Pressing, punching, shearing, stamping, spinning, folding	300-500-750	2	
7.2.2	Bench work, scribing, inspection	500-750-1000	2	
7.3	Machine and Tool Shops			
7.3.1	Rough bench and machine work	200-300-500	3	
7.3.2	Medium bench and machine work	300-500-750	2	
7.3.3	Fine bench and machine work	500-750-1000	2	
7.3.4	Gauge rooms	750-1000-1500	1	Optical aids may be required
7.4	Die Sinking Shops			
7.4.1	General	300-500-750	2	
7.4.2	Fine work	1000-1500-2000	1	Flexible local lighting is desirable
7.5	Welding and Soldering Shops			
7.5.1	Gas and arc welding, rough spot welding	200-300-500	3	
7.5.2	Medium soldering, brazing, spot welding	300-500-750	3	
7.5.3	Fine soldering, fine spot welding	750-1000-1500	2	Local lighting is desirable
7.6	Assembly Shops			
7.6.1	Rough work for example, frame and heavy machine assembly	200-300-500	3	The lighting of vertical surface may be important
7.6.2	Medium work, for example, engine assembly, vehicle body assembly	300-500-750	2	
7.6.3	Fine work, for example, office machinery assembly	500-750-1000	1	Localized lighting may be useful
7.6.4	Very fine work, for example, instrument assembly	750-1000-1500	1	Local lighting and optical aids are desirable
7.6.5	Minute work, for example, watch making	1000-1500-2000	1	Local lighting and optical aids are desirable
7.7	Inspection and Testing Shops			
7.7.1	Coarse work, for example, using go/no-go gauges, inspection of large sub-assemblies	300-500-750	2	Local or localized lighting may be appropriate

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
7.7.2	Medium work, for example, inspection of painted surfaces	500-750-1000	1	Local or localized lighting may be appropriate
7.7.3	Fine work, for example, using calibrated scales, inspection of precision mechanisms	750-1000-1500	1	Local or localized lighting may be appropriate
7.7.4	Very fine work, for example, inspection of small intricate parts	1000-1500-2000	1	Local lighting and optical aids are desirable
7.7.5	Minute work, for example, inspection of very small instruments	2000	1	Local lighting and optical aids are desirable
7.8	Paints Shops and Spray Booths			
7.8.1	Dipping, rough spraying	200-300-500	3	
7.8.2	Preparation, ordinary painting, spraying and finishing	200-500-750	2	
7.8.3	Fine painting, spraying and finishing	500-750-1000	2	
7.8.4	Inspection, re-touching and matching	750-1000-1500	2	
7.9	Plating Shops			
7.9.1	Vats and baths	200-300-500	3	
7.9.2	Buffing, polishing burnishing	300-500-750	2	
7.9.3	Final buffing and polishing	500-750-1000	2	
7.9.4	Inspection	-	-	Special light to reveal fault in the surface of the material will be required
8	**ELECTRICAL AND ELECTRONIC ENGINEERING**			
8.1	Electrical Equipment Manufacture			
8.1.1	Manufacture of cables and insulated wires, winding, varnishing and immersion of coils, assembly of large machines, simple assembly work	200-300-500	3	
8.1.2	Medium assembly, for example, telephones, small motors	300-500-750	3	Local lighting may be appropriate
8.1.3	Assembly of precision components, for example, telecommunication equipment, adjustment, inspection and calibration	750-1000-1500	1	Local lighting is desirable. Optical aids may be useful
8.1.4	Assembly of high precision parts	1000-1500-2000	1	Local lighting is desirable. Optical aids

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
8.2	Electronic Equipment Manufacture			
8.2.1	Printed circuit board			
8.2.1.1	Silk screening	300-500-750	1	Local lighting may be appropriate
8.2.1.2	Hand insertion of components, soldering	500-750-1000	1	Local lighting may be appropriate
8.2.1.3	Inspection	750-1000-1500	1	A large, low luminance luminaire overhead ensures specular reflection conditions which are helpful for inspection of printed circuits
8.2.1.4	Assembly of wiring harness, cleating harness, testing and calibration	500-750-1000	1	Local lighting may be appropriate
8.2.1.5	Chassis assembly	750-1000-1500	1	Local lighting may be appropriate
8.2.2	Inspection and testing			
8.2.2.1	Soak test	150-200-300	2	
8.2.2.2	Safety and functional tests	200-300-500	2	
9	**FOOD, DRINK AND TOBACCO**			
9.1	Slaughter Houses			
9.1.1	General	200-300-500	3	
9.1.2	Inspection	300-500-750	2	
9.2	Canning, Preserving and Freezing			
9.2.1	Grading and sorting of raw materials	500-750-1000	2	Lamp of colour rendering group 1A or 1B will be required, if colour judgement is required
9.2.2	Preparation	300-500-750	3	
9.2.3	Canned and bottled goods			
9.2.3.1	Retorts	200-300-500	3	
9.2.3.2	Automatic processes	150-200-300	3	
9.2.3.3	Labelling and packaging	200-300-500	3	
9.2.4	Frozen foods			
9.2.4.1	Process area	200-300-500	3	
9.2.4.2	Packaging and storage	200-300-500	3	
9.3	Bottling, Brewing and Distilling			

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
9.3.1	Keg washing and handling, bottle washing	150-200-300	3	
9.3.2	Keg inspection	200-300-500	3	
9.3.3	Bottle inspection	-	-	Special lighting will be required
9.3.4	Process areas	200-300-500	3	
9.3.5	Bottle filling	500-750-1000	3	
9.4	Edible Oils and Fats Processing			
9.4.1	Refining and blending	200-300-500	3	
9.4.2	Production	300-500-750	2	
9.5	Mills-Milling, Filtering and	200-300-500	3	
9.6	Bakeries			
9.6.1	General	200-300-500	2	
9.6.2	Hand decorating, icing	300-500-750	2	
9.7	Chocolate and Confectionery			
9.7.1	General	200-300-500	3	
9.7.2	Automatic processes	150-200-300	3	
9.7.3	Hand decoration, inspection, wrapping and packing	300-500-750	2	If accurate colour judgements are required, lamps of colour rendering group 1A or 1B are used
9.8	Tobacco Processing	300-500-750	2	
9.8.1	Material preparation, making and	500-750-1000	2	
9.8.2	Hand processes			
10	**TEXTILES**			
10.1	Fibre Preparation			
10.1.1	Bale breaking, washing	200-300-500	3	
10.1.2	Stock dyeing, tinting	200-300-500	3	
10.2	Yarn Manufacture			
10.2.1	Spinning, roving, winding, etc	300-500-750	2	
10.2.2	Healding (drawing in)	750-1000-750	2	
10.3	Fabric Production			
10.3.1	Knitting	300-500-750	2	
10.3.2.	Weaving			
10.3.2.1	Jute and hemp	200-300-500	2	

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
10.3.2.2	Heavy woolens	300-500-750	1	
10.3.2.3	Medium worsteds, fine woolens,	500-750-1000	1	
10.3.2.4	Fine worsteds, fine linens,	750-1000-	1	
10.3.2.5	Mending	1000-1500-	1	
10.3.2.6	Inspection	1000-1500-2000	1	
10.4	Fabric Finishing			
10.4.1	Dyeing	200-300-500	3	
10.4.2	Calendaring, chemical treatment, etc	300-500-750	2	
10.4.3	Inspection			
10.4.3.1	'Grey' cloth	750-1000-1500	1	
10.4.3.2	Final	1000-1500-2000	1	
10.5	Carpet Manufacture			
10.5.1	Winding, beaming	200-300-500	3	
10.5.2	Setting pattern, turfing cropping, trimming, fringing, latexing and latex drying	300-500-750	2	
10.5.3	Designing, weaving, mending	500-750-1000	2	
10.5.4	Inspection			
10.5.4.1	General	750-1000-1500	1	Local lighting may be appropriate
10.5.4.2	Peace dyeing	500-750-1000	1	Local lighting may be appropriate
11	**LEATHER INDUSTRY**			
11.1	Leather Manufacture			
11.1.1	Cleaning, tanning and stretching, vats, cutting, fleshing, stuffing	200-300-500	3	
11.1.2	Finishing, scarfing	300-500-750	2	
11.2	Leather Working			
11.2.1	General	200-300-500	3	
11.2.2	Pressing, glazing	300-500-750	2	
11.2.3	Cutting, splitting, scarfing, sewing	500-750-1000	2	Directional lighting may be useful.
11.2.4	Grading, matching		2	Local lighting may be appropriate

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
12	**CLOTHING AND FOOTWEAR**			
12.1	Clothing Manufacture			
12.1.1	Preparation of cloth	200-300-500	2	
12.1.2	Cutting	500-750-1000	1	
12.1.3	Matching	500-750-1000	1	
12.1.4	Sewing	750-1000-1500	1	
12.1.5	Pressing	300-500-750	2	
12.1.6	Inspection	1000-1500-2000	1	Local lighting may be appropriate
12.1.7	Hand tailoring	1000-1500-2000	1	Local lighting may be appropriate
12.2	Hosiery and Knitwear Manufacture			
12.2.1	Flat bed knitting machines	300-500-750	2	
12.2.2	Circular knitting machines	500-750-1000	2	
12.2.3	Lockstitch and over locking machine	750-1000-1500	1	
12.2.4	Linking or running on	750-1000-1500	1	
12.2.5	Mending, hand finishing	1000-1500-3000	-	Local lighting may be appropriate
12.2.6	Inspection	1000-1500-2000	2	Local lighting may be appropriate
12.3	Glove Manufacture			
12.3.1	Sorting and grading	500-750-1000	1	
12.3.2	Pressing, knitting, cutting	300-500-750	2	
12.3.3	Sewing	500-750-1000	2	
12.3.4	Inspection	1000-1500-2000	-	Local lighting may be appropriate
12.4	Hat Manufacture			
12.4.1	Stiffening, braiding, refining, forming, sizing, pounding ,ironing	200-300-500	2	
12.4.2	Cleaning, flanging, finishing	300-500-750	2	
12.4.3	Sewing	500-750-1000	2	
12.4.4	Inspection	1000-1500-2000	-	Local lighting may be appropriate
12.5	Boot and Shoe Manufacture			
12.5.1	Leather and synthetics			

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
12.5.2	Sorting and grading	750-1000-1500	1	
12.5.3	Clicking, closing	750-1000-1500	2	
12.5.4	Preparatory operations	750-1000-1500	2	
12.5.5	Cutting tables and pressure	1000-1500-2000	1	
12.5.6	Bottom stock preparation, lasting, bottoming finishing, shoe rooms	750-1000-1500	1	
12.5.7	Rubber			
12.5.7.1	Washing, compounding, coating, drying, varnishing, vulcanizing, calendaring, cutting	200-300-500	3	
12.5.7.2	Lining, making and finishing	300-500-750	2	
13	**TIMBER AND FURNITURE**			
13.1	Sawmills			
13.1.1	General	150-200-300	3	
13.1.2	Head saw	300-500-750	2	Localized lighting may be appropriate
13.1.3	Grading	500-750-1000	2	Directional lighting may be useful
13.2	Woodwork Shops			
13.2.1	Rough sawing, bench work	200-300-500	2	
13.2.2	Sizing, planning, sanding, medium machining and bench work	300-500-750	2	
13.2.3	Fine bench and machine work, fine sanding, finishing	500-750-1000	2	Localized lighting may be appropriate
13.3	Furniture Manufacture			
13.3.1	Raw material stores	50-100-150	3	
13.3.2	Finished goods stores	100-150-200	3	
13.3.3	Wood matching and assembly, rough sawing, cutting	200-300-500	2	
13.3.4	Machining, sanding and assembly, polishing	300-500-750	2	Localized lighting may be appropriate
13.3.5	Tool room	300-500-750	2	
13.3.6	Spray booths			
13.3.6.1	Colour finishing	300-500-750	2	

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
13.3.6.2	Clear finishing	200-300-500	2	
13.3.7	Cabinet making			
13.3.7.1	Veneer sorting and grading	750-1000-1500	1	
13.3.7.2	Marquetry, pressing, patching and fitting	300-500-750	1	
13.3.7.3	Final inspection	500-750-1000	1	Special lighting will be required
13.4	Upholstery Manufacture			
13.4.1	Cloth inspection	1000-1500-2000	1	Special lighting will be required
13.4.2	Filling, covering	300-500-750	2	
13.4.3	Slipping, cutting, sewing	500-750-1000	2	
13.4.4	Mattress making			
13.4.5	Assembly	300-500-750	2	
13.4.6	Tape edging	750-1000-1500	2	Local lighting may be appropriate
14	**PAPER AND PRINTING**			
14.1	Paper Mills			
14.1.1	Pulp mills, preparation plants	200-300-500	3	
14.1.2	Paper and board making			
14.1.2.1	General	200-300-500	3	
14.1.2.2	Automatic process	150-200-300	3	Supplementary lighting may be necessary for maintenance work
14.1.2.3	Inspection, sorting	300-500-750	1	
14.1.3	Paper converting processes			
14.1.3.1	General	200-300-500	3	
14.1.3.2	Associated printing	300-500-750	2	
14.2	Printing Works -			
14.2.1	Type foundries			
14.2.1.1	Matrix making, dressing type, hand and machine coating	200-300-500	3	
14.2.1.2	Front assembly, sorting	500-750-1000	2	
14.2.2	Composing rooms	-		
14.2.2.1	Hand composing, imposition and distribution	500-750-1000	1	
14.2.2.2	Hot metal keyboard	500-750-1000	1	
14.2.2.3	Hot metal casting	200-300-500	2	

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
14.2.2.4	Photo composing keyboard or setters	300-500-750	1	
14.2.2.5	Paste up	500-750-1000	1	
14.2.2.6	Illuminated tables-general lighting	200-300-500	-	Dimming may be required
14.2.2.7	Proof presses	300-500-750	2	
14.2.2.8	Proof reading	500-750-1000	1	
14.2.3	Graphic reproduction			
14.2.3.1	General	300-500-750	2	
14.2.3.2	Precision proofing, retouching, etching	750-1000-1500	1	Local lighting may be appropriate
14.2.3.3	Colour reproduction and inspection	750-1000-1500	1	
14.2.4	Printing machine room			
14.2.4.1	Presses	300-500-750	2	
14.2.4.2	Premake ready	300-500-750	2	
14.2.4.3	Printed sheet inspection	750-1000-1500	1	
14.2.5	Binding			
14.2.5.1	Folding, pasting, punching and stitching	300-500-750	2	
14.2.5.2	Cutting, assembling, embossing	500-750-1000	2	
15	**PLASTIC AND RUBBER**			
15.1	Plastic Products			
15.1.1	Automatic plant			
15.1.1.1	Without manual control	30-50-100	3	
15.1.1.2	With occasional manual control	50-100-150	3	
15.1.1.3	With continuous manual control	200-300-500	3	
15.1.1.4	Control rooms	200-300-500	1	
15.1.1.5	Control platforms	200-300-500	2	
15.1.2	Non-automatic plant			
15.1.2.1	Mixing, calendaring, extrusion, injection, compression and blow moulding, sheet fabrication	200-300-500	3	
15.1.2.2	Trimming, cutting, polishing, cementing	300-500-750	2	
15.1.2.3	Printing, inspection	750-1000-1500	1	
15.2	Rubber Products			

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
15.2.1	Stock preparation — plasticizing, milling	150-200-300	3	
15.2.2	Calendaring, fabric preparation, stock-cutting	300-500-750	3	
15.2.3	Extruding, moulding	300-500-750	2	
15.2.4	Inspection	750-1000-1500	-	
16	**DISTRIBUTION AND STORAGE**			
16.1	Work Stores	100-150-200	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.1	Unpacking, sorting	150-200-300	3	bay Avoid glare to drivers of vehicles approaching the loading bay
16.1.2	Large item storage	50-100-150	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.3	Small item rack storage	200-300-500	3	Avoid glare to drivers of vehicles approaching the loading bay
16.1.4	Issue counter, records, storeman's desk	300-500-750	2	Local or localized lighting may be appropriate
16.2	Warehouses and Bulk Stores			
16.2.1	Storage of goods where indentification requires only limited preparation of detail	50-100-150	3	
16.2.2	Storage of goods where indentificiation requires perception of details	100-150-200	3	
16.2.3	Automatic high bay rack stores			
16.2.3.1	Gangway	20	-	
16.2.3.2	Control station	150-200-300	3	
16.2.3.3	Packing and dispatch	200-300-500	3	
16.2.3.4	Loading bays	100-150-200	3	Avoid glare to drivers of vehicles approaching the loading bay
16.3	Cold Stores			
16.3.1	General	200-300-500	3	

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
16.3.2	Breakdown, make-up and dispatch	200-300-500	3	
16.3.3	Loading bays	100-150-200	3	Avoid glare to drivers of vehicles approaching the loading bay
17	**COMMERCE**			
17.1	Offices			
17.1.1	General offices	300-500-750	1	
17.1.2	Deep plan general offices	500-750-1000	1	
17.1.3	Computer work stations	300-500-750	1	
17.1.4	Conference rooms, executive offices	300-500-750	1	
17.1.5	Computer and data preparation rooms	300-500-750	1	
17.1.6	Filing rooms	200-300-500	1	
17.2	Drawing Offices			
17.2.1	General	300-500-750	1	
17.2.2	Drawing boards	500-750-1000	1	
17.2.3	Computer aided design and drafting	-	-	Special lighting is required
17.2.4	Print rooms	200-300-500	1	
17.3	Banks and Building Societies			
17.3.1	Counter, office area	300-500-750	1	
17.3.2	Public area	200-300-500	1	
18	**SERVICES**			
18.1	Garages			
18.1.1	Interior parking areas	20-30-50	3	
18.1.2	General repairs, servicing, washing, polishing	200-300-500	2	
18.1.3	Workbench	300-500-750	1	Local or localized lighting may be appropriate
18.1.4	Spray booths	300-500-750	1	
18.1.5	External apron			
18.1.5.1	General	30-50-100	-	Care should be taken to avoid glare to drivers and Neighbouring residents
18.1.5.2	Pump area (retail sales)	200-300-500	-	See ‘ Retailing
18.2	Appliance servicing			

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
18.2.1	Workshop			
18.2.1.1	General	200-300-500	2	
18.2.1.2	Workbench	300-500-750	2	Localized lighting may be appropriate
18.2.1.3	Counter	200-300-500	2	Localized lighting may be appropriate
18.2.1.4	Stores	200-300-500	3	
18.3	Laundries			
18.3.1	Commercial laundries			
18.3.2	Receiving, sorting, washing, drying, ironing, despatch, dry-cleaning, bulk machine work	200-300-500	3	
18.3.3	Head ironing, pressing, mending, spotting, inspection	300-500-750	3	
18.3.4	Launderettes	200-300-500	3	
18.4	Sewage Treatment Works			
18.4.1	Walkways	30-50-100	3	
18.4.2	Process areas	50-100-150	3	
19	**RETAILING**			
19.1	Small Shops with Counters	300-500-750	1	The service illuminance should be provided on the horizontal plane of the counter. Where wall displays are used, a similar illuminance on the walls is desirable
19.2	Small Self-Service Shops with Island Displays	300-500-750	1	
19.3	Super Markets, Hyper-Markets			
19.3.1	General	300-500-750	2	
19.3.2	Checkout	300-500-750	2	
19.3.3	Showroom for large objects, for example, cars, furniture	300-500-750	1	
19.3.4	Shopping precincts and arcades	100-150-200	2	
20	**PLACES OF PUBLIC ASSEMBLY**			
20.1	Public Rooms, Village Halls, Worship Halls	200-300-500	1	
20.2	Concert Halls, Cinemas and Theatres			

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
20.2.1	Foyer	150-200-300	-	
20.2.2	Booking office	200-300-500	-	Local or localized lighting may be appropriate
20.2.3	Auditorium	50-100-150	-	Dimming facilities will be necessary. Special lighting of the aisles is desirable
20.2.4	Dressing rooms	200-300-500	-	Special mirror lighting for make-up may be required
20.2.5	Projection room	100-150-200	-	
20.3	Churches			
20.3.1	Body of church	100-150-200	2	
20.3.2	Pulpit, lectern	200-300-500	2	Use local lighting
20.3.3	Choir stalls	200-300-500	2	Local lighting may be appropriate
20.3.4	Alter, communion table, chancel	100-150-200	2	Additional lighting to provide emphasis is desirable
20.3.5	Vestries	100-150-200	2	
20.3.6	Organ	200-300-500	-	
20.4	Hospitals			
20.4.1	Anaesthetic rooms			
20.4.1.1	General	200-300-500	-	
20.4.1.2	Local	750-1000-1500	-	
20.4.2	Consulting areas			
20.4.2.1	General	200-300-500	-	
20.4.2.2	Examination	750-1000-1500	-	
20.4.3	Corridors			
20.4.3.1	General	100-150-200	-	
20.4.4	Ward corridors		-	
20.4.4.1	Day, screened from bays	150-200-300	-	
20.4.4.2	Day, open to natural light	150-200-300 (total)		
20.4.4.3	Morning/Evening	100-150-200	-	
20.4.4.4	Night	5-10	-	
20.4.5	Cubicles			

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
20.4.5.1	General	200-300-500	-	
20.4.5.2	Treatment	750-1000-1500	-	
20.4.6	Examination			
20.4.6.1	General	200-300-500	-	
20.4.6.2	Local inspection	750-1000-1500	-	
20.4.7	Intensive therapy			
20.4.7.1	Bad head	30-50	-	
20.4.7.2	Circulation between bed ends	50-100-150	-	
20.4.7.3	Observation	200-300-500	-	
20.4.7.4	Local observation	750-1000-1500	-	
20.4.7.5	Staff base (day)	200-300-500	-	
20.4.7.6	Staff base (night)	30	-	
20.4.8	Laboratories			
20.4.8.1	General	200-300-500	-	
20.4.8.2	Examination	300-500-750	-	
20.4.9	Nurses' stations			
20.4.9.1	Morning/day/evening	200-300-500	-	
20.4.9.2	Night desks	30	-	
20.4.9.3	Night, medical trolleys	50-100-150	-	
20.4.10	Operating theatres			
20.4.10.1	General	300-500-750	-	
20.4.10.2	Local	10000 to 50000	-	Special operating lights are used
20.4.11	Pathology departments			
20.4.11.1	General	200-300-500	-	
20.4.11.2	Examination	300-500-750	-	
20.4.11.3	Pharmacies	200-300-500	-	
20.4.11.4	Reception/enquiry	200-300-500	-	
20.4.11.5	Recovery rooms	200-300-500	-	
20.4.12	Ward-circulation			
20.4.12.1	Day	50-100-150	-	
20.4.12.2	Morning/Evening	50-100-150	-	
20.4.12.3	Night	3-5	-	
20.4.13	Ward-bed head			
20.4.13.1	Morning/Evening	30-50		

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
20.4.13.2	Reading	100-150-200		
20.4.14	Night			
20.4.14.1	Adult	0.1-1		
20.4.14.2	Pediatric	1		
20.4.14.3	Psychiatric	1-5		
20.4.14.4	Watch	5		
20.4.15	X-Ray areas			
20.4.15.1	General	150-200-300		
20.4.15.2	Diagnostic	150-200-300		
20.4.15.3	Operative	200-300-500		
20.4.15.4	Process dark room	50		
20.4.16	Surgeries			
20.4.16.1	General	200-300-500	-	
20.4.16.2	Waiting rooms	100-150-200	-	
20.4.17	Dental surgeries			
20.4.17.1	Chair	Special lighting	-	
20.4.17.2	Laboratories	300-500-750	-	
20.4.18	Consulting rooms			
20.4.18.1	General	200-300-500	-	
20.4.18.2	Desk	300-500-750	-	
20.4.18.3	Examination couch	300-500-750	-	
20.4.18.4	Ophthalmic wall and near-vision charts	300-500-750	-	
20.5	Hotels			
20.5.1	Entrance halls	50-100-150		
20.5.2	Reception, cashier's and porters' desks	200-300-500		Localized lighting may be appropriate
20.5.3	Bars, coffee base, dining rooms, grill rooms, restaurants, lounges	50-200		The lighting should be designed to create an appropriate atmosphere
20.5.4	Cloak rooms, baggage rooms	50-100-150	3	
20.5.5	Bed rooms	30-50-100	-	Supplementary local lighting at the bed head, writing table should be provided
20.5.6	Bathroom	50-100-150		Supplementary local lighting near the mirror is desirable

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
20.5.7	Food preparation and stores, cellars, lifts and corridors	-	-	
20.6	Libraries			
20.6.1	Lending library			
20.6.1.1	General	200-300-500	1	
20.6.1.2	Counters	300-500-750	1	Localized lighting may be appropriate
20.6.1.3	Bookshelves	100-150-200	2	The service illuminance should be provided on the vertical face at the bottom of the bookshelves.
20.6.1.4	Reading rooms	200-300-500	1	
20.6.1.5	Reading tables	200-300-500	1	Localized lighting may be appropriate
20.6.2	Catalogues			
20.6.2.1	Card	100-150-200	2	
20.6.2.2	Microfiche/Visual display units	100-150-200	2	
20.6.3	Reference libraries			
20.6.3.1	General	200-300-500	1	
20.6.3.2	Counters	300-500-750	1	Localized lighting may be appropriate
20.6.3.3	Bookshelves	100-150-200	2	The service illuminance should be provided on the vertical face at the bottom of the bookshelves.
20.6.3.4	Study tables, carrels	300-500-750	1	
20.6.3.5	Map room	200-300-500	1	
20.6.4	Display and exhibition areas			
20.6.4.1	Exhibits insensitive to light	200-300-500	-	
20.6.4.2	Exhibit sensitive to light, for example, pictures, prints, rare books in archives	50 to 150	-	
20.6.5	Library workrooms			
20.6.5.1	Book repair and binding	300-500-750	2	
20.6.5.2	Catalogue and sorting	300-500-720	2	
20.6.5.3	Remote book stores	100-150-200	3	
20.7	Museums and Art Galleries			

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
20.6.5.3	Remote book stores	100-150-200	3	
20.7	Museums and Art Galleries			
20.7.1	Exhibits insensitive to light	200-300-500	-	
20.7.2	Light sensitive exhibits, for example, oil and temper paints, undyed leather, bone, ivory, wood, etc	150	-	This is a maximum illuminance to be provided on the principal plane of the exhibit
20.7.3	Extremely light sensitive exhibits, for example, textiles, water colours, prints and drawings, skins, botanical specimens, etc	50	-	This is the maximum illuminance to be provided on the principal plane of the object
20.7.4	Conservation studies and workshops	300-500-750	1	
20.8	Sports Facilities			
	Multi-purpose sports halls	300-750	-	This lighting system should be sufficiently flexible to provide lighting suitable for the variety of sports and activities that take place in sports halls. Higher illuminance of 1000-2000 lux would be required for television coverage
21	**EDUCATION**			
21.1	Assembly Halls			
21.1.1	General	200-300-500	3	
21.1.2	Platform and stage	-	-	Special lighting to provide emphasis and to facilitate the use of the platform/ stage is desirable
21.2	Teaching Spaces			
	General	200-300-500	1	
21.3	Lecture Theatres			
21.3.1	General	200-300-500	1	
21.3.2	Demonstration benches	300-500-750	1	Localized lighting may be appropriate
21.4	Seminar Rooms	300-500-750	1	
21.5	Art Rooms	300-500-750	1	

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
21.6	Needlework Rooms	300-500-750	1	
21.7	Laboratories	300-500-750	1	
21.8	Libraries	200-300-500	1	
21.9	Music Rooms	200-300-500	1	
21.10	Sports Halls	200-300-500	1	
21.11	Workshops	200-300-500	1	
22	**TRANSPORT**			
22.1	Airports			
22.1.1	Ticket counters, checking desks, and information desks	300-500-750	2	Localized lighting may be appropriate
22.1.2	Departure lounges, other waiting areas	150-200-300	2	
22.1.3	Baggage reclaim	150-200-300	2	
22.1.4	Baggage handling	50-100-150	2	
22.1.5	Customs and immigration halls	300-500-750	2	
22.1.6	Concourse	150-200-300	2	
22.2	Railway Stations			
22.2.1	Ticket office	300-500-750	2	Localized lighting may be appropriate
22.2.2	Information office	300-500-750	2	Localized lighting over the counter may be appropriate
22.2.3	Parcels office, left			
22.2.4	Luggage office			
22.2.4.1	General	50-100-150	2	
22.2.4.2	Counter	150-200-300	2	
22.2.5	Waiting rooms	150-200-300	2	
22.2.6	Concourse	150-200-300	2	
22.2.7	Time table	150-200-300	2	Localized lighting may be appropriate
22.2.8	Ticket barriers	150-200-300	2	Localized lighting may be appropriate
22.2.9	Platforms (covered)	30-50-100	2	Care should be taken to light and mark the edge of the platform clearly
22.2.10	Platforms (open)	20	-	Care should be taken to light and mark the edge of the platform clearly

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
22.3	Coach Stations			
22.3.1	Ticket offices	300-500-750	2	Localized lighting over the counter may be appropriate
22.3.2	Information offices	300-500-750	2	Localized lighting over the counter may be appropriate
22.3.3	Left luggage office			
22.3.3.1	General	50-100-150	3	
22.3.3.2	Counter	150-200-300	3	Localized lighting is appropriate
22.3.4	Waiting rooms	150-200-300	2	
22.3.5	Concourse	150-200-300	2	
22.3.6	Time tables	150-200-300	2	Localized lighting is appropriate
22.3.7	Loading areas	100-150-200	3	
23	**GENERAL BUILDING AREAS**			
23.1	Entrance			
23.1.1	Entrance halls, lobbies, waiting rooms	150-200-300	2	
23.1.2	Enquiry desks	300-500-750	2	Localized lighting may be appropriate
23.1.3	Gatehouses	150-200-300	2	
23.2	Circulation Areas			
23.2.1	Lifts	50-100-150	-	
23.2.2	Corridors, passageways, stairs	50-100-150	2	
23.2.3	Escalators, travellators	100-150-200	-	
23.3	Medical and First Aid Centre			
23.3.1	Consulting rooms, treatment rooms	300-500-750	1	
23.3.2	Rest rooms	100-150-200	1	
23.3.3	Medical stores	100-150-200	2	
23.4	Staff Rooms			
23.4.1	Changing, locker and cleaners rooms, cloakrooms, lavatories	50-100-150	-	
23.4.2	Rest room	100-150-200	1	
23.5	Staff Restaurants			
23.5.1	Canteens, cafeterias, dining rooms, mess rooms	150-200-300	2	

Table 1- *Continued*

(1)	(2)	(3)	(4)	(5)
23.5.2	Servery, vegetable preparation, washing-up area	200-300-500	2	
23.5.3	Food preparation and cooking	300-500-750	2	
23.5.4	Food stores, cellars	100-150-200	2	
23.6	Communications			
23.6.1	Switchboard rooms	200-300-500	2	
23.6.2	Telephone apparatus rooms	100-150-200	2	
23.6.3	Telex room, post room	300-500-750	2	
23.6.4	Reprographic room	200-300-500	2	
23.7	Building Services			
23.7.1	Boiler houses			
23.7.1.1	General	50-100-150	3	
23.7.1.2	Boiler front	100-150-200	3	
23.7.1.3	Boiler control room	200-300-500	2	Localized lighting of the control display and the control desk may be appropriate
23.7.1.4	Control rooms	200-300-500	2	Localized lighting of the control display and the control desk may be appropriate
23.7.1.5	Mechanical plant room	100-150-200	2	
23.7.1.6	Electrical power supply and distribution rooms	100-150-200	2	
23.7.1.7	Store rooms	50-100-150	3	
23.8	Car Parks			
23.8.1	Covered car parks			
23.8.1.1	Floors	5-20	-	
23.8.1.2	Ramps and corners	30	-	
23.8.1.3	Entrances and exits	50-100-150	-	
23.8.1.4	Control booths	150-200-300		
23.8.1.5	Outdoor car parks	5-20		

NOTE For details on use of the ranges of illumination given in three steps in this table, reference shall be made to 5A.3.1.3.2, 5A.3.1.3.2.1 and 5A.3.1.3.2.2.

For the same reason, it is desirable that the illumination level of rooms which open off a working area should be fairly high even though the rooms may be used only occasionally**.**

It is important, when lighting stairways, to prevent disability from glare caused by direct sight of bright sources to emphasize the edges of the treads and to avoid confusing shadows. The same precautions should be taken in the lighting of cat-walks and stairways on outdoor industrial plants.

5A.3.1.5.2 Entrances

The problems of correctly grading the lighting within a building to allow adequate time for adaptation when passing from one area to another area are particularly acute at building entrances. These are given below:

a) By day, people entering a building will be adapted to the very high levels of brightness usually present outdoors and there is risk of accident if entrance areas, particularly any steps, are poorly lighted. This problem may often be overcome by arranging windows to give adequate natural lighting at the immediate entrance, grading to lower levels further inside the entrance area. Where this cannot be done, supplementary artificial lighting should be installed to raise the level of illumination to an appropriate value.

b) At night it is desirable to light entrance halls and lobbies so that the illuminationlevelreduces towards the exit and so that no bright fittings are in the line of sight of peopleleavingthe building. Any entrance steps to the building should be well-lighted by correctly screened fittings.

5A.3.1.6 For detailed information regarding principles of good lighting, reference may be made to standard practice.

5A.3.2 Artificial Lighting

5A.3.2.1 Artificial lighting may have to be provided

a) where the recommended illumination levels have to be obtained by artificial lighting only,

b) to supplement daylighting when the level of illumination falls below the recommended value, and

c) where visual task may demand a higher level of illumination.

5A.3.2.2 *Artificial Lighting Design for Interiors*

For general lighting purposes, the recommended practice is to design for a level of illumination on the working plane on the basis of the recommended levels for visual tasks given in Table 1 by a method called 'Lumen method'. In order to make the necessary detailed calculations concerning the type and quantity of lighting equipment necessary, advance information on the surface reflectances of walls, ceilings and floors is required. Similarly, calculations concerning the brightness ratio in the interior call for details of the interior decor and furnishing. Stepwise guidance regarding designing the interior lighting systems for a building using the 'Lumen method' is given in **5A.3.2.2.1**to **5A.3.2.2.4.**

5A.3.2.2.1 *Determination of the illumination level*

Recommended value of illumination shall be taken from Table 1, depending upon the type of work to be carried out in the location in question and the visual tasks involved.

5A.3.2.2.2 *Selection of the light sources and luminous*

The selection of light sources and luminaires depends on the choice of lighting system, namely, general lighting, directional lighting and localized or local lighting.

5A.3.2.2.3 *Determination of the luminous flux*

a) The luminous flux (*Ø*) reaching the working plane depends upon the following:

1) lumen output of the lamps,

2) type of luminaire,

3) proportion of the room (room index) (k_r),

4) reflectance of internal surfaces of the room,

5) depreciation in the lumen output of the lamps after burning their rated life, and

6) depreciation due to dirt collection on luminous and room surface**.**

b) *Coefficient of Utilization or Utilization Factor*

1) The compilation of tables for theutilization factor requires a considerable amount of calculations, especially if these tables have to cover a wide range of lighting practices. For every luminaire, the exact light distribution has to be measured in the laboratory and their efficiencies have to be calculated and measured exactly. These measurements comprise:

(i) the luminous flux radiated by the luminaires directly to the measuring surface,

(ii) the luminous flux reflected and re- reflected by the ceiling and the walls to the measuring surface, and

(iii) the inter-reflections between the ceiling and wall which result in the measuring surface receiving additional luminous flux.

All these measurements have to be made for different reflection factors of the ceiling and the walls for all necessary room indices. These tables have also to indicate the maintenance factor to be taken for the luminous flux depreciation throughout the life of an installation due to ageing of the lamp and owing to the deposition of dirt on the lamps and luminaires and room surfaces.

2) The values of the reflection factor of the ceiling and of the wall are as follows:

White and very light colours	0.7
Light colours	0.5
Middle tints	0.3
Dark colours	0.1

For the walls, taking into account the influence of the windows without curtains, shelves, almirahs and doors with different colours, etc, should be estimated,

c) Calculation for determining the luminous flux

$$E_{av} = \frac{\mu\phi}{A}$$

or, $\phi = \frac{E_{av}A}{\mu}$ for new condition

and $\phi = \frac{E_{av}A}{\mu d}$ for working condition

where

ϕ = Total luminous flux of the light sources installed in the room in lumens;

E_{av} = Average illumination level required on the working plane in lux;

A = Area of the working plane in m^2;

μ = the utilization factor in new conditions; and

d = maintenance factor.

In practice, it is easier to calculate straightaway the number of lamps or luminaires from:

$$N_{\mathrm{lamp}} = \frac{E_{av}\ A}{\mu\ d\ \phi_{\mathrm{lamp}}}$$

$$N_{\mathrm{luminaires}} = \frac{E_{av}\ A}{\mu\ d\ \phi_{\mathrm{luminaires}}}$$

where

ϕ_{lamp} = Luminous flux of each lamp in lumens,

$\phi_{\mathrm{luminaires}}$ = Luminous flux of each luminaire in lumens,

N_{lamp} = Total number of lamps, and

$N_{\mathrm{luminaires}}$ = Total number of luminaires

5A.3.2.2.4 *Arrangement of the luminaires*

This is done to achieve better uniformly distributed illumination. The location of the luminaires has an important effect on the utilization factor.

a) In general, luminaires are spaced 'a' metre apart in either direction, while the distance of the end luminaire from the wall is ‘ ½*a*’ metre. The distance '*a*' is more or less equal to the mounting height 'H_m' between the luminaire and the working plane. The utilization factor tables are calculated for this arrangement of luminaires.
b) For small rooms where the room index (k_r) is less than 1, the distance '*a*' should always be less than H_m since otherwise luminaires cannot be properly located. In most cases of such rooms, four or two luminaires are placed for good general lighting. If, however, in such rooms only one luminaire is installed in the middle, higher utilization factors are obtained, but the uniformity of distribution is poor. For such cases, references should be made to the additional tables for k_r = 0.6 to 1.25 for luminaires located centrally.

5A.3.2.3 *Artificial Lighting to Supplement Day lighting*

5A.3.2.3.1 The need for general supplementary artificial lighting arises due to diminution of daylighting beyond design hours, that is, for solar altitude below 15° or when dark cloudy conditions occur.

5A.3.2.3.2 The need may also arise for providing artificial lighting during the day in the innermost parts of the building which cannot be adequately provided with daylighting, or when the outside windows are not of adequate size or when there are unavoidable external obstructions to the incoming day lighting.

5A.3.2.3.3 The need for supplementary lighting during the day arises, particularly when the daylighting on the working plane falls below 100 lux and the surrounding luminance drops below 19 cd/m^2 .

5A.3.2.3.4 The requirement of supplementary artificial lighting increases with the*decrease* in day lighting availability. Therefore, conditions near sunset or sunrise or equivalent conditions due to clouds or obstructions, etc, represent the worst conditions when the supplementary lighting is most needed.

5A.3.2.3.5 The requirement of supplementary artificial lighting when day lighting

availability becomes poor may be determined from Fig. 2 for an assumed ceiling height of 3.0 m, depending upon floor area, fenestration percentage and room surface reflectance.

Cool daylight fluorescent tubes are recommended with semi-direct luminaires. To ensure a good distribution of illumination, the mounting height should be between 1.5 m and 2.0 m above the work plane for a separation of 2.0 m to 3.0 m between the luminaires. Also the number of lamps should preferably be more in the rear half of the room than in the vicinity of windows. The following steps may be followed for using Fig. 2 for determining the number of fluorescent tubes required for supplementary day lighting.

a) Determine fenestration percentage of the floor area, that is,

$$\frac{Window\ Area}{Floor\ Area} \times 100$$

b) In Figure 2, refer to the curve corresponding to the percent fenestration determined above and the set of reflectances of ceiling, walls and floor actually provided.

c) For the referred curve of Figure 2 read, along the ordinate, the number of 40 W fluorescent tubes required, corresponding to the given floor area on the abscissa.

5A.3.2.4 For detailed information on the design aspects and principles of artificial lighting, reference may be made to standard practice [(1) IS 3646].

5A.3.2.5 For specific requirements for lighting of special occupancies and areas, reference may be made to Standard practice [(2) IS 1944].

5A.3.2.6 Electrical installation aspect for artificial lighting shall be in accordance with Part 5B 'Building Services, Electrical and Allied Installations'.

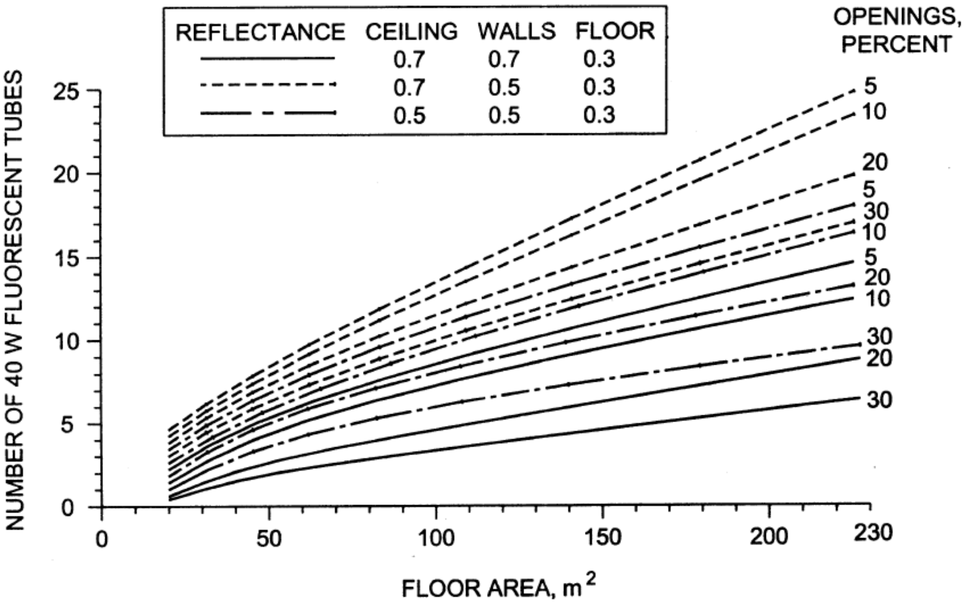


Figure 2: Supplementary Artificial Lighting for 40W Fluorescent Tubes

A.3.3 Energy Conservation in Lighting

5A.3.3.1A substantial portion of the energy consumed on lighting may be saved by utilization of daylight and rational design of supplementary artificial lights.

5A.3.3.2 Daytime use of artificial lights may be minimized by proper design of windows for adequate daylight indoors.

5A.3.3.3 Fenestration expressed as percentage of floor area required for satisfactory visual performance of a few tasks for different separation to height*(S/H)* ratio of external obstructions such as opposite buildings may be obtained from the design nomograph (Figure 3). The obstructions at a distance of three times their height or more*(S/H*> 3) from a window facade are not significant and a window facing such an obstruction may be regarded as a case of unobstructed window.

5A.3.3.3.1 The nomograph consists of horizontal lines indicating fenestration percentage of floor area and vertical lines indicating the separation to height ratio of external obstructions such as opposite buildings. Any vertical line for separation to height ratio other than already shown in the nomograph (1.0,2.0 and 3.0) may be drawn by designer, if required. For cases where there is no obstruction, the ordinate corresponding to the value 3.0 may be used. The value of percentage fenestration and separation to height ratio are marked on left hand ordinate and abscissa respectively. The illumination levels are marked on the right hand ordinate. The values given within brackets are the illumination levels on the work plane at centre and rear of the room. The wattage of fluorescent tubes required per square metre of the floor area for different illumination levels is shown on each curve.

5A.3.3.3.2 Following assumptions have been made in the construction of the nomograph:

An average interior finish with ceiling white, walls off white and floor grey has been assumed.

Ceiling height of 3 m and room depths up to 10 m and floor area between 30 m^2 and 50 m^2 have been assumed. For floor area beyond 50 m^2 and less than 30 m^2, the values of percent fenestration as well as wattage per m^2 should be multiplied by a factor of 0.85 and 1.15 respectively.

It is assumed that windows are of metallic sashes with louvers of width up to 600 mm or a *CHHAJJA* (balcony projection) at ceiling level of width up to 2.0 m. For wooden sashes, the window area should be increased by a factor of about 1.1.

Luminaires emanating more light in the downward direction than upward direction (such as reflectors with or without diffusing plastics) and mounted at a height of 1.5 m to 2.0 m above the work plane have been considered.

5A.3.3.3.3*Method of use*

The following steps shall be followed for the use of nomograph:

Step 1 — Decide the desired illumination level depending upon the task illumination requirement in the proposed room and read the value of watts per square metre on the curve corresponding to the required illumination level.

Step 2 — Fix the vertical line corresponding to the given separation to height ratio of opposite buildings on the abscissa. From the point of intersection of this vertical line and the above curve move along horizontal, and read the value of fenestration percent on the left hand ordinate.

Step 3 — If the floor area is greater than 50 m^2 and less than 30 m^2, the value of watts per square metre as well as fenestration percent may be easily determined for adequate day lighting and supplemental artificial lighting for design purposes. However, if the fenestration provided is less than the required value, the wattage of supplementary artificial lights should be increased proportionately to make up for the deficiency of natural illumination.

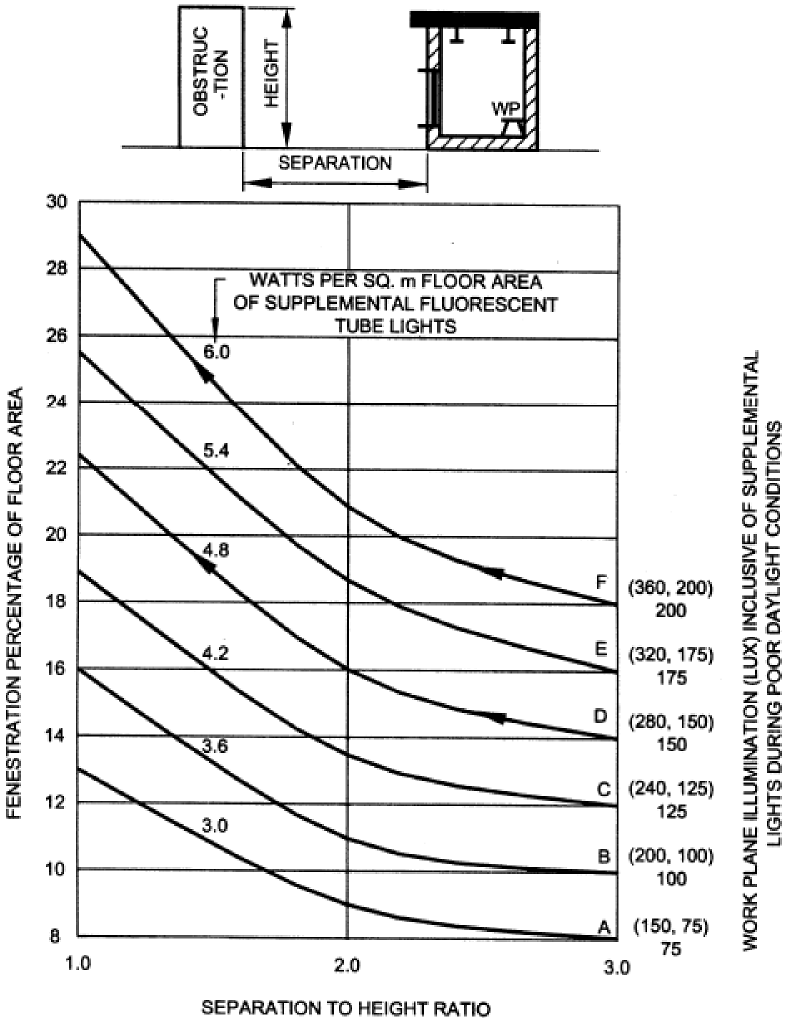


Figure 3: Nomograph for Daylighting and Suplemental Lighting Design of Building

5A.3.3.4 For good distribution of day light on the working plane in a room, window height, window width and height of sill should be chosen in accordance with the following recommendations**:**

a) In office buildings windows of height 1.2 m or more in the center of a bay with sill levelat 1.0 to 1.2 m above floor and in residential buildings windows of height 1.0 m to 1.1 m with sill height as 0.9 m to 0.7 m above floor are recommended for good distribution of daylight indoors. Window width can accordingly be adjusted depending upon the required fenestration percentage of the floor area.

b) If the room depth is more than 10 m, windows should be provided on opposite sides for bilateral lighting.

c) It is desirable to have a white finish for ceiling and off white (light colour) to white for walls. There is about 7 percent improvement in lighting levels in changing the finish of walls from moderate to white.

5A.3.3.5 For good distribution and integration of daylight with artificial lights the following guidelines are recommended**:**

a) Employ cool daylight fluorescent tubes for supplementary artificial lighting.

b) Distribute luminaries with a separation of 2 m to 3 m in each bay of 3 m to 4 m width.

c) Provide more supplementary lights such as twin tube luminaries in work areas where daylight is expected to be poor for example in the rear region of a room having single window and in the central region of a room having windows on opposite walls. In the vicinity of windows only single tube luminaries should be provided.

5A.3.3.6 *Artificial Lighting*

Energy conservation in lighting is affected by reducing wastage and using energy effective lamps and luminaires without sacrificing lighting quality. Measures to be followed comprise utilization of daylight, energy effective artificial lighting design by providing required illumination where needed, turning off artificial lights when not needed, maintaining lighter finishes of ceiling, walls and furnishings, and implementing periodic schedule for cleaning of luminaires and group replacement of lamps at suitable intervals. Choice of light sources with higher luminous efficacy and luminaires with appropriate light distribution is the most effective means of energy saving in lighting. However, choice of light sources also depends on the other lighting quality parameters like colour rendering index and colour temperature or appearance. For example, high pressure sodium vapour lamps, which have very high luminous efficacy, are not suitable for commercial interiors because of poor colour rendering index and colour appearance, but are highly desirable in heavy industries. Also the choice of light sources depends on the mounting height in the interiors. For example, fluorescent lamps are not preferred for mounting beyond 7 m height, when high pressure gas discharge lamps are preferred because of better optical control due to their compact size.

5A.3.3.6.1 *Efficient artificial light sources and luminaires*

Luminous efficacy of some of the lamps used in lighting of buildings are given in Table 2 along with average life in burning hours, Colour Rendering Index and Colour Temperature.

Following recommendations may be followed in the choice of light sources for different locations:

a) For supplementary artificial lighting of work area in office building care should be taken to use fluorescent lamps, which match with colour temperature of the daylight.

b) For residential buildings fluorescent lamps and/or CFLs of proper CRI and CCT are recommended to match with the colours and interior design of the room.

c) For commercial interiors, depending on the mounting heights and interior design, fluorescent lamps, CFLs and low wattage metal halide lamps are recommended. For highlighting the displays in show windows, hotels, etc, low wattage tubular or dichroic reflector type halogen lamps can be used.

d) For industrial lighting, depending on the mounting height and colour consideration fluorescent lamps, high pressure mercury vapour lamps or high pressure sodium vapour lamps are recommended.

5A.3.3.6.2 For the same lumen output, it is possible to save 50 to 70 percent energy if CFL lamps are replaced with induction lighting, and 40 to 60 percent if replaced with LED lamps. Similar energy effective solutions are to be chosen for every application area.
Similarly with white fluorescent tubes recommended for corridors and staircases, the electrical consumption reduces to 1/4.5 of the energy consumption with incandescent lamps.

Table 2: Luminous Efficacy, Life, CRI and CCT of Light Sources

*(Clause **5A.3.4.6.1**)*

Sr No.	Light Source Rendition	Wattage Range W	Efficacy Im/W	Average Life h	Lumen Maintenance	Colour
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Incandescent lamp	15 to 200	12 to 20	500 to 1000	Fair to good	Very good
ii)	Tungsten halogen	300 to 1500	20 to 27	200 to 2000	Good to Very good	Very good
iii)	Standard fluorescent lamps	20 to 80	55 to 65	5000	Fair to good	Good
iv)	Compact fluorescent lamp(CFL)	5 to 40	60 to 70	7500	Good	Good to very good
v)	Slim line fluorescent	18 to 58	57 to 67	5000	Fair to good	Good
v)	High pressure mercury vapour lamps	60 to 1000	50 to 65	5000	Very low to fair	Federate
vi)	Blended- light lamps	160 to 250	20 to 30	5000	Low to fair	federate
vii)	High pressure sodium vapour lamps	50 to 1000	90 to 125	10000 to 1500	Fair to good	Low to good
viii)	Metal halide lamps	35 to 2000	80 to 95	4000 to 10000	Very low	Very good
ix)	Low pressure sodium	10 to 180	100 to 200	10000 to 2000	Good to very good	Poor
x)	LED	0.5 to 2.0	60 to 100	10000	Very good	Good for white LED

NOTES
1. The table includes lamps and wattages currently in use in buildings.
2. Luminous efficacy varies with the wattage of the lamp.
3. Average life values are only indicative.
4. For exact values, it is advisable to contact manufacturers.

5A.3.3.6.3 Efficient luminaire also plays an important role for energy conservation in lighting. The choice of a luminaire should be such that it is efficient not only initially but also throughout its life. Following luminaries are recommended for different locations:

a) For offices semi-direct type of luminaries are recommended so that both the work plane illumination and surround luminance can be effectively enhanced.
b) For corridors and staircases direct type of luminaries with wide spread of light distributions are recommended.
c) In residential buildings, bare fluorescent tubes are recommended. Wherever the incandescent lamps are employed, they should be provided white enamelled conical reflectors
at an inclination of about 45° from vertical.

5A.3.3.7 Cleaning Schedule for Window Panes and Luminaires
Adequate schedule for cleaning of window panes and luminaries will result in significant advantage of enhanced daylight and lumen output from luminaries. This will tend to reduce the duration over which artificial lights will be used and minimise the wastage of energy. Depending upon the location ofthe building a minimum of three to six months interval for periodic cleaning of luminaries and window panes is recommended for maximum utilization of daylight and artificial lights.

5A.3.3.8 Photocontrols for Artificial Lights
There is a considerable wastage of electrical energy in lighting of buildings due to carelessness in switching off lights even when sufficient daylight is available indoors. In offices and commercial buildings, occupants may switch on lights in the morning and keep them on throughout the day. When sufficient daylight is available inside, suitable photo controls can be employed to switch off the artificial lights and thus prevent the wastage of energy.
The photocontrol should have the following features:

a) An integrated photocontrol system continually measures the amount of visible light under the lighting fixture and maintains the lux levels as referred in Table 1.

b) An integrated photocontrol system should maintain six daylighting scenarios that can be adjusted by the user namely; daytime occupied, daytime unoccupied, sunset occupied, sunset unoccupied, night time occupied and night time unoccupied.

c) The photocontrol sensor should have a 60° cone of reference to measure the amount of light on the work surface.

5A.3.3.9 Solar Photovoltaic Systems (SPV)
Solar photovoltaic system enables direct conversion of sunlight into electricity and is a viable option for lighting purpose in remote nongrid areas. The common SPV lighting systems are:
a) Solar lantern.
b) Fixed type solar home lighting system, and
c) Street lighting system.

5A.3.3.9.1 SPV lighting system should preferably be provided with CFL for energy efficiency.

5A.3.3.9.2 Inverters used in buildings for supplying electricity during the power cut period should be charged through SPV system.

5A.3.3.9.3 Regular maintenance of SPV system is necessary for its satisfactory functioning.

5A.3.3.10 Lighting shelves and light pipes may be explored for utilization and integration in the lighting design.

LIST OF STANDARDS

The following list records those standards which are acceptable as 'standard practice' and 'accepted standards' in the fulfillment of the requirements of the Code. The latest version of a standard shall be adopted at the time of enforcement of the Code. The standards listed may be used by the Authority as a guide in conformance with the requirements of the referred clauses in the Code.

IS No.		**Title**
(1)	IS 3646	Code of practice for interior illumination: Part 1 General requirements and (Part 1): 1992recommendations for building interiors *(first revision)*
(2)	1944	Code of practice for lighting of public thoroughfares: Parts 1 and 2 For main and secondary roads (Group A and B) *(first revision)*
	2672 : 1966	Code of practice for library lighting
	4347 : 1967	Code of practice for hospital lighting
	6665 : 1972	Code of practice for industrial lighting
	10894 : 1984	Code of practice for lighting educational institutions
	SP 32 : 1986	Handbook on functional requirements of industrial buildings (lighting and ventilation)
	SP 41 : 1987	Handbook on functional requirements of buildings other than industrial buildings

References may be made to the following publications for the common personal protective equipment and tools used.

[01] International Building Code 2009 (SECTION 1205 - LIGHTING)

[02] International Energy Conservation Code 2009

[03] ASHRAE hand book-Fundamentals 2009 (SECTION 15 - FENESTRATION)

[04] International Energy Conservation Code 2012

Provisions given in India National Lighting Code may also be referred.

MNBC -2025 TECHNICAL WORKING GROUP (TWG-5A)
Participants List

1.	Daw Than Than Newt	Group Leader
2.	U Aung Thein	Deputy Group Leader
3.	U Aye Win	Member
4.	U Myint Thein	Member
5.	U Kyi Hlaing Win	Member
6.	U Win Myint	Member
7.	U Thein Lin	Member
8.	U Tin Oo	Member
9.	Daw Nan Loon Aung	Member
10.	Daw Lae Lae Yee Win	Member
11.	Daw Tha Zin Han	Member
12.	U Than Lwin	Member
13.	U Thiha Soe	Secretary

MYANMAR

NATIONAL

BUILDING

CODE

2025

PART5B

BUILDING SERVICES

(ELECTRICAL AND ALLIED INSTALLATIONS)

MYANMAR NATIONAL BUILDING CODE - 2025

PART - 5B BUILDING SERVICES

Electrical and Allied Installations

C O N T E N T S

MYANMAR NATIONAL BUILDING CODE - 2025

PART 5B BUILDING SERVICES

Electrical and Allied Installations

5B.1 SCOPE

This Section covers the essential requirements for electrical installations in buildings to ensure efficient use of electricity including safety from fire and shock. This Section also includes general requirements relating to lightning protection of buildings and brief provisions on certain allied installation.

5B.2 TERMINOLOGY AND SYMBOLS

5B.2.1 For the purpose of this Section, the following definitions shall apply.

5B.2.1.1 *Accessory* — A device, other than current using equipment, associated with such equipment or with the wiring of an installation.

5B.2.1.2 *Apparatus* — Electrical apparatus including all machines, appliances and fittings in which conductors are used or of which they form a part.

5B.2.1.3 *Appliance* — An item of current using equipment other than a luminaire or an independent motor.

5B.2.1.4 *Back-up Protection* — Protection which is intended to operate when a system fault is not cleared or abnormal condition not detected in the required time, because of failure or inability of other protection to operate or failure of appropriate circuit-breaker to trip.

5B.2.1.5 *Bonding Conductor* — A protective conductor providing equipotential bonding.

5B.2.1.6 *Bunched* — Cables are said to be 'bunched' when two or more are contained within a single conduit, duct, ducting, or trunking, or, if not enclosed, are not separated from each other.

5B.2.1.7 *Buried Direct* — A cable laid in the ground in intimate contact with the soil.

5B.2.1.8 *Busbar Trunking System* — A type-tested assembly, in the form of an enclosed conductor system comprising solid conductors separated by insulating materials. The assembly may consist of units such as;

a) Busbar trunking units, with or without tap-off facilities;
b) Tap-off units where applicable; and
c) Phase-transposition, expansion, building-movement, flexible, end-feeder and adaptor units.

5B.2.1.9 *Cable* — A length of single-insulated conductor (solid or stranded), or two or more such conductors, each provided with its own insulation, which are laid up together. The insulated conductor or overall mechanical protective covering.

5B.2.1.10 *Cable Armoured* — A cable provided with a wrapping of metal (usually in the form of tape or wire) serving as a mechanical protection.

5B.2.1.11 *Cable, Flame Retardant Low Smoke and Halogen (FR-LSH)* — A cable which is flame retardant and emits low smoke and halogen.

5B.2.1.12 *Cable, Flexible* — A cable containing one or more cores, each formed of a group of wires, the diameters of the cores and of the wires being sufficiently small to afford flexibility.

5B.2.1.13 *Cable, Metal-Sheathed* — An insulated cable with a metal sheath.

5B.2.1.14 *Cable, PVC Sheathed-Insulated* — A cable in which the insulation of the conductor is a polyvinylchloride (PVC) compound; with PVC sheath also providing mechanical protection to the conductor core or cores in the cable.

5B.2.1.15 *Cable, Weatherproof* — A cable so constructed that when installed in uncovered locations, it will withstand all kinds of weather variations (see 5B.2.1.141 for definition of weatherproof).

5B.2.1.16 *Cable, XLPE* — A cable in which the insulation of the conductor is cross-linked polythene and the mechanical protection is provided for the core or cores by a sheath of a polyvinyl chloride compound.

5B.2.1.17 *Ceiling Rose* — A fitting (usually used to attach to the ceiling) designed for the connection between the electrical installation wiring and a flexible cord (which is in turn connected to a lampholder).

5B.2.1.18 *Circuit* — An assembly of electrical equipment supplied from the same origin and protected against overcurrent by the same protective device(s). Circuits are categorized as follows:

a) *Category 1 circuit* — A circuit (other than a fire alarm annunciation or emergency lighting circuit and other circuits required to work during fire in a building) operating at low voltage and supplied directly from a mains supply system.

b) *Category 2 circuit* — With the exception of Category 3 circuits, any circuit for extra low-voltage (ELV)/telecommunication [for example, radio, telephone, sound distribution, building management system (BMS), public address system (PAS), intruder alarm, bell and call and data transmission circuits)] which is supplied from a safety source.

c) *Category 3 circuit* — A fire alarm circuit or an emergency lighting circuit and other circuits required to work during fire in a building.

5B.2.1.19 *Circuit Breaker* — A mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also of making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions such as those of short circuit.

NOTE — A circuit breaker is usually intended to operate infrequently, although some types are suitable for frequent operation.

5B.2.1.19.1 *Miniature Circuit Breaker (MCB)* — A compact mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions and also making and carrying currents for specified times and automatically breaking currents under specified abnormal circuit conditions, such as those of overload and short circuits.

5B.2.1.19.2 *Circuit Breaker, Linked* — A circuit breaker, the contacts of which are so arranged as to make or break all poles simultaneously or in a definite sequence.

5B.2.1.19.3 *Moulded Case Circuit Breaker (MCCB)* — A circuit breaker having a supporting housing of moulded insulating material forming an integral part of the circuit breaker.

5B.2.1.19.4 *Air Circuit Breaker (ACB)* — A circuit breaker in which the contacts open and close in air at atmospheric pressure.

5B.2.1.19.5 *Residual Current Operated Circuit Breaker* — A mechanical switching device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions.

5B.2.1.19.5.1 *Residual current operated circuit breaker with integral overcurrent protection (RCBO)* — A residual current operated circuit breaker designed to perform the functions of protection against overload and/or short-circuit.

5B.2.1.19.5.2 *Residual current operated circuit breaker without integral overcurrent protection (RCCB)* — A residual current operated circuit breaker not designed to perform the functions of protection against overload and/or short-circuits.

NOTE — Similar function is provided by earth leakage circuit breaker (ELCB).

5B.2.1.20 *Circuit, Final Sub* — An outgoing circuit connected to one-way distribution board and intended to supply electrical energy at one or more points to current, using appliances without the intervention of a further distribution board other than a one-way board. It includes all branches and extensions derived from that particular way in the board.

5B.2.1.21 *Cleat* — An insulated incombustible support normally used for insulated cable.

5B.2.1.22 *Conductor of a Cable or Core* — The conducting portion consisting of a single wire or group of wires, assembled together and in contact with each other or connected in parallel.

5B.2.1.23 *Conductor, Aerial* — Any conductor which is supported by insulators above the ground and is directly exposed to the weather.

NOTE — Following four classes of aerial conductors are recognized:

a) Bare aerial conductors,

b) Covered aerial conductors,

c) Insulated aerial conductors, and

d) Weatherproof neutral-screened cable.

5B.2.1.24 *Conductor, Bare* — A conductor not covered with insulating material.

5B.2.1.25 *Conductor, Earthed* — A conductor with no provision for its insulation from earth.

5B.2.1.26 *Conductor, Insulated* — A conductor adequately covered with insulating material of such quality and thickness as to prevent danger.

5B.2.1.27 *Connector* — The part of a cable coupler or of an appliance coupler which is provided with female contact and is intended to be attached to the flexible cable connected to the supply.

5B.2.1.28 *Connector Box or Joint Box* — A box forming a part of wiring installation, provided to contain joints in the conductors of cables of the installations.

5B.2.1.29 *Connector for Portable Appliances* — A combination of a plug and socket arranged for attachment to a portable electrical appliance or to a flexible cord.

5B.2.1.30 *Consumer's Terminals* — The ends of the electrical conductors situated upon any consumer's premises and belonging to him, at which the supply of energy is delivered from the service line.

5B.2.1.31 *Cord, Flexible* — A flexible cable having conductors of small cross-sectional area. Two flexible cords twisted together are known as twin 'flexible cord'.

5B.2.1.32 *Core of a Cable* — A single conductor of a cable with its insulation but not including any mechanical protective covering.

5B.2.1.33 *Current Carrying Capacity of a Conductor* — The maximum current which can be carried by a conductor under specified conditions without its steady state temperature exceeding a specified value.

5B.2.1.34 *Cut-out* — Any appliance for automatically interrupting the transmission of energy through any conductor when the current rises above a pre- determined amount.

5B.2.1.35 *Damp Situation* — A situation in which moisture is either permanently present or intermittently present to such an extent as likely to impair the effectiveness of an installation conforming to the requirements for ordinary situations.

5B.2.1.36 *Dead* — A portion of an electrical circuit (normally expected to carry a voltage) at or near earth potential or apparently disconnected from any live system. A circuit apparently disconnected from all sources is expected to be at earth potential; but capacitive storage of charge in cables, capacitors, etc, can keep the electric circuit at a significant voltage (and often dangerous voltages from aspects of shock). Such circuits with storage components will be dead only on connection to earth.

5B.2.1.37 *Design Current (of a Circuit)* — The magnitude of the current intended to be carried by the circuit in normal service.

5B.2.1.38 *Direct Contact* — Contact of persons or live stock with live parts which may result in electric shock.

5B.2.1.39 *Direct Earthing System* — A system of earthing in which the parts of an installation are so earthed as specified, but are not connected within the installation to the neutral conductor of the supply system or to earth through the trip coil of an earth leakage circuit-breaker.

5B.2.1.40 *Disconnector* — A mechanical switching device which, in the open position, complies with the requirements specified for the isolation function.

NOTES

1. A disconnector is otherwise known as isolator.
2. A disconnector is capable of opening and closing a circuit when either a negligible current is broken or made, or when no significant change in the voltage across the terminals of each pole of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time, current under abnormal conditions, such as those of short-circuit.

5B.2.1.41 *Distance Area or Resistance Area (for an Earth Electrode Only)* — The surface area of ground (around an earth electrode) within which a voltage gradient measurable with ordinary commercial instruments exists when the electrode is being tested.

5B.2.1.42 *Discrimination (Over-Current Discrimination)* — Coordination of the operating characteristics of two or more over-current protective devices such that, on the incidence of over-currents within stated limits, the device intended to operate within these limits does so, while the others do not.

NOTES

1. Protective devices should have discrimination so that only the affected part (minimum section) of the circuit is isolated, even though a number of protective devices may be in the path of the over current.
2. Distinction is made between series discrimination involving different over-current protective devices passing substantially the same over-current and network discrimination involving identical protective devices passing different proportions of the over-current.

5B.2.1.43 *Earth* — The conductive mass of the earth, whose electric potential at any point is conventionally taken as zero.

5B.2.1.44 *Earth Continuity Conductor* — The conductor, including any clamp, connecting to the earthing lead or to each other, those parts of an installation which are required to be earthed. It may be in whole or in part, the metal conduit or the metal sheath or armour of the cables, or the special continuity conductor of a cable or flexible cord incorporating such a conductor.

5B.2.1.45 *Earth Electrode* — A conductor or group of conductors in Intimate contact with the ground to provide a low resistance path for flow of current to earth.

5B.2.1.46 *Earth Electrode Network* — Part of an earthing arrangement comprising only the earth electrodes and their interconnections.

5B.2.1.47 *Earth Electrode Resistance* — The resistance of an earth electrode to earth.

5B.2.1.48 *Earth Fault* — An unintended and undesirable connection of phase/neutral conductor to earth. When the impedance is negligible, the connection is called a dead earth fault.

5B.2.1.49 *Earth Fault Current* — A current resulting from a fault of negligible Impedance between a line conductor and an exposed conductive part or a protective conductor.

5B.2.1.50 *Earthing Lead* — The final conductor by which the connection to the earth electrode is made.

5B.2.1.51 *Earth Leakage Current* — A current which flows to earth, or to extraneous conductive parts, in a circuit which is electrically sound.

NOTE — This current may have a capacitive component including that resulting from the deliberate use of capacitors.

5B.2.1.52 *Electric Shock* — A dangerous pathophysiological effect resulting from the passing of an electric current through a human body or an animal.

5B.2.1.53 *Emergency Switching* — Rapid cutting off of electrical energy to remove any hazard to persons, livestock, or property which may occur unexpectedly.

5B.2.1.54 *Enclosure* — A part providing protection of equipment against certain external influences and, in any direction, protection against direct contact.

5B.2.1.55 *Equipotential Bonding* — Electrical connection putting various exposed conductive parts and extraneous conductive parts at a substantially equal potential.

NOTE — In a building installation equipotential bonding conductors shall interconnect the following conductive parts:

a) Protective conductor,

b) Earth continuity conductor, and

c) Risers of air conditioning system and heating systems(if any).

5B.2.1.56 *Exposed Conductive Part* — A conductive part of electrical equipment, which can be touched and which is not normally live, but which may become live under fault conditions.

5B.2.1.57 *Enclosed Distribution Board* — An enclosure containing bus bars with one or more control and protected devices for the purpose of protecting, controlling or connecting more than one outgoing circuits fed from one or more incoming circuits.

5B.2.1.58 *Exposed Metal* — All metal parts of an installation which are easily accessible other than,

a) parts separated from live parts by double insulation;

b) metal name-plates, screw heads, covers, or plates, which are supported on, or attached, or

   i) connected to substantial non-conducting material only in such a manner that they do not

   ii) become alive in the event of failure of insulation of live parts and whose means of fixing

   iii) do not come in contact with any internal metal; and

c) parts which are separated from live parts by other metal parts which are themselves earthed or have double insulation.

5B.2.1.59 *Extraneous Conductive Part* — A conductive part not forming part of the electrical installation and liable to introduce a potential, generally the earth potential.

5B.2.1.60 *Fault Current* — A current resulting from a fault.

5B.2.1.61*Fault Protection* — Protection against electric shock under single fault conditions.

NOTE — For low voltage installation, system's and equipment's fault protection generally corresponds to protection against indirect contact, mainly with regards to failure of basic insulation. Indirect contact is 'contact of persons or livestock with exposed-conductive parts which have become live under fault conditions'.

5B.2.1.62 *Fire resistant cable*— A cable which continues in service after exposure to a temperature of 900°C for 20 min or 700°C for 90 min.

5B.2.1.63 *Fitting, Lighting* **—**A device for supporting or containing a lamp or lamps (for example, fluorescent or incandescent) together with any holder, shade, or reflector, for example, a bracket, a pendant with ceiling rose, an electrolier, or a portable unit.

5B.2.1.64 *Flameproof Enclosure* — An enclosure which will withstand without injury any explosion of inflammable gas that may occur within it under practical conditions of operation within the rating of the apparatus (and recognized overloads, if any, associated therewith) and will prevent the transmission of flame which may ignite any inflammable gas that may be present in the surrounding atmosphere.

NOTES

1 Hazardous areas are classified into different zones, depending upon the extent to which an explosive atmosphere may exist at that place. In such areas, flame proof switchgear, fittings, accessories, have to be used/installed in flameproof enclosure.

2 An electrical apparatus is not considered as flameproof unless it complies with the appropriate statutory regulations.

3 Other types of fittings are also in vogue in wiring installations, for example, 'increased safety'.

5B.2.1.65 *Flame Retardant Cable* — Flame retardant cable with reduced halogen evaluation and smoke.

5B.2.1.66 *Fuse* — A device which, by melting of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time. The fuse comprises all the parts that form the complete device.

5B.2.1.67 *Fuse Element* — A part of a fuse designed to melt when the fuse operates.

5B.2.1.68 *Harmonics (Current and Voltage)* — All alternating current which is not absolutely sinusoidal is made up of a fundamental and a certain number of current and voltage harmonics [multiples of 50 Hz (basic frequency)) which are the cause of its deformation (distortion) when compared to the theoretical sine wave.

5B.2.1.69 *Indirect Contact* — Contact of persons or livestock with exposed conductive parts made live by a fault and which may result in electric shock.

5B.2.1.70 *Inflammable* — A material capable of being easily ignited.

5B.2.1.71 *Installation (Electrical), of Buildings* — An assembly of associated electrical equipment to fulfill a specific purpose or purposes and having coordinated characteristics.

5B.2.1.72 *Insulated* — Insulated shall mean separated from adjacent conducting material or protected from personal contact by a non-conducting substance or an air space, in either case offering permanently sufficient resistance to the passage of current or to disruptive discharges through or over the surface of the substance or space, to obviate danger or shock or injurious leakage of current.

5B.2.1.73 *Insulation* — Suitable non-conducting material, enclosing, surrounding or supporting a conductor.

5B.2.1.74 *Insulation, Basic* — Insulation applied to live parts to provide basic protection against electric shock and which does not necessarily include insulation used exclusively for functional purposes.

5B.2.1.75 *Insulation, Double* — Insulation comprising both basic and supplementary insulation.

5B.2.1.76 *Insulation (Electrical)* **—**Suitable non-conducting material, enclosing, surrounding or supporting a conductor.

5B.2.1.77 *Insulation, Reinforced* — Single insulation applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in the relevant standard.

NOTE — The term 'single insulation' does not imply that the insulation is a homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

5B.2.1.78 *Insulation, Supplementary* — Independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation.

5B.2.1.79 *Isolator* — A mechanical switching device which, in the open position, complies with the requirements specified for the isolating function. An isolator is otherwise known as a disconnector.

5B.2.1.80 *LEMP Protection Measures (SPM)* — Measures taken to protect internal systems against the effects of LEMP.

5B.2.1.81 *Lightning Electromagnetic Impulse (LEMP)* — All electromagnetic effects of lightning current via resistive, inductive and capacitive coupling that create surges and radiated electromagnetic fields.

5B.2.1.82 *Lightning Protection* — Complete system for protection of structures against lightning, including their internal systems and contents, as well as persons, in general consisting of an LPS and SPM.

5B.2.1.83 *Lightning Protection Level (LPL)* — A number related to a set of lightning current parameters values relevant to the probability that the associated maximum and minimum design values will not be exceeded in naturally occurring lightning.

NOTE — Lightning protection level is used to design protection measures according to the relevant set of lightning current parameters.

5B.2.1.84 *Lightning Protection System (LPS)* — Complete system used to reduce physical damage due to lightning flashes to a structure.

5B.2.1.84.1 *External Lightning Protection System* — Part of the LPS consisting of an air-termination system, a down-conductor system and an earth-termination system.

5B.2.1.84.2 *Internal Lightning Protection System* — Part of the LPS consisting of lightning equipotential bonding and/or electrical insulation of external LPS.

5B.2.1.85 *Lightning Protection Zone* — Zone where the lightning electromagnetic environment is defined.

5B.2.1.86 *Linked Switch* **—**Switches linked together mechanically so as to operate simultaneously or in definite sequence.

5B.2.1.87 *Live or Alive* — Electrically charged so as to have a potential different from that of earth.

5B.2.1.88 *Locations, Industrial* — Locations where tools and machinery requiring electrical wiring are installed for manufacture or repair.

5B.2.1.89 *Locations, Non-Industrial* — Locations other than industrial locations, and shall include residences, offices, shops, showrooms, stores and similar premises requiring electrical wiring for lighting, or similar purposes.

5B.2.1.90 *Leakage Current* — Electric current in an unwanted conductive path under normal operating conditions.

5B.2.1.91 *Line Conductor* — A conductor of an a.c. system for the transmission of electrical energy other than a neutral conductor or a PEN conductor. This also means the equivalent conductor of a d.c. system unless otherwise specified in this Code.

5B.2.1.92 *Live Part* — A conductor or conductive part intended to be energised in normal use including a neutral conductor but, by convention, not a PEN conductor.

5B.2.1.93 *Main Earthing Terminal* — The terminal or bar which is the equipotential bonding conductor of protective conductors, and conductors for functional earthing, if any, to the means of earthing.

5B.2.1.94 *Meshed Bonding Network (MESH-BN)* — Bonding network in which all associated equipment frames, racks and cabinets and usually the d.c. power return conductor are bonded together as well as at multiple points to the CBN and may have the form of a mesh.

5B.2.1.95 *Monitoring* — Observation of the operation of a system or part of a system to verify correct functioning or detect incorrect functioning by measuring system variables and comparing the measured value with the specified value.

5B.2.1.96 *Multiple Earthed Neutral System* — A system of earthing in which the parts of an installation specified to be earthed are connected to the general mass of earth and, in addition, are connected within the installation to the neutral conductor of the supply system.

5B.2.1.97 *Neutral Conductor* — Includes the conductor of a three-phase four-wire system; the conductor of a single-phase or d.c. installation, which is earthed by the supply undertaking (or otherwise at the source of the supply), and the middle wire or common return conductor of a three-wire d.c. or single-phase a.c. system.

5B.2.1.98 *Origin of an Electrical Installation* — The point at which electrical energy is delivered to an installation.

NOTE — An electrical installation may have more than one origin.

5B.2.1.99 *Overcurrent* — A current exceeding the rated value. For conductors the rated value is the current carrying capacity.

5B.2.1.100 *Overload Current (of a Circuit)* — An overcurrent occurring in a circuit in the absence of an electrical fault.

5B.2.1.101 *PEN Conductor* — A conductor combining the functions of both protective conductor and neutral conductor.

5B.2.1.102 *Phase Conductor* — See 5B.2.1.91.

5B.2.1.103 *Plug* — A device, provided with contact pins, which is intended to be attached to a flexible cable, and which can be engaged with a socket outlet or with a connector.

5B.2.1.104 *Point (in Wiring)* — A termination of the fixed wiring intended for the connection of current using equipment.

5B.2.1.105 *Protection, Ingress* — The degree of protection against Intrusions (body parts such as hands and fingers), dust, accidental contact and water.

NOTE — The classification of degrees of ingress protection provided by enclosures for electrical equipment shall be as per the accepted standard [8-2(6)].

5B.2.1.106 *Protection, Mechanical Impact* — The degrees of protection provided by enclosures for electrical equipment against external mechanical impacts.

NOTE — The classification of degrees of protection against mechanical impact provided by enclosures for electrical equipment shall be as per IEC 62262:2002 'Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)'.

5B.2.1.107 *Prospective Fault Current (I_{pf})* — The value of overcurrent at a given point in a circuit resulting from a fault of negligible Impedance between live conductor having a difference of potential under normal operating conditions, or between a live conductor and an exposed-conductive part.

5B.2.1.108 *Protective Conductor* — A conductor used for some measures of protection against electric shock and Intended for connecting together any of the following parts;

a) Exposed conductive parts,

b) Extraneous conductive parts,

c) Main earthing terminal, and

d) Earthed point of the source, or an artificial neutral.

5B.2.1.109 *Protective Conductor Current* — Electric current appearing in a protective conductor, such as leakage current or electric current resulting from an Insulation fault.

5B.2.1.110 *Protective Earthing* — Earthing of a point or points in a system or in equivalent for the purpose of safety.

5B.2.1.111 *Protective Separation* — Separation of one electric circuit from another by means of,

a) double insulation;

b) basic Insulation and electrically protective screening (shielding); or

c) reinforced insulation.

5B.2.1.112 *Rated Current* — Value of current used for specification purposes, established for a specified set of operating conditions of a component, device, equipment or system.

5B.2.1.113 *Rated Impulse Withstand Voltage Level (U_w)* — The level of impulse withstand voltage assigned by the manufacturer to the equipment, or to part of it, characterizing the specified withstand capability of its insulation against overvoltage.

5B.2.1.114 *Residual Current* — The algebraic sum of the instantaneous values of current flowing through all live conductors of a circuit at a point of the electrical installation.

5B.2.1.115 *Residual Current Device (RCD)* — A mechanical switching device or association of devices intended to cause the opening of the contacts when the residual current attains a given value under specified conditions.

5B.2.1.116 *Residual Operating Current* — Residual current which causes the residual current device to operate under specified conditions.

5B.2.1.117 *Service* — The conductors and equipment required for delivering energy from the electric supply system to the wiring system of the premises served.

5B.2.1.118 *Shock Current* — A current passing through the body of a person or an animal and having characteristics likely to cause dangerous patho-physiological effects.

5B.2.1.119 *Short-Circuit Current* — An overcurrent resulting from a fault of negligible impedance between live conductors having a difference in potential under normal operating conditions.

5B.2.1.120 *Space Factor* — The ratio (expressed as a percentage) of the sum of the overall cross-sectional areas of cables (including insulation and sheath) to the internal cross-sectional area of the conduit or other cable enclosure in which they are installed. The effective overall cross-sectional area of a non-circular cable is taken as that of a circle of diameter equal to the major axis of the cable.

5B.2.1.121 *Standby Supply System* — A system intended to maintain supply to the installation or part thereof, in case of interruption of the normal supply, for reasons other than safety of persons.

NOTE — Standby supplies are necessary, for example, to avoid interruption of continuous industrial processes or data processing.

5B.2.1.122 *Step Voltage* — The potential difference between two points on the earth's surface, separated by distance of one pace, that will be assumed to be one metre in the direction of maximum potential gradient.

5B.2.1.123 *Socket-Outlet* — A device, provided with female contacts, which is intended to be installed with the fixed wiring, and intended to receive a plug.

NOTE — A luminaire track system is not regarded as a socket- outlet system.

5B.2.1.124 *Surge* — A transient created by LEMP that appears as an overvoltage and/or an overcurrent.

5B.2.1.125 *Surge Protective Devices (SPD)* — A device intended to limit transient overvoltages and divert surge currents. It contains at least one non-linear component.

5B.2.1.126 *Switch* — A mechanical switching device capable of making, carrying and breaking current under normal circuit conditions, which may include specified operating overload conditions; and also of carrying for a specified time currents under specified abnormal circuit conditions, such as those of short circuit.

NOTE — A switch may also be capable of making, but not breaking, short-circuit currents.

5B.2.1.127 *Switchboard* — An assembly of switchgear with or without instruments, but the term does not apply to a group of local switches in a final circuit.

NOTE — The term 'switchboard' includes a distribution board.

5B.2.1.128 *Switch Disconnector* — A switch which, in the open position, satisfies the isolating requirements specified for a disconnector.

NOTE — A switch disconnector is otherwise known as an isolating switch.

5B.2.1.129 *Switch Disconnector Fuse* — A composite unit, comprising a switch with the fuse contained in or mounted on the moving member of the switch.

5B.2.1.130 *Switch, Linked* — A switch, the contacts of which are so arranged as to make or break all poles simultaneously or in a definite sequence.

5B.2.1.131 *Switchgear* — An assembly of main and auxiliary switching apparatus for operation, regulation, protection or other control of electrical installations.

5B.2.1.132 *System (Electrical)* — An electrical system consisting of a single source or multiple sources running in parallel of electrical energy and an installation. Types of system are identified as follows, depending upon the relationship of the source, and of exposed- conductive parts of the installation, to earth:

a) *TN system* — A system having one or more points of the source of energy directly earthed, the exposed conductive-parts of the installation being connected to that point by protective conductors.

b) *TN-C system* — A system in which neutral and protective conductors are combined in a single conductor throughout the system.

c) *TN-S system* — A system having separate neutral and protective conductor throughout the system.

d) *TN-C-S system* — A system in which neutral and protective conductors are combined in a single conductor in part of the system.

e) *TT system* — A system having one point of the source of energy directly earthed, the exposed-conductive-parts of the installation being connected to the earth electrodes electrically independent of the earth electrodes of the source.

f) *IT system* — A system having no direct connection between live parts and earth, the exposed-conductive-parts of the electrical installation being earthed.

5B.2.1.133 *Touch Voltage* — The potential difference between the ground potential rise (GPR) of a grounded metallic structure and the surface potential at the point where a person could be standing while at the same time having a hand in contact with the grounded metallic structure. Touch voltage measurements can be 'open circuit' (without the equivalent body resistance included in the measurement circuit) or 'closed circuit' (with the equivalent body resistance included in the measurement circuit) voltage by which an installation or part of an installation is designated.

5B.2.1.134 *Usable Wall Space* — All portions of a wall, except that occupied by a door in its normal open position, or occupied by a fire place opening, but excluding wall spaces which are less than 1 m in extent measured along the wall at the floor line.

5B.2.1.135 *Utility Building* — A standalone separate single or two storied service building structure outside the main building structure meant for only accommodating services' spaces, such as electric substation, diesel generator plant room, a.c. plant room, plumbing plant room, sewerage treatment plant, medical gases, electrical and mechanical maintenance rooms. Such buildings do not have any permanent occupancy other than by personnel on duty.

5B.2.1.136 *Voltage, Extra Low (ELV)* — The voltage which does not normally exceed 50 Va.c.

5B.2.1.137 *Voltage, Low (LV)* — The voltage which normally exceeds 50 Va.c but does not normally exceed 1000 Va.c.

5B.2.1.138 *Voltage, Medium (MV)* — The voltage which normally exceeds 1000 Va.c but does not exceed 33 kVa.c.

5B.2.1.139 *Voltage, High (HV)* — The voltage which normally exceeds 33 kVa.c but less than or equal to 230 kVa.c.

5B.2.1.140 *Voltage, Extra High (EHV)* — The voltage, which normally exceeds 230 kVa.c.

5B.2.1.141 *Weatherproof* — Accessories, lighting fittings, current using appliances and cables are said to be of the weatherproof type with ingress protection according to the application, if they are so constructed that when installed in open situation they will withstand the effects of rain, snow, dust and temperature variations.

5B.2.2 Symbols

The architectural symbols that are to be used in all drawings, wiring plans, etc, for electrical installations in buildings shall be as given in **Annex A**. For other graphical symbols used in electro-technology, reference may be made to Standard practice [(1) IS 8270].

5B.3 GENERAL REQUIREMENTS

5B.3.1 The installation shall generally be carried out in conformity with the requirements of the Myanmar Electricity Rules and Regulations**.**

5B.3.2 Materials

All materials, fittings, appliances, etc, used in electrical and allied installations, shall conform to Part 6 ‘Building Materials' and other related Standards.

5B.3.3 Coordination with Local Supply Authority

a) In all cases, that is, whether the proposed electrical work is a new installation or extension of an existing one, or a modification involving major changes, the electricity supply undertaking shall be consulted about the feasibility, etc, at an early date.

b) Addition to an Installation — An addition, temporary or permanent, shall not be made to the authorized load of an existing installation, until it has been definitely ascertained that the current carrying capacity and the condition of existing accessories, conductors, switches, etc, affected, including those of the supply authority are adequate for the increased load. The size of the cable/ conductor shall be suitably selected on the basis of the ratings of the protective devices. Ratings of protective devices and their types shall be based on the installed load, switching characteristics and power factor.

c) Load assessment and application of suitable diversity factor to estimate the full load current shall be made as a first step. This should be done for every circuit, submain and feeder. Power factor and efficiency of loads shall also be considered. Diversity factor assumed shall be based on one's own experience. Allowance should be made for about 15 percent to 20 percent for extension in near future and the design circuit is calculated for each circuit and submain. The wiring system to be adopted should also be decided in accordance with the environmental requirements. The sizes of wiring cables are decided not merely to carry the load currents, but also to withstand thermal effects of likely over currents and also ensure acceptance level of voltage drop.

5B.3.4 Power Factor Improvement in Consumers' Installation

5B.3.4.1 Conditions of supply of electricity boards or licensees stipulate the lower-limit of power factor which is generally 0.85.

5B.3.4.2 Principal causes of low power factor are many. For guidance to the consumers of electric energy who take supply at low and medium voltages for improvement of power factor, reference shall be made in accordance with Standard practice.

5B.3.5 Execution of Work

Unless otherwise exempted under the appropriate rule of the Myanmar Electricity Rules, the work of electrical installations shall be carried out by a licensed electrical contractor and under the direct supervision of a person holding a certificate of competency and by persons holding a valid permit issued and recognized by any State Government.

5B.3.6 Safety procedures and practices shall be kept in view during execution of the work in accordance with Standard practice.

5B.3.7 Safety provisions given in Part 5F 'Fire Protection Systems' shall be followed.

5B.4 PLANNING OF ELECTRICAL INSTALLATIONS

5B.4.1 General

The design and planning of an electrical wiring installation involve consideration of all prevailing conditions, and is usually influenced by the type and requirement of the consumer. A competent electrical design engineer should be involved at the planning stage with a view to providing for an installation that will prove adequate for its intended purpose, and safe and efficient in its use. The information given in **5B.3** shall also be kept in view.

5B.4.1.1 The design and planning of an electrical wiring installation shall take into consideration, some or all of the following:

a) the type of supply, occupancy, envisaged load and the earthing arrangement available;
b) the atmospheric condition, such as cooling air temperature, moisture or such other conditions which are likely to affect the installation adversely;
c) the possible presence of inflammable or explosive dust, vapour or gas;
d) the degree of electrical and mechanical protection necessary;
e) the importance of continuity of service including the possible need for standby supply;
f) the probability of need for modification or future extension;
g) the probable operation and maintenance cost taking into account the electricity supply tariffs available;
h) the relative cost of various alternative methods;
i) the need for radio and telecommunication interference suppression;
j) ease of maintenance;
k) safety aspects;
l) energy conservation
m) the importance of proper discrimination between protective devices for continuity of supply and limited isolation of only the affected portion; and
n) reliable and sustainable electricity supply

5B.4.1.2 All electrical apparatus shall be suitable for the services these are intended for.

5B.4.1.3 *Co-ordination*

Proper co-ordination and collaboration between the architect, civil engineer and the electrical and mechanical engineer shall be effected from the planning stage of the installation. The provisions that will be needed for the accommodation of substation, transformer, switch rooms, service cable ducts, rising mains and distribution cables, sub-distribution boards, openings and chases in floors and walls for all required electrical installations, etc, shall be specified in advance.

5B.4.1.4 Before starting wiring and installation of fittings and accessories, information should be exchanged between the owner of the building/architect/electrical contractor and the local supply authority in respect of tariffs applicable, types of apparatus that may be connected under each tariff, requirement of space for installing meters, switches, etc, and for total load requirements of lights, fans and power.

5B.4.1.5 While planning an installation, consideration should be taken of the anticipated increase in the use of electricity for lighting, general purpose socket- outlet, kitchen heating, etc. It is essential that adequate provision should be made for all the services which may be required immediately and during the intended useful life of the building, for the householder may otherwise be tempted to carry out extension of the installation himself or to rely upon use of multi-plug adapters and long flexible cords, both of which are not recommended.

5B.4.2 Location and Requirement of Substation

Information on location and requirements of a substation should cover the following:

5B.4.2.1 *Location*

a) The substation should preferably be located in separate building and could be adjacent to the generator room, if any. Location of substation in the basement floors should be avoided, as far as possible.

b) The ideal location for an electrical substation for a group of buildings would be at the electrical load centre on the ground floor.

c) The floor level of the substation or switch room shall be above the highest flood level of the locality.

d) Generally the load centre would be somewhere between the geometrical centre and the air conditioning plant room, as air conditioning plant room would normally be the largest chunk of load, if the building is air conditioned.

e) Substations with oil filled equipment will require great consideration for the fire detection, protection and suppression. Oil cooled transformers require a suitable soak pit with gravity flow to contain the oil in the event of the possibility of oil spillage from the transformer on its failure. Substations with oil filled equipment shall not be located in any floor other than the ground floor or a semi-basement. Such substations with high oil content may be housed in a separate service building or a substation building, which is not the part of a multi-storied building.

f) In case electric substation has to be located within the main multi-storied building itself for unavoidable reasons, then it should be located on the floor close to ground level, but shall have direct access from the street for operation of the equipment. The provision for installation and removal of substation equipment may be provided from inside the building.

g) Substations located within a multi-storied building shall not have oil filled transformers, even if it is at the ground level (*see* Fire Services Department Instruction) Substations with very little combustible material, such as a Dry type transformer, with Vacuum (or SF_6) HT switchgear and ACB or MCCB for LV can be located in the basement as well as upper floors in a building with high load density in the upper floors. (Some functional buildings such as hospitals, air traffic control towers, computer centers are likely to have high loading in a few upper floors and in such cases, it may be preferable to provide oil-free substations at upper levels. This measure will decrease the current flow at various points, thereby contributing to reduction of vulnerability to fire).

h) The power supply control to any such substation or transformer (located at basement levels or upper floors) shall be from a location on ground floor/first basement level having direct access from outside so that in case of fire, the electrical supply can be easily disconnected.

i) Oil filled transformers may be used only in substations located in separate single or two storied service buildings outside the main building structure and there shall at least 6 meter clear distance between the adjoining buildings and substation such that fire tender is able to pass between the two structures.

j) If dry type transformer is used, it may be located adjacent to medium voltage switchgear in the form of unit type substation. No separate room or fire barrier for the transformer is required, in a substation with oil free equipment. In such a case the room size will decrease. Layout of equipment has to keep the requirement that any one piece of equipment or sub-assembly can be taken out of service and out of the installed location, while keeping the remaining system in service.

k) The emergency power supply (such as Generating Sets) should not be allowed to be installed above ground floor or below first basement level of building. There shall be provision of separate direct escape and entry into these areas from outside so that in case of fire, electrical supplies can be disconnected to avoid additional losses which may be caused due to electrical supply, present at the time of fire.

Note:

In unavoidable circumstances emergency generators , power transformers ,chiller units , water pumps and other heavy equipment machineries can also be installed in the intermediate floor level of a tall building , designated as mechanical service floors , provided that the building can safely withstand both static and dynamic load of the said installed equipment in the event of seismic vibration and similar ones , and that shall be certified by the authority concerned. So also in such a case acoustics and environmental disturbances together with ease of maintenance and access for the people shall be considered and it shall be within the acceptable limits. Standard fire protection system shall be provided in respective equipment rooms also.

l) For transformers having large oil content (more than 2000 litres) Myanmar Electricity Rules shall apply.

m) Facility for connection from substation to adjoining building to feed essential emergency load in that building, such as escape route lighting, fire or sprinkler pumps, emergency communication systems shall be provided. Similarly, the essential emergency load switchboard of this building or building complex should be so as to be capable of receiving power for such loads from the adjoining building or building complex, with its own substation/DG sets shut off due to crisis conditions such as fire,

n) The availability of power lines nearby may also be kept in view while deciding the location of the substation,

o) For detailed information regarding location of transformers reference may be made to Standard practice.

p) All door openings from substation, electrical rooms, etc., should open towards outside.

5B.4.2.2 *Type of Building for Substations*

The substations enclosure, that is, walls, floor, ceiling, openings, doors, etc., shall have 2 hours fire rating (*see* Fire Services Department Instruction).

5B.4.2.3 *Layout of Substation*

In allocating the area of substation, it is to be noted that the flow of electric power is from supply company's room to MV room, then to transformer and finally to the medium voltage switchgear room. The layout of the room shall be in accordance with this flow, so as to optimize the cables, bus trunking etc., Visibility of equipment controlled from the operating point of the controlling switchgear is also a desirable feature, though it may not be achievable in case of large substation.

5B.4.2.4 *Room /Spaces Required*

Generally the following rooms /spaces are required in a substation:

a) Supply company's switchgear room and/or space for meters.

b) Capacity and Size — The capacity of a substation depends upon the area of the building and its type. The capacity of substation may be determined based on the following load requirements:

After calculating the electrical load on the above basis, a load factor of 70-90 percent is to be applied to arrive at the minimum capacity of substation. The area required for substation and transformer room for different capacities is given in **Annex B** for general guidance. For reliability, it would be necessary to split the load into more than one transformer and also provide for standby transformer as well as multiple sources, bus-section, etc.

c) Medium Voltage Switch Room— In case of substation having one transformer and one source of supply, the owner is required to provide one high voltage switch. In case of single point supply with two or more transformers the number of switch required will be one for incoming supply and one for each transformer. In case of duplicate supply two switches shall be provided with mechanical/electrical interlocking arrangement where necessary in cables with switches. In case the number of incoming and outgoing switches exceed five, bus coupler of suitable capacity should invariably be provided. The floor area required in case of a single switch is roughly 4 m x 4 m and for every additional switch the length would be increased by 1 m.

d) Facility for connection from substation of adjoining building to feed emergency loads shall be permitted for feeding escape route and signage lighting as well as selected section of the fire protection system. Similarly on a reciprocal basis facility to feed the adjoining building for such emergency loads may be provided by necessary switchgear.

e) *Low Voltage Switch Room* — The floor area required in respect of low voltage switchgear room may be determined keeping in view the number and type of incoming/outgoing bus coupler switches including likely expansion in future.

f) *Room for Standby Generator* — It is preferable to install the standby generator in service building. If installed in main building it shall be at the ground floor or at the semi basement, alternatively, in the first basement with facilities for forced ventilation. Adequate space shall be provided for storing of fuel. Compartmentation for fire protection with detection and first-aid protection measures is essential. Different type of requirements exist for the diesel engine and generator for the oil storage area and for the switchgear.

Table of Typical Allowances for Diversity

Sl No.	*Purpose of Final Circuit Fed from Conductors or Switchgear to which Diversity Applies*	*Typical Allowances for Diversity Based on: Type of Building*		
		Individual House Hold Installations, Including Individual Dwelling of a Block	Small Shops, Stores, Offices and Business Premises	Small Hotels, Boarding Houses, etc
(1)	(2)	(3)	(4)	(5)
i)	Lighting	66 percent of total current demand	90 percent of total current demand	75 percent of total current demand
ii)	Heating and power [*see also* Sl No. (iii) to (iv)]	100 percent of total current demand up to 10 A + 50 percent of any current demand in excess of 10 A	100 percent of full load of largest appliance + 75 percent of remaining appliances	100 percent of full load of largest appliance + 80 percent of second largest appliance + 60 percent of remaining appliances

Sl No.	*Purpose of Final Circuit Fed from Conductors or Switchgear to which Diversity Applies*	*Typical Allowances for Diversity Based on: Type of Building*		
		Individual House Hold Installations, Including Individual Dwelling of a Block	Small Shops, Stores, Offices and Business Premises	Small Hotels, Boarding Houses, etc
(1)	(2)	(3)	(4)	(5)
iii)	Cooking appliances	10 A + 30 percent full load of connected cooking appliances in excess of 10 A + 6 A if socket-outlet incorporated in the unit	100 percent of full load of largest appliance + 80 percent of full load of second largest appliance + 60 percent of full load of remaining appliances	100 percent of full load of largest appliance + 80 percent of full load of second largest appliance + 60 percent of full load of remaining appliances
iv)	Motors (other than lift motors which are subject to special consideration)		100 percent of full load of largest motor + 80 percent of full load of second	100 percent of full load of largest motor + 50 percent of full load of
v)	Water heater [instantaneous type[1]]	100 percent of full load of largest appliance + 100 percent of full load of second largest appliance + 25 percent of full load of remaining appliances	100 percent of full load of largest appliance + 100 percent of full load of second largest appliance + 25 percent of full load of remaining appliances	100 percent of full load of largest appliance + 100 percent of full load of second largest appliance + 25 percent of full load of remaining appliances
vi)	Water heater (thermostatically controlled)	No diversity allowable[2]		
vii)	Floor warming installations	No diversity allowable[2]		
viii)	Water heaters thermal storage space heating installations	No diversity allowable[2]		
ix)	Standard arrangements of final circuits in accordance with good practice [8-2(11)]	100 percent of the current demand of the largest circuit + 40 percent of the current demand of every other circuit	100 percent of the current demand of the largest circuit + 50 percent of the current demand of every other circuit	

Sl No.	*Purpose of Final Circuit Fed from Conductors or Switchgear to which Diversity Applies*	*Typical Allowances for Diversity Based on: Type of Building*		
		Individual House Hold Installations, Including Individual Dwelling of a Block	Small Shops, Stores, Offices and Business Premises	Small Hotels, Boarding Houses, etc
(1)	(2)	(3)	(4)	(5)
x)	Socket outlets other than those included in Sl No. (ix) and stationary equipment other than those listed above	100 percent of the current demand of the largest point + 40 percent of the current demand of every other point	100 percent of the current demand of the largest point + 75 percent of the current demand of every other point	100 percent of the current demand of the largest point + 75 percent of the current demand of every point in main rooms (dining rooms, etc) + 40 percent of the current demand of every other point

NOTE — Diversity may be considered , if multiple units of water he ater are there in an individual house -hold installation, including individual dwelling of a block

[1] For the purpose of the table, an instantaneous water heater is deemed to be a water heater of any loading which heats water only while the tap is turned o n and therefore uses electricity intermittently.
[2] It is important to ensure that the distribution boards are of sufficient rating to take the total load connected to them without the application of any diversity.

Facilities including space at appropriate positions, relative to the location of the installed equipment has to be kept in the layout design for removal of equipment or sub-assemblies for repair or maintenance. When it is located, other than the ground level with direct equipment access, a hatch or ramp shall be required.

g) Other environmental requirements under the provisions of Standard Environment Protection Rules, from the aspect of engine emissions including regarding the height of exhaust pipe and permitted noise levels/noise control.

h) The capacity of standby generating set shall be chosen on the basis of essential light load, essential air conditioning load, essential equipment load and essential services load, such as one lift out of the bank of lifts, one or all water pumps, etc. Having chosen the capacity and number of generating sets, required space may be provided for their installation (see **Annex C** for general guidance).

i) The generating set should preferably be housed adjacent to LV switchgear in the substation building to enable transfer of electrical load quickly as well as to avoid transfer of vibration and noise to the main building. Acoustics lining of the room shall be in line with the Standard requirement. If DG Set is located outdoor, it shall be housed in acoustics enclosure. The generator house should have proper ventilation, fire-fighting equipment, etc (*see* Fire Services Department Instruction).

j) *Requirements of Room*

   1) The areas given above in respect of the different categories of rooms holds good if they are provided with windows and independent access doors in accordance with local regulations.

2) All the rooms shall be provided with partitions up to the ceiling and shall have proper ventilation. Special care should be taken to ventilate the transformer rooms and where necessary louvers at lower level and exhaust fans at higher level shall be provided at suitable locations.

3) In order to prevent storm water entering the transformer and switch rooms through the soak-pits, the floor level, the substation shall be at least 15 cm above the highest flood water level that may be anticipated in the locality. Also, facility shall be provided for automatic removal of water.

4) The minimum height of medium voltage switchgear room shall be 3.6 m below the soffit of the beam.

k) *Fire Compartmentation*— It is advisable to provide fire compartmentation of buildings and segregation of associated wiring. Busbar trunking of horizontal and vertical distribution type in place of cable-based distribution system shall be used.

5B.4.3 Location of Switch Room

In large installations other than where a substation is provided, a separate switch room shall be provided; this shall be located as closely as possible to the electrical load centre preferably near the entrance of the building on the ground floor or on the first basement level, and suitable ducts shall be laid with minimum number of bends from the points of entry of the main supply cable to the position of the main switchgear. The switch room shall also be placed in such a position that rising ducts may readily be provided there from to the upper floors of the building in one straight vertical run. In larger buildings, more than one rising duct may be required and then horizontal ducts may also be required for running cables from the switch room to the foot of each rising main. Such cable ducts shall be either be reserved for the electrical services only or provided with a means of segregation for medium and low voltage installations, such as call-bell systems; telephone installations, fire detection and alarm system, announcement or public address system. Cables for essential emergency services such as those related to fire detection, alarm, announcement should use either metal conduit in addition to physical segregation from power cables or use fire resistant cables, so that the service is maintained even in the event of a fire at least for a period of about 2 hrs.

5B.4.4 Location and Requirements of Distribution Panels

The electrical control gear distribution panels and other apparatus, which are required on each floor may conveniently be mounted adjacent to the rising mains, and adequate space should be provided at each floor for this purpose.

5B.4.5 Substation Safety

The owner or the operator of any substation shall be collectively and severally be responsible for any lapse or neglect leading to an accident or an incidence of an avoidable abnormality and shall take care of the safety requirements as follows:

a) enclose the substation where necessary to prevent, so far as is reasonably practicable, danger or unauthorized access;

b) enclose any part of the substation, which is open to the air and contains live equipment which is not encased, with a fence or wall not less than 2.4 m in height to prevent, so far as is reasonably practicable, danger or unauthorized access;

c) ensure that, so far as is reasonably practicable, there are at all times displayed:

d) sufficient safety signs of such size and placed in such positions as are necessary to give due warning of such danger as is reasonably foreseeable in the circumstances;

e) a notice which is placed in a conspicuous position and which gives the location or identification of the substation, the name of each generator or distributor who owns or operates the substation equipment making up the substation and the telephone number where a suitably qualified person appointed for this purpose by the generator or distributor will be in constant attendance; and

f) such other signs, which are of such size and placed in such positions, as are necessary to give due warning of danger having regard to the sitting of, the nature of, and the measures taken to ensure the physical security of, the substation equipment; and

g) take all reasonable precautions to minimize the risk of fire associated with the equipment.

5B.4.6 Overhead Lines, Wires and Cables

5B.4.6.1 *Height Requirement*

While overhead lines may not be relevant within buildings, regulations related to overhead lines are of concern from two different angles.

a) Overhead lines may be required in building complexes, though use of underground cables is the preferred alternative.

b) Overhead lines may be passing through the site of a building. In such a case the safety aspects are important for the construction activity in the vicinity of the overhead line as well as portions of low height buildings that may have to be constructed below the overhead lines. For minimum distance (vertical and horizontal) of electric lines/wires/cables from buildings, reference may be made to the Myanmar Electricity Rules and Regulations.

c) Any person responsible for erecting an overhead line will keep informed the authority(s) responsible for services in that area for telecommunication, gas distribution, water and sewage network, roads so as to have proper co-ordination to ensure safety. He shall also publish the testing, energizing programme for the line in the interests of safety.

5B.4.6.2 *Position, Insulation and Protection of Overhead Lines*

Any part of an overhead line which is not connected with earth and which is not ordinarily accessible shall be supported on insulators or surrounded by insulation. Any part of an overhead line which is not connected with earth and which is ordinarily accessible shall be:

a) made dead; or

b) so insulated that it is protected, so far it is reasonably practicable, against mechanical damage or interference; or

c) adequately protected to prevent danger.

Any person responsible for erecting a building or structure which will cause any part of an overhead line which is not connected with earth to become ordinarily accessible shall give reasonable notice to the generator or distributor who owns or operates the overhead line of his intention to erect that building or structure.

Any bare conductor not connected with earth, which is part of a low voltage overhead line, shall be situated throughout its length directly above a bare conductor which is connected with earth.

No overhead line shall, so far as is reasonably practicable, come so close to any building, tree or structure as to cause danger.

In this regulation the expression "ordinarily accessible" means the overhead line could be reached by hand if any scaffolding, ladder or other construction was erected or placed on/in, against or near to a building or structure.

5B.4.6.3 *Precautions Against Access and Warnings of Dangers*

Every support carrying a high voltage overhead line shall, if the circumstances reasonably require, be fitted with devices to prevent, so far it is reasonably practicable, any unauthorized person from reaching a position at which any such line would be a source of danger.

Every support carrying a high voltage overhead line, and every support carrying a low voltage overhead line incorporating bare phase conductors, shall have attached to it sufficient safety signs and placed in such positions as are necessary to give due warning of such danger as is reasonably foreseeable in the circumstances.

Poles supporting overhead lines near the road junction and turnings shall be protected by a masonry or earth fill structure or metal barricade, to prevent a vehicle from directly hitting the pole, so that the vehicle, if out of control, is restrained from causing total damage to the live conductor system, likely to lead to a hazardous condition on the road or foot path or building.

5B.4.6.4 *Fitting of Insulators to Stay Wires*

Every stay wire which forms part of, or is attached to, any support carrying an overhead line incorporating bare phase conductors (except where the support is a lattice steel structure or other structure entirely of metal and connected to earth) shall be fitted with an insulator no part of which shall be less than 3 m above ground or above the normal height of any such line attached to that support.

5B.4.7 Maps of Underground Networks

5B.4.7.1 Any person or organization or authority laying cables shall contact the local authority in charge of that area and find out the layout of

a) water distribution pipe lines in the area;
b) sewage distribution network;
c) telecommunication network; and
d) gas pipeline network and plan the cable network in such a manner that the system is compatible, safe and non-interfering either during its installation or during its operation and maintenance. Plan of the proposed cable installation shall be brought to the notice of the other authorities referred above.

5B.4.7.2 Suitable cable markers and danger sign as would be appropriate for the safety of the workmen of any of the systems shall be installed along with the cable installation. Notification of testing and energizing of the system shall also be suitably published for ensuring safety.

5B.4.7.3 Any person or organization or authority laying cables shall have and, so far it is reasonably practicable, keep up to date, a map or series of maps indicating the position and depth below surface level of all networks or parts there of which he owns or operates.

Any map prepared or kept shall be available for inspection by any of the municipal authority, other service providers, general public provided they have a reasonable cause for requiring to inspect any part of the map.

5B.5 DISTRIBUTION OF SUPPLY AND CABLING

5B.5.0 General

In the planning and design of an electrical wiring installation, due consideration shall be made of all the prevailing conditions. It is recommended that advice of a competent electrical engineer be sought at the initial stage itself with a view to providing an installation that will prove adequate for its intended purpose be reliable and safe and efficient.

A certain redundancy in the electrical system is necessary and has to be built in from the initial design stage itself. The extent of redundancy will depend on the type of load, its criticality, normal hours of use, quality of power supply in that area, co-ordination with the standby power supply, capacity to meet the starting current requirements of large motors etc.

5B.5.1 System of Supply

5B.5.1.1 All electrical apparatus shall be suitable for the voltage and frequency of supply.

5B.5.1.2 In case of connected load of 100 kVA and above, the relative advantage of medium voltage three-phase supply should be considered. Though the use of medium voltage supply entails the provisions of space for the capital cost of providing suitable transformer substation at the consumer's premises, the following advantages are gained:

a) advantage in tariff;

b) more effective earth fault protection;

c) elimination of interference with supplies to other consumers permitting the use of large size motors, welding plant, etc; and

d) better control of voltage regulation and more constant supply voltage.

NOTE — Additional safety precautions required to be observed in MV installations shall also be kept in view.

In many cases there may be no choice available to the consumer, as most of the licensees have formulated their policy of correlating the supply voltage with the connected load or the contract demand. Generally, the supply is at 400/230 volts, 11 kV for loads up to 1 MVA and 33 kV or 66 kV for consumers of more than 1 MVA.

5B.5.1.3 In very large industrial buildings where heavy electric demands occur at scattered locations, the economics of electrical distribution at medium voltage from the main substation to other subsidiary transformer substations or to certain items of plant, such as large motors and furnaces, should be considered. The relative economy attainable by use of low or medium voltage distribution and medium voltage plant is a matter for expert judgement and individual assessment in the light of experience by a professionally qualified electrical engineer.

5B.5.2 Substation Equipment and Accessories

Substations require an approval by the Electrical Inspectorate. Such approval is mandatory before energizing the substation. It is desirable to get the approval for the general layout, schematic layout, protection plan etc, before the start of the work from the Inspectorate. All substation equipment and accessories and materials, etc, shall conform to relevant Standards wherever they exist, otherwise the consumer (or his consultant) has to specify the standards to which the equipment to be supplied confirms and that shall be approved by the authority. Manufacturers of equipment have to furnish certificate of conformity as well as type test certificates for record, in addition to specified test certificates for acceptance tests and installation related tests for earthing, earth continuity, load tests and tests for performance of protective gear.

5B.5.2.1 Medium Voltage Switchgear

5B.5.2.1.1 The selection of the type of medium voltage switchgear for any installation inter alia depends upon the following:

a) voltage of the supply system;

b) the prospective short-circuit current at the point of supply;

c) the size and layout of electrical installation;

d) the accommodation available; and

e) the nature of industry.

Making and breaking capacity of switchgear shall be commensurate with short-circuit potentialities of the supply system and the supply authority shall be consulted on this subject.

5B.5.2.1.2 Guidelines on various types of switchgear equipment and their choice for a particular application shall be in accordance with International Standard (IEC) practice.

5B.5.2.1.3 In extensive installations of switchgear (having more than four incoming supply cables or having more than 12 circuit breakers), banks of switchgears shall be segregated from each other by means of fire resisting barriers having 2h fire resistance rating in order to prevent spreading of the risk of damage by fire or explosion arising from switch failure. Where a bus-bar section switch is installed, it shall also be segregated from adjoining banks in the same way. Except main LT panel, it would be preferable to locate the sub panels/distribution boards near load centre. Further, it should be ensured that these panels are easily approachable. The preferable location of panels shall be near the exit ways.

5B.5.2.1.4 It should be possible to isolate any section from the rest of the switchboards such that work might be undertaken on this section without the necessity of making the switchboard dead. Isolating switches used for the interconnection of sections or for the purpose of isolating circuit-breakers of other apparatus, shall also be segregated within its compartment so that no live part is accessible when work in a neighbouring section is in progress.

5B.5.2.1.5 In the case of duplicate or ring main supply, switchgears with interlocking arrangement shall be provided to prevent simultaneous switching of two different supply sources. Electrical and/or mechanical interlocks may preferably be provided.

5B.5.2.2 *Cables*

5B.5.2.2.1 The smallest size of the cable that shall be used, will depend upon the method of laying cable permissible maximum temperature it shall withstand, voltage drop over the length of the cable, the prospective short-circuit current to which the cable may be subjected, the characteristics of the overload protection gear installed, load cycle and thermal resistivity of the soil.

NOTE — Guidelines for correlation of the ratings of cables and characteristics of protective devices are under consideration. Continuous current carrying capacity (thermal limit leading to permanent change in properties of the insulation) under the installed conditions, voltage drop under required load and the fault current withstand ability of the cable for the duration that the protective device controlling the cable installation will let go the fault current, operating voltage are the prime considerations.

5B.5.2.2.2 The advice of the cable manufacturer with regard to installation, jointing and sealing shall be followed.

5B.5.2.2.3 The LV cables shall either be laid on the cable rack/built-up concrete trenches/tunnel/basement or directly buried in the ground depending upon the specific requirement. It is preferable to use four core cable in place of three and half core to minimize heating of neutral core due to harmonic content in the supply system and also avoidance of overload failures. All cables shall be installed in accordance with Standard practice.

5B.5.2.2.4 *Colour identification of cores of non-flexible cables*

Function	*Colour Identification of Core of Rubber of PVC Insulated Non flexible Cable, or of Sleeve or Disc to be Applied to Conductor or Cable Code*
Protective or earthing	Green and yellow or Green with yellow stripes[1)]
Neutral of a.c. single or three phase circuit	Blue
Phase R of 3-phase a.c. circuit	Brown
Phase Y of 3-phase a.c. circuit	Black
Phase B of 3-phase a.c. circuit	Grey
Positive of d.c. 2-wire circuit	Brown
Negative of d.c. 2-wire circuit	Grey
Outer (positive or negative) of d.c. 2-wire circuit derived from 3-wire system	Brown/Grey
Positive of 3-wire system positive of 3-wire d.c. circuit)	Brown
Middle wire of 3-wire d.c. circuit	Blue
Negative of 3-wire d.c. circuit	Grey
Functional Earth-Telecommunication	Cream

[1)]Bare conductors are also used for earthing and earth continuity conductors. But it is preferable to use insulated conductors with green insulation with yellow stripes.

5B.5.2.2.5 *Colour, identification of cores of flexible cables and flexible cords*

Number of Cores	*Function of Core*	*Colour(s) of Core*
1	Phase Neutral Protective or Earthing	Brown[1)] (Light) Blue Green & yellow
2	Phase Neutral	Brown (Light) Blue[1)]
3	Phase Neutral Protective or Earthing	Brown (Light) Blue [1)] Green & yellow
4 or 5	Phase Neutral Protective or Earthing	Brown, Black[1)], Grey (Light) Blue [1)] Green & yellow

[1)] Certain alternative are allowed in Wiring Regulations.

5B.5.2.3 *Medium Voltage Bus bar Trunking /Ducting*

Medium voltage busbar trunking system is a type-tested switchgear and control gear assembly in the form of an enclosed system. MV busbar system is used for transporting power between MV Generators, transformers and the infeed main switchgear of the main MV switchgear.

Generally, three types of bus ducts namely non-segregated, segregated and isolated phase bus duct shall be used. The non-segregated bus ducts consist of three phase busbars running in a common enclosure made of steel or aluminium. The enclosure shall provide safety for the operational personnel and reduces chances of faults. The enclosures shall be effectively grounded.

Segregated phase bus duct are similar to non-segregated phased duct except that metal or insulation barriers are provided between phase conductors to reduce chances of phase to phase faults. However, it is preferable to use metal barriers.

In the case of isolated bus ducts, each phase conductor shall be housed in a separate non-magnetic enclosure. The bus duct shall be made of sections which are assembled together at site to make complete assembly. The enclosure shall be of either round or square shape and welded construction. The enclosures of all phases in general to be supported on a common steel structure. Provision of fire protection shall be provided in all openings' [*see* Fire Services Department Instruction]. Fire separation in openings shall be provided using materials having 2h fire resistance rating.

5B.5.2.4 *MV/LV Busbar Trunking/Rising Mains*

Where heavy loads are to be carried, busbar systems are preferred. The busbars are available for continuous run from point to point or with tap offs at standard intervals and have to be chosen as per specific requirement. MV/LV busbar trunking shall be a type-tested switchgear and control gear assembly in the form of an enclosed system. There are two types of MV/LV bus duct system for power distribution system:

a) Conventional type.

b) Compact and sandwich type.

Conventional type bus duct is used for large power handling between transformer and switchgear or between switchgear and large power loads, such as compressor drive motor etc. This type is generally used in plant rooms, riser shafts, substations etc.

Compact type is available either air insulated or sandwich type for use within areas of the building which are put to other higher (aesthetic) level of use. They could be used in false ceiling spaces or even in corridors and shafts for distribution without any false ceiling as they provide an aesthetically acceptable finish to merge with other building elements such as beams, ducts or pipes in functional buildings.

The class of protection shall be specific depending on the requirement at the place of installation. Protection class (IP xx) will automatically identify the ventilation, protection from weather, water, dust etc.

In modern building technology, high demands are made of the power distribution system and its individual components:

a) Long life and good service quality,

b) Safe protection in the event of fire,

c) Low fire load,

d) Low space requirement, and

e) Minimum effort involved in carrying out retrofits.

The high load density in modern large buildings and high-rise buildings demands compact and safe solution for the supply of power. The use of busbar trunking system is ideal for such applications.

Busbar trunking can be installed in vertical risers ducts or horizontally in passages for transmission and distribution of power. Busbar trunking systems allow electrical installations to be planned in a simple and clear fashion. In the building complexes, additional safety demands with respect to fire barriers and fire load and use of bus bar trunking meets this requirement.

Busbar trunking system reduces the combustible material near the area with high energy in comparison with other distribution systems such as cables and makes the building safe from the aspect of vulnerability to fire of electrical origin. In addition, unlike cable systems the reliability of a bus trunking system is very high. These systems also require very little periodic maintenance.

Choice of busbar trunking for distribution in buildings can be made on the basis of

a) reduced fire load (drastically reduced in comparison to the cable system),

b) reduced maintenance over its entire lifetime,

c) longer service lifetime in comparison with a cable distribution

d) enhanced reliability due to rigid bolted joints and terminations and extremely low possibility of insulation failure.

5B.5.2.5 *Transformers*

5B.5.2.5.1 General design objective while selecting the transformer(s) for a substation would be to provide at least two or more transformers, so that a certain amount of redundancy is built in, even if a standby system is provided. The total installed transformation capacity would be marginally higher than the anticipated maximum demand. With growing emphasis on energy conservation, the system design is made for both extremes of loading. During the periods of lowest load in the system, it would be desirable to operate only one transformer and switch in additional transformers as the load variation takes place in a day. The minimum size of a transformer would quite often depend on the minimum load that is anticipated over a period of about 4h in a day. Total transformer capacity is generally selected on the basis of present load, possible future load, operation and maintenance cost and other system conditions and selection of the maximum size(capacity) of the transformer is guided by short-circuit making and breaking capacity of the switchgear used in the medium voltage distribution system. Maximum size limitation is important from the aspect of feed to a downstream fault.

For feeding final single phase domestic type of loads or general office loads it is advisable to even use transformers of capacity much lower than what the switchgear can handle, so that lower fault MVA is available in such areas and use of hand held equipment fed through flexible cords is safe.

For reasons of reliability and redundancy it is normal practice to provide at least two transformers for any important installation. Interlinking by tie lines is an alternative to enhance reliability/redundancy is areas where there are a number of substations in close vicinity, such as a campus with three or four multi-storied blocks each with a substation.

Ring main type of distribution is preferred for complexes having a number of substations.

5B.5.2.5.2 Where two or more transformers are to be installed in a substation to supply a low voltage distribution system, the distribution system shall be divided into separate sections each of which shall be normally fed from one transformer only unless the low voltage switchgear has the requisite short circuit capacity. Provision may, however, be made to interconnect separate sections, through a bus coupler in the event of failure or disconnection of one transformer. *See* **5B.4.2** for details of location and requirements of substation.

The transformers, that may at any time operate in parallel, shall be so selected as to share the load in proportion to their respective load ratings. While the general practice is to avoid operation of transformers in parallel for feeding final distribution in buildings, it is possible to use transformers with slightly different impedance or voltage taps to operate in parallel, but with appropriate protection. Installations designed for parallel operation of transformers shall have protection for avoiding circulating current between transformers, avoid overload of any one transformer due to reactance mismatch and the system shall be so arranged as to trip the secondary breaker in case the primary breaker of that transformer trips.

5B.5.2.6 *Switchgear*

5B.5.2.6.1 Switchgear (and its protective device) shall have breaking capacity not less than the anticipated fault level in the system at that point. System fault level at a point in distribution system is predominantly dependent on the transformer size and its reactance. Parallel operation of transformers naturally increases the fault level.

5B.5.2.6.2 Isolation and controlling circuit breaker shall be interlocked so that the isolator cannot be operated unless the corresponding breaker is in open condition. The choice between alternative types of equipment maybe influenced by the following considerations:

a) In certain installations supplied with electric power from remote transformer substations, it may be necessary to protect main circuits with circuit-breakers operated by earth fault, in order to ensure effective earth fault protection.

b) Where large electric motors, furnaces or other heavy electrical equipment is installed, the main circuits shall be protected from short circuit by switch disconnector fuse or circuit breakers. For motor protection, the combination of contactor overload device and fuse or circuit breakers shall be Type-2 coordinated in accordance with accepted standards.

   Wherever necessary, backup protection and earth fault protection shall be provided to the main circuit.

c) Where mean of isolating main circuits is separately required, switch disconnector fuse or switch disconnector may form part of main switchboards.

5B.5.2.6.3 It shall be mandatory to provide power factor improvement capacitor at the substation bus. Suitable capacitor may be selected in consultation with the capacitor as well as switchgear manufacture depending upon the nature of electrical load anticipated on the system. Necessary switchgear/feeder circuit breaker shall be provided for controlling of capacitor bank.

Power factor of individual motor may be improved by connecting individual capacitor banks in parallel. For higher range of motors, which are running continuously without much variation in load, individual power factor correction at load end is advisable.

NOTE — Care should be taken in deciding the kVA rating of the capacitor in relation to the magnetizing kVA of the motor. Over rating of the capacitor may cause injury to the motor and capacitor bank. The motor still rotating after disconnection from the supply, may act as generator by self-excitation and produce a voltage higher than supply voltage. If the motor is again switched on before the speed has fallen to about 80 percent of the normal running speed, the high voltage will be superimposed on the supply circuits and will damage both the motor and capacitor.

As a general rule, the kVAr rating of the capacitor should not exceed the no-load magnetizing kVA of the motor.

Generally, it would be necessary to provide an automatic control for switching in capacitors matching the load power factor and the bus voltage. Such a scheme would be necessary as capacitors permanently switched in the circuit may cause over voltage at times of light load.

5B.5.2.6.4 Sufficient additional space shall be allowed in substations and switch rooms to allow operation and maintenance and proper means shall be provided for isolating the equipment to allow access for servicing, testing and maintenance. Sufficient additional space shall be allowed for temporary location and installation of standard servicing and testing equipment. Space should also be allowed to provide for anticipated future extensions.

5B.5.2.6.5 Electrical installations in a room or cubicle or in an area surrounded by wall fence, access to which is controlled by lock and key shall be considered accessible to authorized persons only.

A wall or fence less than 1.8 m in height shall not be considered as preventing access unless it has other features that provide a degree of isolation equivalent to a 1.8 m fence.

5B.5.2.6.6 Harmonics on the supply systems are becoming a greater problem due to the increasing use of electronic equipments, computer, fluorescent, mercury vapour and sodium vapour lighting, controlled rectifier and inverters for variable speed drives, power electronics and other non-linear loads. Harmonics may lead to almost as much current in the neutral as in the phases. This current is almost entirely third harmonic. Phase rectification devices may be considered for the limits of harmonic voltage distortion may be considered at the planning stage in such cases.

With the wide spread use of thyristor and rectifier based loads there is necessity of providing a full size neutral; but this requirement is limited to the 3-phase 4-wiredistribution generally in the 400/230V system. As a result it is not desirable to use half-size neutral conductor, as possibility of neutral conductor overload due to harmonics is likely.

5B.5.3 Reception and Distribution of Main Supply

5B.5.3.1 *Control at Point of Commencement of Supply*

5B.5.3.1.1 There shall be a circuit-breaker or miniature circuit-breakers or a load break switch fuse on each live conductor of the supply mains at the point of entry. The wiring throughout the installation shall be such that there is no switch or fuse unit in the earthed neutral of conductor. The neutral shall also be distinctly marked.

5B.5.3.1.2 The main switch shall be easily accessible and situated as near as practicable to the termination of service line.

5B.5.3.1.3 On the main switch, where the conductors include an earthed conductor of a two-wire system or an earthed neutral conductor or a multi-wire system or a conductor which is to be connected thereto, an indication of a permanent nature shall be provided to identify the earthed neutral conductor.

5B.5.3.1.4 *Energy meters*

Energy meters shall be installed in residential buildings at such a place which is readily accessible to the owner of the building and the Authority. These should be installed at a height where it is convenient to note the meter reading, it should preferably not be installed below one metre from the ground. The energy meters should either be provided with a protecting covering, enclosing it completely except the glass window through which the readings are noted or should be mounted inside a completely enclosed panel provided with hinged or sliding doors with arrangement for locking.

In multi-storied buildings meters shall be installed with tapping point for meters of the rising main (bus trunking) on individual floors (Energy Meter Installed Location subject to the requirement of Electricity Supply Authority).

5B.5.3.2 *Main Switches and Switchboard*

5B.5.3.2.1 All main switches shall be either of metal-clad enclosed pattern or of any insulated enclosed pattern which shall be fixed at close proximity to the point of entry of supply. Every switch shall have an environmental protection level rating (IP), so that its operation is satisfactory in the environment of the installation.

NOTE — Woodwork shall not be used for the construction or mounting of switches and switch boards installed in' a building.

5B.5.3.2.2 *Location*

a) The location of the main board should be such that it is easily accessible for fireman and other personnel to quickly disconnect the supply in case of emergencies. If the room is locked for security, means of emergency access, by schemes such as break glass cupboard, shall be incorporated.

b) Main switch board shall be installed in rooms or cupboards so as to safeguard against operation by unauthorized personnel.

c) Switchboards shall be placed only in dry situations and in ventilated rooms and they shall not be placed in the vicinity of storage batteries or exposed to chemical fumes.

d) In damp situation or where inflammable or explosive dust, vapour or gas is likely to be present, the switchboard shall be totally enclosed and shall have adequate degree of protection. In some cases, flameproof enclosure may be necessitated by particular circumstances.

e) Switchboards shall not be erected above gas stoves or sinks, or within 2.5 m or any washing unit in the washing rooms or laundries, or in bathrooms, lavatories or toilets, or kitchens.

f) In case of switchboards unavoidably fixed in places likely to be exposed to weather, to drip, or to abnormal moist temperature, the outer casing shall be weatherproof and shall be provided with glands or bushings or adopted to receive screwed conduit, according to the manner in which the cables are run.

g) Adequate illumination shall be provided for all working spaces about the switchboards when installed indoors.

5B.5.3.2.3 Metal clad switchgear shall preferably be mounted on any of the following types of boards:

a) *Hinged-type metal boards* — These shall consist of a box made of sheet metal not less than 2 mm thick and shall be provided with a hinged cover to enable the board to swing open for examination of the wiring at the back. The joints shall be welded. There shall be a clear distance of not less than 2.5 cm between the teak wood board and the cover, the distance being increased for larger boards in order that on closing of the cover, the insulation of the cables is not subjected to damage and no excessive twisting or bending in any case. The board shall be securely fixed to the wall by means of rag bolts, plugs, or wooden plugs and shall be provided with a locking arrangement and an earthing stud. All wires passing through the metal board shall be protected by a rubber or wooden bush at the entry hole. The earth stud should commensurate with the size of earth lead/leads. Alternatively, metal boards may beam of suitable size angle iron of minimum size 35 mm x 35 mm x 6 mm or channel iron of minimum size 35 mm x 25 mm x 6 mm frames work suitably mounted on front with a 3 mm thick mild steel plate and on back with1.5 mm thick mild steel sheet. No apparatus shall project beyond any edge of panel. No fuse body shall be mounted within 2.5 cm of any edge of the panel.

   NOTE — Such type of boards are particularly suitable for small switchboard for mounting metal-clad switchgear connected to supply at low voltages.

b) *Fixed-type metal boards* — These shall consist of an angle or channel iron frame fixed on the wall or on floor and supported on the wall at the top, if necessary. There shall be a clear distance of 1 m in front of the switchboards. If there are any attachments of bare connections at the back of the switchboard *Myanmar Electricity Rules* shall apply. The connections between the switchgear mounting and the outgoing cable up to the wall shall be enclosed in a protection pipe.

NOTE — Such type of boards are particularly suitable for large switchboards for mounting large number of switchgears or high capacity metal-clad switchgear or both.

c) *Protected-type switchboard* — A protected switchboard is one where all of the conductors are protected by metal or other enclosures. They may consist of a metal cubicle panel, or an iron frame upon which is mounted metal clad switchgear. They usually consist of a main switch, busbars and circuit breakers or fuses controlling outgoing circuits.

d) *Open-type switchboard*— An open type switchboard is one, which has exposed current carrying parts on the front of the switchboard. This type of switchboard is rarely used nowadays but where this exists, a hand rail or barrier has to be provided to prevent unintentional or accidental contact with exposed live parts. They must be located in a special switch room or enclosure and only a competent person may have access to these switchboards.

NOTE — These boards may be existing in old installations. It is recommended that they be phased out. With the continuously increasing fault power feed due to increases in generation and strengthening of distribution systems, these open boards are a source of accidents.

5B.5.3.2.4 *Recessing of boards*

Where so specified, the switchboards shall be recessed in the wall. Ample room shall be provided at the back for connection and at the front between the switchgear mountings.

5B.5.3.2.5 ***Marking of apparatus***

a) Where a board is connected to voltage higher than 250 V, all the apparatus mounted on it shall be marked on the following colors to indicate the different poles or phases to which the apparatus or its different terminals may have been connected:

Alternating Current	*Direct Current*
Three-phases — Brown, Black, Grey	Three-wire system— 2 outer wire,
	positive Brown and negative Grey
1 Neutral —Blue	1Neutral —Blue

b) Where four-wire three-phase wiring is done, the neutral shall be in one colour and the other three wires in another colour as mentioned above or shall be suitably tagged or sleeved for full proof identification.

c) Where a board has more than one switch, each such switch shall be marked to indicate which section of the installation it controls. The main switch shall be marked as such and where there is more than one main switch in the building, each such switch shall be marked to indicate which section of the installation it controls.

All markings shall be clear and permanent.

5B.5.3.2.6 *Drawings*

Before proceeding with the actual construction, a proper drawing showing the detailed dimensions and design including the disposition of the mountings of the boards, which shall be symmetrically and neatly arranged for arriving at the overall dimensions, shall be prepared along the building drawing. Such drawings will show the mandatory clearance spaces if any, and clear height below the soffit of the beam required to satisfy regulations and safety considerations, so that other designers or installers do not get into such areas or spaces for their equipment.

5B.5.3.2.7 Where a board has more than one switch, each such switch shall be marked to indicate which section of the installation it controls. The main switch shall be marked as such and where there is more than one main switch in the building, each such switch shall be marked to indicate which section of the installation it controls.

All markings shall be clear and permanent.

5B.5.3.2.8 *MV/LV Bus bar chambers (400 V/230 V)*

Busbar chambers, which feed two or more circuits, must be controlled by a main disconnector (TP &N), or Isolating links or TPN MCB to enable them to be disconnected from the supply.

5B.5.3.3 Distribution Boards

A distribution board comprises of one or more protective devices against over current and ensuring the distribution of electrical energy to the circuits. Distribution board shall provide plenty of wiring space, to allow working as well as to allow keeping the extra length of connecting cables, likely to be required for maintenance.

5B.5.5.3.1 Main distribution board shall be provided with a circuit breaker on each pole of each circuit, or a switch with a fuse on the phase or live conductor and a link on the neutral or earthed conductor of each circuit. The switches shall always be linked.

All incomers should be provided with surge protection devices.

5B.5.3.4 *Branch Distribution Boards*

5B.5.3.4.1 Branch MCB distribution boards shall be provided, along with earth leakage protective device (RCCB/RCD) in the incoming, with a fuse or a miniature circuit breaker or both of adequate rating setting chosen on the live conductor of each sub-circuit and the earthed neutral conductor shall be connected to a common link and be capable of being disconnected individually for testing purposes. At least one spare circuit of the same capacity shall be provided on each branch distribution board. Further, the individual branching circuits (outgoing) shall be protected against over-current with miniature circuit breaker of adequate rating. In residential/industrial lighting installations, the various circuits shall be separated and each circuit shall be individually protected so that in the event of fault, only the particular circuit gets disconnected. In order to provide protection against electric shock due to leakage current for human being, a 30 mA RCCB/ RCD shall be installed at distribution board incomer of buildings, such as residential, schools and hospitals. For all other buildings, a 100 mA RCCB/RCD will suffice for protection against leakage current.
In case of phase segregated distribution boards, earth leakage protective device shall be provided in the sub¬ incomer to provide phase wise earth fault protection. The provision of sub-incomer in distribution board shall be as per consumer requirement.

5B.5.3.4.2 Common circuit shall be provided for installations at higher level (those in the ceiling and at higher levels, above 1 m, on the walls) and for installations at lower level but with separate switch control (sockets for portable or stationery plug in equipment). For devices consuming high power and which are to be supplied through supply cord and plug, separate wiring shall be done. For plug-in equipment provisions shall be made for providing RCCB/RCD protection in the distribution board.

5B.5.3.4.3 It is preferable to have additional circuit for kitchen and bathrooms. Such sub-circuit shall not have more than a total of ten points of light, fans and 6 A socket outlets. The load of such circuit shall be restricted to 800 W and the wiring with 1.5 mm^2 copper conductor cable is recommended. If a dedicated circuit is planned for light fixtures, the load of such circuit shall be restricted to 400W and the wiring with 1.5 mm^2 copper conductor cable is recommended. If a dedicated circuit is planned for 6A sockets the load of such a circuit shall be restricted to 800 W or

a maximum of 8 numbers, whichever is lesser, controlling MCB should be sized accordingly. The wiring shall be with 1.5 mm^2 copper conductor cable. If a separate fan circuit is provided, the number of fans in the circuit shall not exceed ten. Power sub-circuit shall be designed according to the load but in no case shall there be more than two 16 A outlets on each sub-circuit which can be wired with 4 mn^2 for miscellaneous socket loads and shall be with 4 mm^2 copper conductor cable for equipment consuming more than 1 kW. Power sockets complying with the accepted standards with current rated according to their starting load, wiring, MCB, etc, shall be designed for special equipment space heaters, air conditioners, heat pumps, VRF, etc.
For feeding final single phase domestic type of loads or general office loads it is advisable to introduce additional cables if required to allow lowering of short circuit rating of the switchgear required at user end. Use of hand held equipment fed through flexible cords is safe.

5B.5.3.4.4 The circuits for lighting of common area shall be separate. For large halls 3-wire control with individual control and master control installed near the entrance shall be provided for effective conservation of energy.

5B.5.3.4.5 Where daylight would be available, particularly in large halls, lighting in the area near the windows, likely to receive daylight shall have separate controls for lights, so that they can be switched off selectively when daylight is adequate, while keeping the lights in the areas remote from the windows on.

5B.5.3.4.6 Circuits for socket outlets may be kept separate circuits feeding fans and lights. Normally, fans and lights may be wired on a common circuit. In large spaces circuits for fans and lights may also be segregated. Lights may have group control in large halls and industrial areas. While providing group control consideration may be given for the nature of use of the area lit by a group. Consideration has to be given for the daylight utilization, while grouping, so that a group feeding areas receiving daylight can be selectively switched off during daylight period.

5B.5.3.4.7 The load on any low voltage sub-circuit shall not exceed 3000 W. In case of a new installation, all circuits and sub-circuits shall be designed with an initial load of about 2 500 W, so as to allow a provision of 20percent increase in load due to any future modification. Power sub-circuits shall be designed according to the load, where the circuit is meant for a specific equipment. Good practice is to limit a circuit to a maximum of four sockets, where it is expected that there will be diversity due to use of very few sockets in large spaces (example sockets for use of vacuum cleaner). General practice is to limit it to two sockets in a circuit, in both residential and non-residential buildings and to provide a single socket on a circuit for a known heavy load appliance such as air conditioner, cooking range etc.

5B.5.3.4.8 In wiring installations at special places like construction sites, stadium, shipyards, open yards in industrial plants, etc, where a large number of high wattage lamp may be required, there shall be no restriction of load on any circuit but conductors used in such circuits shall be of adequate size for the load and proper circuit protection shall be provided.

5B.5.3.5 *Location of Distribution Boards*

a) The distribution boards shall be located as near as possible to the centre of the load they are intended to control.

b) These shall be fixed on suitable stanchion or wall and shall be accessible for replacement/reset of protective devices, and shall not be more than 1.8 m from floor level.

c) These shall be of either metal-clad type, or air insulated type. But, if exposed to weather or damp situations, these shall be of the weatherproof type and, if installed where exposed to explosive dust, vapour or gas, these shall be of flameproof type in accordance with accepted standards. In corrosive atmospheres, these shall be treated with anti-corrosive preservative or covered with suitable plastic compound.

d) Where two and/or more distribution boards feeding low voltage circuits are fed from a supply of medium voltage, the metal case shall be marked 'Danger 400 V' and identified with proper phase marking and danger marks.

e) Each shall be provided with a circuit list giving diagram of each circuit which it controls and the current rating of the circuit and size of fuse element.

f) In wiring branch distribution board, total load of consuming devices shall be divided as far as possible evenly between the number of ways in the board leaving spare circuits for future extension.

5B.5.3.6 *Protection of Circuits*

a) Appropriate protection shall be provided at switchboards, distribution boards and at all levels of panels for all circuits and sub-circuits against short circuit, over-current and other parameters as required. The protective device shall be capable of interrupting maximum prospective short circuit current that may occur, without danger. The ratings and settings of fuses and the protective devices (ACB, MCCB, MCB) shall be co-ordinate so as to afford selectivity in operation and in accordance with accepted standards.

b) Where circuit-breakers are used for protection of a main circuit and of the sub-circuits derived there from, discrimination in operation may be achieved by adjusting the protective devices of the sub-main circuit-breakers to operate at lower current settings and shorter time-lag than the main circuit-breaker.

c) Where HRC type fuses are used for back-up protection of circuit-breakers, or where HRC fuses are used for protection of main circuits, and circuit-breakers for the protection of sub-circuits derived there from, in the event of short-circuits protection exceeding the short circuits capacity of the circuit-breakers, the HRC fuses shall operate earlier than the circuit-breakers; but for smaller overloads within the short-circuit capacity of the circuit breakers, the circuit-breakers shall operate earlier than the HRC fuse blows.

d) If rewireable type fuses are used to protect sub-circuits derived from a main circuit protected by HRC type fuses, the main circuit fuse shall normally blow in the event of a short-circuit or earth fault occurring on sub-circuit, although discrimination may be achieved in respect of overload currents. The use of rewireable fuses is restricted to the circuits with short-circuit level of 4 kA; for higher level either cartridge or HRC fuses shall be used. However, use of rewireable fuses not desirable, even for lower fault level areas. MCB's provide a better and dependable protection, as their current setting is not temperable.

e) A fuse carrier shall not be fitted with a fuse element larger than that for which the carrier is designed.

f) The current rating of a fuse shall not exceed the current rating of the smallest cable in the circuit protected by the fuse.

g) Every fuse shall have its own case or cover for the protection of the circuit and an indelible indication of its appropriate current rating in an adjacent conspicuous position.

5B.5.4 Voltage and Frequency of Supply

It should be ensured that all equipment connected to the system including any appliances to be used on it are suitable for the voltage and frequency of supply of the system. The nominal values of low voltage system in Myanmar is 230 V and 400 V ac, respectively, and the frequency 50 Hz.

5B.5.5 Rating of Cables and Equipment

5B.5.5.1 The current-carrying capacity of different types of cables shall be chosen in accordance with Standard practice.

5B.5.5.2 The current ratings of switches for domestic and similar purposes are 6A,10A,16A and 20A.

5B.5.5.3 The current ratings of isolators and normal duty switches and composite units of switches and fuses shall be selected from one of the following values:

16, 25, 32, 63,100,160, 200, 320,400,500,630,800, 1 000 and 1 250 A etc. up to applicable limit.

5B.5.5.4 The ratings of rewireable and HRC fuses shall be in accordance with Standard practice.

5B.5.5.5 The current ratings of miniature circuit-breakers shall be chosen from the values given below:

6,8,10,13,16,20,25,32,40,50,63, 80,100 and125 A.

5B.5.5.6 The current ratings of moulded-case circuit breakers shall be chosen from the values given below:

100,125,160,200,250,315,400,630,800,1 000,1250,1600A and applicable range as practically possible.

5B.5.5.7 The current ratings of air circuit-breakers shall, be chosen from the values given below:

630,800,1000,1250,1600,2000,2500,3200,4000A,6300A and applicable range as practically possible.

NOTES

The design of the wiring system and the sizes of the cables should be decided taking into account two factors.

a) *Voltage Drop*— This should be kept as low as economy permits to ensure proper functioning of all electrical appliances and equipment including motors; and

b) First cost against operating losses.

5B.5.5.8 The current ratings of the distribution fuse board shall be selected from one of the following values:

6,16,25,63 and 100A

5B.5.6 Installation Circuits

Sl No.	*Type of Circuit*	*Minimum Copper Wire Size*	*Number of Circuits*
(1)	(2)	(3)	(4)
i)	Lighting	1.5 mm^2	2 or more
ii)	Socket-outlets, 6 A	2.5 mm^2	Any number Areas such as kitchens and laundries 3 × double socket-outlets per circuit. Other areas up to 12 double socket-outlets
iii)	Signaling and control circuits	0.5 mm^2 (*see* Note 1)	—
iv)	Socket-outlets, 16 A	2.5 mm^2	1
v)	Water heater < 3 kW	2.5 mm^2	1
vi)	Heaters or electric equipment more than or equal to 3 kW	4.0 mm^2	1
vii)	Free standing electric range Separate oven and/or cook top	4.0 mm^2	1
viii)	Air conditioner > 1.5 t	4.0 mm^2	1
ix)	Permanently connected appliances including dishwashers, heaters, etc	2.5 mm^2	1 above 10 A. Up to 10 A can be wired as part of a socket-outlet circuit
x)	Appliance rated >3 kW<6 kW	6.0 mm^2	—
xi)	Submains to garage or out-building	2.5 mm^2	1 for each
xii)	Mains cable	—	It should be based on demand load/peaking loads and future loading.

NOTE — In multi-core flexible cables containing 7 or more cores and in signalling control circuits intended for electronic equipment a minimum nominal cross -sectional area of 0.1 mm^2 is permitted.

5B.5.6.1 *Selecting and Installing Cables*

5B.5.6.1.1 *Cable insulation types*

For installation wiring	Polyvinyl chloride (PVC) cables
For main earth or main equipotential wire	Polyvinyl chloride (PVC) insulated conduit wire
Underground installation and installation in cable trench, feeders between buildings etc.,	PVC insulated, PVC sheathed armoured cables or XLPE insulated, PVC sheathed cables armoured cables
Installation in plant rooms, switch rooms etc, on cable tray or ladder or protected trench, where risk of mechanical damage to cable does not exist.	PVC insulated, PVC sheathed or XLPE insulated, PVC sheathed unarmoured cable

For the purposes of this Code cables above 1mm^2must have stranded conductors. All cables when installed, must be adequately protected against mechanical damage. This can be carried out by either having additional protection, such as being enclosed in PVC conduit or metal pipes, or placing the cables in a suitable location that requires no additional protection. The cables for wiring circuits in electrical installation must have the appropriate wire size matching the requirement of the loads and the following table gives the recommendations for different types of loads.

5B.5.6.1.2 *Circuit wire sizes*

Circuits	*Minimum Wire Size*	*Wire Colour*
1-way lighting	2 + E cable wires 1.5 mm^2	Brown-Blue-Green or Green/Yellow
2-way lighting control (straps between the 2 switches)	3-wire cable 1.5 mm^2	Brown –Brown- Blue
Storage water heaters up to 3 kW	2+Ecable 2.5mm^2(stranded conductors)	Brown-Blue-Green or Green/ Yellow
Storage water heaters between3 kW and 6 kW	2 + E cable 4 mm^2(stranded conductors)	Brown-Blue-Green or Green/Yellow
Socket-outlets and permanent and permanent connection units	2 + E cable 2.5 mm^2(stranded conductors)	Brown-Blue-Green or Green/Yellow
Submains to garages or outbuildings	2 + E cable 2.5 mm^2(stranded conductors)	Brown-Blue-Green or Green/ Yellow
Cooking hobs	2 + E cable 4 mm^2	Brown-Blue-Green or Green/Yellow
Separate ovens	2 + E cable 4 mm^2(stranded conductors)	
Electric range	2 + E cable 6 mm^2(stranded conductors)	Brown-Blue-Green or Green/Yellow
Mains	2 wire cable 6.0 / 10.0 /16 mm^2 etc: (stranded conductors)	Brown-Blue
Main equipotential bonding wire	Conduit wire 4 mm^2 (stranded conductors) (minimum)	Green or Green/Yellow
Main earth wire	Conduit wire 6 mm^2(stranded conductors) 2 + E is also known as twin and earth	Green or Green/Yellow

Switch or isolator controlling a water heater or geyser should not be located within 1m from the location of a shower or bath tub, to avoid a person in wet condition reaching the switch or isolator. It is preferable to provide the control switch outside the bathroom near the entrance and provide an indication at the water heater. A socket or a connector block with suitable protection against water spray should be provided to connect the water heater. The above considerations apply to switches for outdoor lights and other appliances, with the object of avoidance of operation of a switch when a person is wet. Sockets in kitchen, bathroom, toilet, garage etc, should not be provided within a height of 1 m from the ground level. Similar care has to be taken for installations involving fountains, swimming pools etc. Light fittings in such areas should be fed at low voltage, preferably through an isolating transformer with a proper earth leakage protection.

5B.5.6.2 *Requirements for Physical Protection of Underground Cables*

Protective Element	*Specifications*
Bricks	a) 100mm minimum width b) 25 mm thick c) sand cushioning 100 mm and sand cover 100 mm.
Concrete slabs	at least 50 mm thick.
Plastic slabs (polymeric cover strips) Fiber reinforced plastic	at least 10 mm thick, depending on properties and has to be matched with the protective cushioning and cover.
PVC conduit or PVC pipe or stoneware pipe or hume pipe	The pipe diameter should be such so that the cable is able to easily slip down the pipe
Galvanized pipe	The pipe diameter should be such so that the cable is able to easily slip down the pipe.

The trench shall be backfilled to cover the cable initially by 200 mm of fill; and then a plastic marker strip over the full length of cable in the trench. Fill the trench shall be laid before filling the full trench. The marker signs where any cable enters or leaves a building shall be put. This will identify that there is a cable located underground near the building. If the cables rise above ground to enter a building or other structure, a mechanical protection such as a GI pipe or PVC pipe for the cable from the trench depth to a height of 2.0 m above ground shall be provided.

5B.5.7 Lighting and Levels of Illumination

5B.5.7.1 *General*

Lighting installation shall take into consideration the many factors on which the quality and quantity of artificial lighting depends. The modern concept is to provide illumination with the help of a large number of light sources not of higher illumination level. Also much higher levels of illumination are called for, than in the past, often necessitating the use of fluorescent lighting suitably supplemented with incandescent fittings, where required (PART 5A, Building Services (Lighting)).

5B.5.7.2 *Future Demand*

However, if for financial reasons, it is not possible to provide a lighting installation to give the recommended illumination levels, the wiring installation at least should be so designed that at a later date, it will permit the provision for additional lighting fittings or conversion from incandescent to fluorescent lighting fittings or high efficient LED light to bring the installation to the required standard. It is essential that adequate provisions should be made for all the electrical services which may be required immediately and during the intended useful life of the building.

5B.5.7.3 *Principles of Lighting*

When considering the function of artificial lighting, attention shall be given to the following principle characteristics before designing an installation:

a) illumination and its uniformity;

b) special distribution of light. This includes a reference to the composition of diffused and directional light, direction of incidence, the distribution of luminances and the degree of glare; and

c) colour temperature of the light and colour rendition.

5B.5.7.4 The variety of purposes which have to be kept in mind while planning the lighting installation could be broadly grouped as:

a) industrial buildings and processes;
b) offices, schools and public buildings;
c) surgeries and hospitals; and
d) hostels, restaurants, shops and residential buildings.

5B.5.7.4.1 It is important that appropriate levels of illumination for these and the types and positions of fittings determined to suit the task and the disposition of the working planes.

5B.5.7.5 For specific requirements for lighting of special occupancies, reference shall be made to Standard practice.

5B.5.7.6 *Energy Conservation*

Energy conservation may be achieved by using the following:

a) Energy efficient lamps, chokes, ballast, etc for lighting equipment.

b) Efficient switching systems such as remote sensors, infrared switches, master switches, remote switches, etc for switching ON and OFF of lighting circuits.

c) Properly made/connected joints/contacts to avoid loose joints leading to loss of power.

5B.5.8 In locations where the system voltage exceeds 650V, as in the case of industrial locations, for details of design and construction of wiring installation, reference may be made to Standard practice.

5B.5.9 Guideline for Electrical Layout in Residential Buildings

For guidelines for electrical installation in residential buildings, reference may be made to Standard practice.

A typical distribution scheme in a residential building with separate circuits for lights and fans and for power appliances is given in Figure1.

5B.5.10 For detailed information regarding the installation of different electrical equipments, reference may be made to Standard practice.

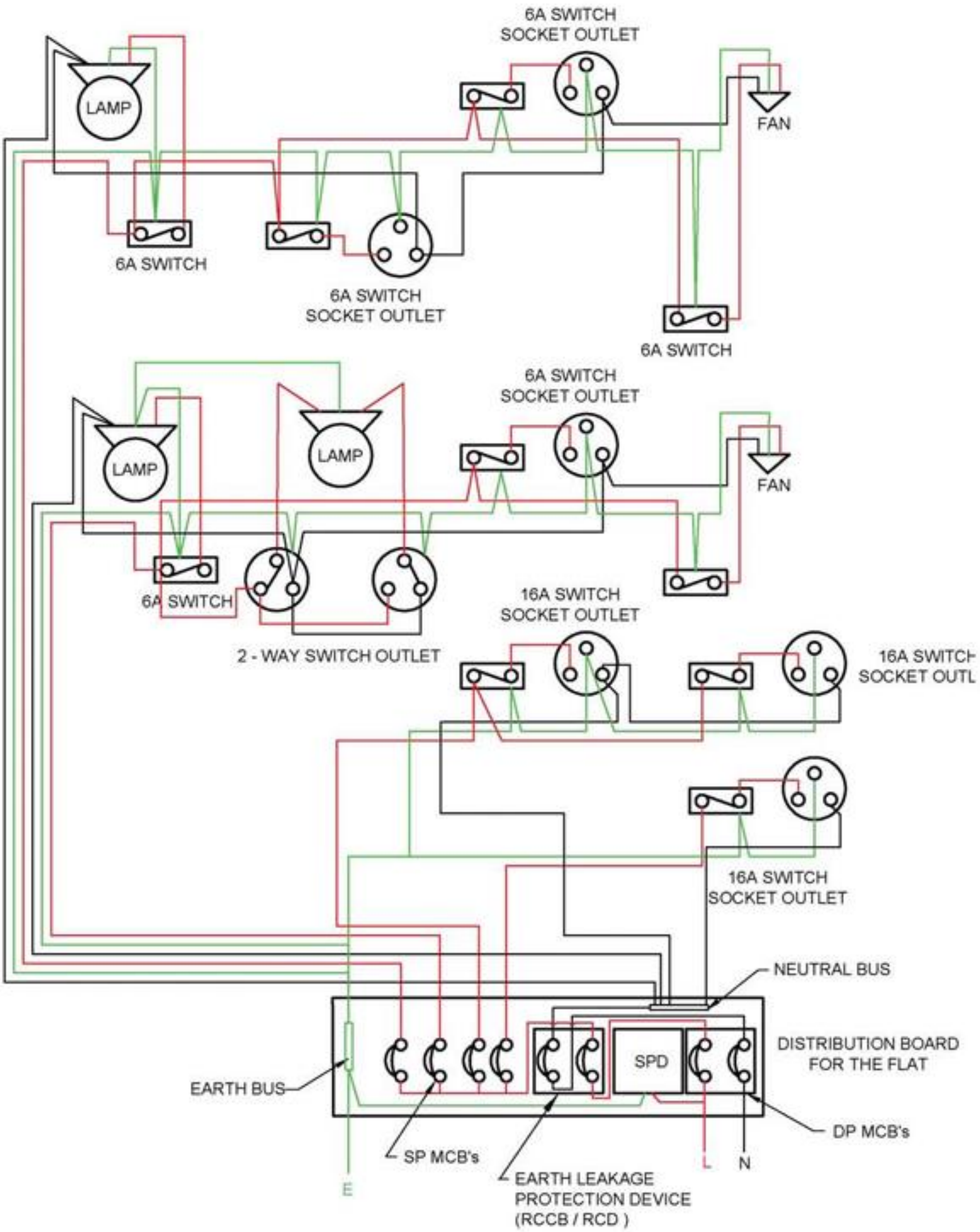


Figure 1: Wiring Diagram for a Typical Distribution Board Scheme in a Residential Building Flat

5B.6 WIRING

5B.6.1 Provision for Maximum Load

All conductors, switches and accessories shall be of such size as to be capable of carrying, without their respective ratings being exceeded, the maximum current which will normally flow through them.

5B.6.1.1 *Estimation of Load Requirements*

In estimating the current to be carried by any conductor the following ratings shall be taken, unless the actual values are known or specified for these elements:

SI No. (1)	Element (2)	Rating W (3)
i)	Incandescent lamp	60
ii)	Ceiling fan	60
iii)	Table fan	60
iv)	10/13 A socket outlet	100, unless the actual value of loads are specified
v)	16 A socket outlet	1 000, unless the actual value of loads are specified
vi)	Fluorescent light: Length :	
	a) 600 mm	25
	b) 1 200 mm	50
	c) 1 500 mm	90
vii)	High pressure mercury vapour (HPMV) lamps, high pressure sodium vapour (HPSV) lamps	According to their capacity, control gear losses shall be also considered as applicable
viii)	Compact fluorescent lamp (CFL)	20
ix)	Light emitting diode (LED)	10
x)	Exhaust fan	50
xi)	Water Heater (storage type) 2	2 000
xii)	Water Heater (instant)	3 000
xiii)	Computer point	150
xiv)	Computer (laptop)	50
xv)	Printer, laser 1	1 500
xvi)	Printer, inkjet	70
xvii)	Kitchen outlet 1	1 500
xviii)	Air conditioner:	
	1 TR	1 250
	1.5 TR	1 875
	2 TR	2 500
	2.5 TR	3 200

5B.6.1.2 Electrical installation in a new building shall normally begin immediately on the completion of the main structural building work and before finishing work such as plastering has begun except in the case of surface wiring which can be carried out after the plaster work. Usually, no installation work should start until the building is reasonably weatherproof, but where electric wiring is to be concealed within the structures as may be the case with a reinforced concrete building, the necessary conduits and ducts shall be positioned firmly by tying the conduit to the reinforcement before concreting. When shutters are removed after concreting, the conduits end shall be given suitable anti-corrosive treatment and holes blocked off by putties or caps to protect conduits from getting blocked. All conduit openings and junction box openings, etc shall be properly protected against entry of mortar, concrete, etc during construction.

5B.6.2 Selection of Size of Conductors

The size of conductors of circuits shall be so selected that the drop in voltage from consumer's terminals in a public supply (or from the busbars of the main switchboard controlling the various circuits in a private generation plant) to any point on the installation does not exceed four percent of the voltage at the consumer’s terminals (or at two busbars as these maybe) when the conductors are carrying the maximum current under the normal conditions of service.

5B.6.2.1 If the cable size is increased to avoid voltage drop in the circuit, the rating of the cable shall be the current which the circuit is designed to carry. In each circuit or sub-circuit the fuse shall be selected to match the cable rating to ensure the desired protection.

5B.6.3 Branch Switches

Where the supply is derived from a three-wire or four wire source, and distribution is done on the two-wire system, all branch switches shall be placed in the outer or live conductor of the circuit and no single phase switch or protective device shall be inserted in the middle wire, earth or earthed neutral conductor of the circuit. Single-pole switches (other than for multiple control) carrying not more than 16 A may be of tumbler type or flush type which shall be on when the handle or knob is down.

5B.6.4 Layout and Installation Drawing

5B.6.4.1 The electrical layout should be drawn indicating properly the locations of all outlets for lamps, fans, appliances both fixed and transportable, motors, etc, and best suit for wiring.

5B.6.4.2 All runs of wiring and the exact positions of all points of switch-boxes and other outlets shall be first marked on the plans of the building and approved by the engineer-in-charge or the owner before actual commencement of the work.

5B.6.4.3 Industrial layout drawings should indicate the relative civil and mechanical details.

5B.6.4.4 *Layout of Wiring*

The layout of wiring should be designed keeping in view disposition of the lighting system to meet the illumination levels. All wirings shall be done on the distribution system with main and branch distribution boards at convenient physical and electrical load centres. All types of wiring, whether concealed or unconcealed should be as near the ceiling as possible. In all types of wirings due consideration shall be given for neatness and good appearance.

5B.6.4.5 Balancing of circuits in three-wire or poly-phase installation shall be arranged beforehand. Proper balancing can be done only under actual load conditions. Conductors shall be so enclosed in earthed metal or incombustible insulating material that it is not possible to have ready access to them. Means of access shall be marked to indicate the voltage present.

Where terminals or other fixed live parts between which a voltage exceeding 250 V exists are housed in separate enclosures or items of apparatus which, although separated are within reach of each other, a notice shall be placed in such a position that anyone gaining access to live parts is warned of the magnitude of the voltage that exists between them.

Where loads are single phase, balancing should be for the peak load condition based on equipment usage. Facility for change should be built into the distribution design.

NOTE — The above requirements apply equally to three-phase circuits in which the voltage between lines or to earth exceeds 250 V and to groups of two or more single-phase circuits, between which low voltage may be present, derived therefrom. They apply also to 3-wire dc or 3-wire single-phase ac circuits in which the voltage between lines or to earth exceeds 250 V and to groups of 2-wire circuits, between which low voltage may be present, derived therefrom.

5B.6.4.6 Low voltage wiring and associated apparatus shall comply, in all respects, with the requirements of Myanmar Electricity Rules.

5B.6.5 Conductors and Accessories

5B.6.5.1 *Conductors*

Conductors for all the internal wiring shall be of copper. Conductors for power and lighting circuits shall be of adequate size to carry the designed circuit load without exceeding the permissible thermal limits for the insulation. The conductor for final sub-circuit for fan and light wiring shall have a nominal cross-sectional area not less than 1.5 mm^2 copper. The cross-sectional area of conductor for power wiring shall be not less than 2.5 mm^2 copper. The minimum cross-sectional area of conductor of flexible cord shall be 1.5 mm^2 copper.

In existing buildings where aluminium wiring has been used for internal electrification, change over from aluminium conductor to copper conductor may be made once the former goes beyond economical repairs.

NOTE — It is advisable to replace wiring, which is more than 30 years old as the insulation also would have deteriorated, and will be in a state to cause failure on the slightest of mechanical or electrical disturbance.

5B.6.5.2 *Flexible Cables and Flexible Cords*

Flexible cables and cords shall be of copper and stranded and protected by flexible conduits or tough rubber or PVC sheath to prevent mechanical damage.

5B.6.5.3 *Cable Ends*

When a stranded conductor having a nominal sectional area less than 6 mm^2 is not provided with cable sockets, all strands at the exposed ends of the cable shall be soldered together or crimped using suitable sleeve or ferrules

5B.6.5.4 *Special Risk*

Special forms of construction, such as flameproof enclosures, shall be adopted where there is risk of the fire or explosion

5B.6.5.5 *Connection to Ancillary Buildings*

Unless otherwise specified, electric connections to ancillary buildings, such as out-houses, garages, etc, adjacent to the main building and when no roadway intervenes shall be taken in an earthed GI pipe or heavy-duty PVC or HDPE pipe of suitable size in the exposed portion at a height of not less than 5.8 m or by buried underground cables. This applies to both runs of mains or sub-mains or final sub-circuit wiring between the buildings.

5B.6.5.6 *Expansion Joints*

Distribution boards shall be so located that the conduits shall not normally be required to cross expansion joints in a building. Where such crossing is found to be unavoidable, special care shall be taken to ensure that the conduit runs and wiring are not in any way put to strain or damaged due to expansion of building structure. Anyone of the standard methods of connection at a structural expansion joint shall be followed:

a) Flexible conduit shall be inserted at place of expansion joint.

b) Oversized conduit overlapping the conduit.

c) Expansion box.

5B.6.5.7 *Low Voltage (Types of Wires/Cables)*

Low voltage services utilize various categories of cables/wires, such as Fibre optic cable, co-axial, etc. These shall be laid at least minimum specified distance of 300 mm from any power wire or cable. Special care shall be taken to ensure that the conduit runs and wiring are laid properly for low voltage signal to flow through it.

5B.6.6 Joints and Looping Back

5B.6.6.1 Where looping back system of wiring is specified, the wiring shall be done without any junction or connector boxes on the line. Where joint box system is specified, all joints in conductors shall be made by means of suitable mechanical connectors in suitable joint boxes. Wherever practicable, looping back system should be preferred. Whenever practicable, only one system shall be adopted for a building, preferably a looping back system.

5B.6.6.2 In any system of wiring, no bare or twist joints shall be made at intermediate points in the through run of cables unless the length of a final sub-circuit, sub-main or main or more than the length of the standard coil as given by the manufacturer of the cable. If any jointing becomes unavoidable such joint shall be made through proper cutouts or through proper junction boxes open to easy inspection, but in looping back system no such junction boxes shall be allowed.

5B.6.6.3 Joints are a source of problems in reliability and are also vulnerable to fire. They should be avoided or at least minimized. Where joints in cable conductors or bare conductors are necessary, they shall be mechanically and electrically sound. Joints in non-flexible cables shall be accessible for inspection; provided that this requirement shall not apply to joints in cables buried underground, or joints buried or enclosed in non-combustible building materials. Joints in non-flexible cables shall be made by soldering, brazing, welding or mechanical clamps, or be of the compression type; provided that mechanical clamps shall not be used for inaccessible joints buried or enclosed in the building structure. All mechanical clamps and compression type sockets shall securely retain all the wires of the conductors. Any joint in a flexible cable of flexible cord shall be effected by means of a cable coupler.

For flexible cables for small loads less than 1 kW, while it would be desirable to avoid joints, if unavoidable, joints can be made either by splicing by a recognized method or by using a connector and protecting the joint by suitable insulating tape or sleeve or straight joint. For application of flexible cable for loads of 1 kW or more, if joint is unavoidable, crimped joint would be preferred. Spliced joint should not be used for large loads.

There are different standard joints such as epoxy resin based joint, heat shrinkable plastic sleeve joint etc, and each one has its advantage and disadvantage. Selection has to be made on the basis of application, site conditions and availability of skilled licensed workmen.

5B.6.6.4 Every joint in a cable shall be provided with insulation not less effective than that of the cable cores and shall be protected against moisture and mechanical damage. Soldering fluxes which remain acidic or corrosive at the completion of the soldering operation shall not be used.

For joints in paper-insulated metal-sheathed cables, a wiped metal sleeve or joint box, filled with insulating compound, shall be provided.

Where an aluminium conductor and a copper conductor are joined together, precautions shall be taken against corrosion and mechanical damage to the conductors.

5B.6.6.5 *Pull at Joints and Terminals*

Every connection at a cable termination shall be made by means of a terminal, soldering socket, or compression type socket and shall securely contain and anchor all the wires of the conductor, and shall not impose any appreciable mechanical strain on the terminal or socket.

Flexible cords shall be so connected to devices and to fittings that tension will not be transmitted to joints or terminal screws. This shall be accomplished by a knot in the cord, by winding with tape, by a special fitting designed for that purpose, or by other approved means which will prevent a pull on the cord from being directly transmitted to joints or terminal screws.

5B.6.7 Passing Through Walls and Floors

5B.6.7.1 Where conductors pass through walls, one of the following methods shall be employed. Care shall be taken to see that wires pass freely through protective pipe or box and that the wires pass through in a straight-line without any twist or cross in wires on either ends of such holes:

a) The conductor shall be carried either in a rigid steel conduit or a rigid non-metallic conduit conforming to accepted standards.

b) *Conduit colour coding*

The conduits shall be colour coded as per the purpose of wire carried in the same. The colour coding may be in form of bands of colour (4 inch thick, with centre-to-centre distance of 12 inches) or coloured throughout in the colour. The colour scheme shall be as follows:

Conduit Type	*Colour Scheme*
Power conduit	Black
Security conduit	Blue
Fire alarm conduit	Red
Low voltage conduit	Brown
UPS conduit	Green

c) *Cable trunking/cable ways*

For the smaller cables, enclosures such as conduit and trunking, may be employed and PVC-insulated, with or without sheath, single core cables installed following completion of the conduit/trunking system. As these cables are usually installed in relatively large groups, care must be taken to avoid overheating and to provide identification of the different circuits.

d) *Tray and ladder rack*

As tray provides continuous support, unless mounted on edge or in vertical runs (when adequate strapping or clipping is essential), the mechanical strength of supported cable is not as important as with ladder-racking or structural support methods. Consequently, tray is eminently suitable for the smaller unarmoured cabling while racks and structural support, except for short lengths, call for armoured cables as they provide the necessary strength to avoid sagging between supports. Both tray and ladder racks can be provided with accessories to facilitate changes of route, and as PVC and similar insulating materials are non-migratory (unlike the older types of impregnated cables) they provide no difficulty in this respect on vertical runs,

Insulated conductors while passing through floors shall be protected from mechanical injury by means of rigid steel conduit, non-metal conduit or mechanical protection to a height not less than 1.5 m above the floors and flush with the ceiling below. This steel conduit shall be earthed and securely bushed. Power outlets and wiring in the floor shall be generally avoided. If not avoidable, use false floor or floor trunking. False floor shall be provided where density of equipment and interconnection between different pieces of equipment is high. Examples are: Mainframe Computer station, Telecommunication switch rooms, etc.

Floor trunking shall be used in large halls, convention centres, open plan offices, laboratory, etc.

In case of floor trunking drain points shall be provided, as there could be possibility of water seepage in the case of wiring passing through the floors. Proper care should be taken for suitable means of draining of water. Possibility of water entry exists from: (1) floor washing, (2) condensation in some particular weather and indoor temperature conditions. At the design stage, these aspects have to be assessed and an appropriate means of avoiding, or reducing, and draining method will have to be built in.

Floor outlet boxes are generally provided for the use of appliances, which require a signal, or communication connection. The floor box and trunking system should cater to serve both power distribution and the signal distribution, with appropriate safety and non-interference.

5B.6.7.2 Where a wall tube passes outside a building so as to be exposed to weather, the outer end shall be bell-mouthed and turned downwards and properly bushed on the open end.

5B.6.8 Wiring of Distribution Boards

5B.6.8.1 All connections between pieces of apparatus or between apparatus and terminals on a board shall be neatly arranged in a definite sequence, following the arrangements of the apparatus mounted thereon, avoiding unnecessary crossings.

5B.6.8.2 Cables shall be connected to a terminal only by soldered or welded or crimped lugs using suitable sleeve, lugs or ferrules unless the terminal is of such a form that it is possible to securely clamp them without the cutting away of cables stands. Cables in each circuit shall be bunched together.

5B.6.8.3 All bare conductors shall be rigidly fixed in such a manner that a clearance of at least 25 mm is maintained between conductors or opposite polarity or phase and between the conductors and any material other than insulation material.

5B.6.8.4 If required, a pilot lamp shall be fixed and connected through an independent single pole switch and fuse to the bus-bars of the board.

5B.6.8.5 In a hinged type board, the incoming and outgoing cables shall be fixed at one or more points according to the number of cables on the back of the board leaving suitable space in between cables, and shall also, if possible, be fixed at the corresponding points on the switchboard panel. The cables between these points shall be of such length as to allow the switchboard panel to swing through on angle of not less than 90°. The circuit breakers in such cases shall be accessible without opening the door of distribution board. Also, circuit breakers or any other equipment (having cable size more than 1.5 sq. mm multi strand wire) shall not be mounted on the door.

NOTE — Use of hinged type boards is discouraged, as these boards lead to deterioration of the cables in the hinged portion, leading to failures or even fire.

5B.6.8.6 Wires terminating and originating from the protective devices shall be properly lugged and taped.

5B.6.9 PVC-Sheathed Wiring System

5B.6.9.1 *General*

Wiring with PVC-sheathed cables is suitable for medium voltage installation and may be installed directly under exposed conditions of sun and rain or damp places.

5B.6.9.2 *PVC Clamps/PVC Channel*

PVC clamps/PVC channel shall conform accepted standards. The clamps shall be used for temporary installations of 1-3 sheathed wires only. The clamps shall be fixed on wall at intervals of 100 mm in the case of horizontal runs and 150 mm in the case of vertical runs.

PVC channel shall be used for temporary installations in case more than 3 wires or wires or unsheathed wires. The channel shall be clamped on wall at intervals not exceeding 300 mm.

5B.6.9.3 *Protection of PVC-Sheathed Wiring from Mechanical Damage*

a) In cases where there are chances of any damage to the wirings, such wirings shall be covered with sheet metal protective covering, the base of which is made flush with the plaster or brickwork, as the case may be, or the wiring shall be drawn through a conduit complying with all requirements of conduit wiring system (see 6.10).

b) Such protective coverings shall in all cases be fitted on all down-drops within 1.5 m from the floor.

5B.6.9.4 *Bends in Wiring*

The wiring shall not in any circumstances be bent so as to form a right angle but shall be rounded off at the corners to a radius not less than six times the overall diameter of the cable.

5B.6.9.5 *Passing Through Floors*

All cables taken through floors shall be enclosed in an insulated heavy gauge steel conduit extending 1.5 m above the floor and flush with the ceiling below, or by means of any other approved type of metallic covering. The ends of all conduits or pipes shall be neatly bushed with porcelain, wood or the approved material.

5B.6.9.6 *Passing Through Walls*

The method to be adopted shall be according to good practice. There shall be one or more conduits of adequate size to carry the conductors [*see***5B.6.10.1(a)**]. The conduits shall be neatly arranged so that the cables enter them straight without bending.

5B.6.9.7 *Stripping of Outer Covering*

While cutting and stripping of the outer covering of the cables, care shall be taken that the sharp edge of the cutting instrument does not touch the rubber or PVC-sheathed insulation of conductors. The protective outer covering of the cables shall be stripped off near connecting terminals, and this protective covering shall be maintained up to the close proximity of connecting terminals as far as practicable. Care shall be taken to avoid hammering on link clips with any metal instruments, after the cables are laid. Where junction boxes are provided, they shall be made moisture-proof with an approved plastic compound.

5B.6.9.8 *Painting*

If so required, the tough rubber-sheathed wiring shall, after erection, be painted with one coat of oil-less paint or distemper of suitable colour over a coat of oil-less primer, and the PVC-sheathed wiring shall be painted with a synthetic enamel paint of quick drying type.

5B.6.10 Conduit Wiring System

5B.6.10.1 *Surface Conduit Wiring System with Rigid Steel Conduits*

a) *Type and size of conduit*— All conduit pipes shall conform to accepted standards, finished with galvanized or stove enameled surface. All conduit accessories shall be of threaded type and under no circumstance pin grip type or clamp type accessories be used. No steel conduit less than 16 mm in diameter shall be used. The number of insulated conductors that can be drawn into rigid conduit are given in Tables 1 and 2.

b) *Bunching of cables*— Unless otherwise specified, insulated conductors of ac supply and dc supply shall be bunched in separate conduits. For lighting and small power outlet circuits phase segregation in separate conduits is recommended.

c) *Conduit joints*— Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. In long distance straight runs of conduit, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and jam-nuts (in the latter case the bare threaded portion shall be treated with anti-corrosive preservative) shall be provided. Threaded on conduit pipes in all cases shall be between 11 mm to 27 mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories. Cut ends of conduit pipes shall have no sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.

d) *Protection against dampness*— In order to minimize condensation or sweating inside the tube, all outlets of conduit system shall be properly drained and ventilated, but in such a manner as to prevent the entry of insects as far as possible.

e) *Protection of conduit against rust*— The outer surface of the conduit pipes, including all bends, unions, tees, conduit system shall be adequately protected against rust particularly when such system is exposed to weather. In all cases, no bare threaded portion of conduit pipe shall be allowed unless such bare threaded portion is treated with anti-corrosive preservative or covered with suitable plastic compound.

f) *Fixing of conduit*— Conduit pipes shall be fixed by heavy gauge saddles, secured to suitable wood plugs or other plugs with screws in an approved manner at an interval in an approved manner at an interval of not more than 1 m, but on either side of couplers or bends or similar fittings, saddles shall be fixed at a distance of 300 mm from the centre of such fittings.

g) *Bends in conduit*— All necessary bends in the system including diversion shall be done by bending pipes; or by inserting suitable solid or inspection type normal bends, elbows or similar fittings; or fixing cast iron, thermoplastic or thermosetting plastic material inspection boxes whichever is more suitable. Conduit fittings shall be avoided as far as possible on conduit system exposed to weather; where necessary, solid type fittings shall be used. Radius of such bends in conduit pipes shall be not less than 75 mm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet, the bends at the outlets not being counted,

h) *Outlets*— All outlets for fittings, switches, etc, shall be boxes of suitable metal or any other approved outlet boxes for either surface mounting system.

i) *Conductors*— All conductors used in conduit wiring shall preferably be stranded. No single-core cable of nominal cross-sectional area greater than 130 mm^2 enclosed along in a conduit and used for alternating current,

j) *Erection and earthing of conduit*— The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirements as already specified by means of suitable earthing clamp efficiently fastened to conduit pipe in a workman like manner for a perfect continuity between each wire and conduit. Gas or water pipes shall not be used as earth medium. If conduit pipes are liable to mechanical damage they shall be adequately protected.

k) Inspection type conduit fittings, such as inspection boxes, draw boxes, bends, elbows and tees shall be so installed that they can remain accessible for such purposes as to withdrawal of existing cables or the installing of traditional cables.

5B.6.10.2 *Recessed Conduit Wiring System with Rigid Steel Conduit*

Recessed conduit wiring system shall comply with all the requirements for surface conduit wiring system specified in **5B.6.10.1 (a)** to **(j)** and in addition, conform to the requirements specified below:

a) *Making of chase*— The chase in the wall shall be nearly made and be of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of buildings under construction, chases shall be provided. In the wall, ceiling, etc, at the time of their construction and shall be filled up neatly after reaction of conduit and brought to the original finish of the wall. In case of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

b) *Fixing of conduit in chase*— The conduit pipe shall be fixed by means of staples or by means of saddles not more than 600 mm apart. Fixing of standard bends or elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with a long radius which will permit easy drawing-in of conductors. All threaded joints of rigid steel conduit shall be treated with preservative compound to secure protection against rust.

c) *Inspection boxes*— Suitable inspection boxes shall be provided to permit periodical inspection and to facilitate removal of wires, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers. The minimum sizes of inspection boxes shall be75 mm x 75 mm.

d) *Types of accessories to be used*— All outlet, such as switches and wall sockets, may be either of flush mounting type or of surface mounting type.

    1) *Flush mounting type*— All flush mounting outlets shall be of cast-iron or mild steel boxes with a cover of insulating material or shall be a box made of a suitable insulating material. The switches and other outlets shall be mounted on such boxes. The metal box shall be efficiently earthed with conduit by a suitable means of earth attachment.

    2) The switches/socket outlets shall be adequately rated IP for various utilizations.

    3) *Surface mounting type*— If surface mounting type outlet box is specified, it shall be of any suitable insulating material and outlets mounted in an approved manner.

5B.6.10.3 *Conduit Wiring System with Rigid Non-Metallic Conduits*

Rigid non-metallic conduits are used for surface, recessed and concealed conduit wiring. Cable trunking and ducting system of insulating material are used for surface wiring.

5B.6.10.3.1 *Type and size*

All non-metallic conduits used shall conform to accepted standards. The conduit may be either threaded type or plain type in accordance with accepted standards and shall be used with the corresponding accessories. The conduits shall be circular or rectangular cross-sections.

5B.6.10.3.2 *Bunching of cables*

Conductors of ac supply and dc supply shall be bunched in separate conduits. For lighting and small power outlet circuits phase segregation in separate circuits is recommended. The number of insulated cables that may be drawn into the conduits are given in **Table 1** and **Table 2**. In these tables the space factor does not exceed 40 percent.

5B.6.10.3.3 *Conduit joints*

Conduits shall be joined by means of screwed or plain couplers depending on whether the conduits are screwed or plain. Where there are long runs of straight conduit, inspection type couplers shall be provided at intervals. For conduit fittings and accessories reference may be made to the Standard practice.

Table 1: Maximum Permissible Number of Single-Core Cables up to and Including 1100 V that can be Drawn into Rigid Steel and Rigid Non-Metallic Conduits

(Clauses 5B.6.10.1 and 5B.6.10.3.2)

Sl No.	Size of Cable		Size of Conduit mm													
	Nominal Cross-Sectional Area mm^2	Number and Diameter (in mm) of Wires	16		20		25		32		40		50		63	
			Number of Cables, *Max*													
			S	B	S	B	S	B	S	B	S	B	S	B	S	B
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
i)	1.0	1/1.12 [1)]	5	4	7	5	13	10	20	14	—	—	—	—	—	—
ii)	1.5	1/1.40	4	3	7	5	12	10	20	14	—	—	—	—	—	—
iii)	2.5	1/1.80 3/1.06 [1)]	3	2	6	5	10	8	18	12	—	—	—	—	—	—
iv)	4	1/2.24 7/0.85 [1)]	3	2	4	3	7	5	12	10	—	—	—	—	—	—
v)	6	1/2.80 7/1.06 [1)]	2	—	3	2	6	5	10	8	—	—	—	—	—	—
vi)	10	1/3.55 [2)]	—	—	2	—	5	4	8	7	—	—	—	—	—	—
		7/1.40 [1)]	—	—	2	—	4	3	6	5	8	6	—	—	—	—
vii)	16	7/1.70	—	—	—	—	2	—	4	3	7	6	—	—	—	—
viii)	25	7/2.24	—	—	—	—	—	—	3	2	5	4	8	6	9	7
ix)	35	7/2.50	—	—	—	—	—	—	2	—	4	3	7	5	8	6
x)	50	19/1.80 7/3.007 [2)]	—	—	—	—	—	—	—	—	2	—	5	4	6	5

NOTES

1 The table shows the maximum capacity of conduits for the simultaneously drawing of cables. The columns headed S apply to runs of conduit which have distance not exceeding 4.25 m between draw-in boxes, and which do not deflect from the straight by an angle of more than 15°. The columns headed B apply to runs of conduit which deflect from the straight by an angle of more than 15°.

2 In case an inspection type draw-in box has been provide and if first drawn through one straight conduit, then through the draw in box, and then through the second straight conduit, such systems may be considered as that of a straight conduit even if the conduit deflects through the straight by more than 15°.

3 Conductor sizes for cables and wires above and including 2.5 mm^2 core size shall be multi-stranded.

1) For copper conductor only.

2) For aluminium conductors only.

Table 2: Maximum Permissible Number of Single-Core Cables that can be Drawn into Cable Tunneling/Trunking and Ducting System (Casing and Capping)

(Clauses 5B.6.10.1 and 5B.6.10.3.2)

Nominal Cross-Sectional Area of Conductor in mm^2	**10/15mm x 10mm**	**20mm x 10mm**	**25mm x 10mm**	**30mm x 10mm**	**40mm x 20mm**	**50mm x 20mm**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.5	3	5	6	8	12	18
2.5	2	4	5	6	9	15
4	2	3	4	5	8	12
6	-	2	3	4	6	9
10	-	1	2	3	5	8
16	-	-	1	2	4	6
25	-	-	-	1	3	5
35	-	-	-	-	2	4
50	-	-	-	-	1	3
70	-	-	-	-	1	2

5B.6.10.3.4 *Fixing of conduits*

The provisions of **5B.6.10.1(f)** shall apply except that the spacing between saddles or supports is recommended to be 600 mm for rigid non-metallic conduits.

5B.6.10.3.5 *Bends in conduits*

Wherever necessary, bends or diversions may be achieved by bending the conduits (*see* **5B.6.10.3.8)** or by employing normal bends, inspection bends, inspection boxes, elbows or similar fittings.

5B.6.10.3.6 Conduit fittings shall be avoided, as far as possible, on outdoor systems

5B.6.10.3.7 *Outlets*

In order to minimize condensation or sweating inside the conduit, all outlets of conduit system shall be properly drained and ventilated, but in such a manner as to prevent the entry of insects.

5B.6.10.3.8 Heat may be used to soften the conduit for bending and forming joints in case of plain conduits. As the material softens when heated, sitting of conduit in close proximity to hot surfaces should be avoided. Caution should be exercised in the use of this conduit in locations where the ambient temperature is 50°C or above. Use of such conduits in places where ambient temperature is 60°C or above is prohibited.

5B.6.10.3.9 Non-metallic conduit systems shall be used only where it is ensured that they are:

a. suitable for the extremes of ambient temperature to which they are likely to be subjected in service,

b. resistant to moisture and chemical atmospheres, and

c. resistant to low temperature and sunlight effects.

For use underground, the material shall be resistant to moisture and corrosive agents.

NOTE — Rigid PVC conduits are not suitable for use where the normal working temperature of the conduits and fittings may exceed 55°C. Certain types of rigid PVC conduits and their associated fittings are unsuitable for use where the ambient temperature is likely to fall below -5°C.

5B.6.10.4 *Non-Metallic Recessed Conduit Wiring System*

5B.6.10.4.1 Recessed non-metallic conduit wiring system shall comply with all the requirements of surface nonmetallic conduit wiring system specified in **5B.6.10.3.1**to **5B.6.10.3.9** except **5B.6.10.3.4**. In addition, the following requirements **5B.6.10.4.2** to **5B.6.10.4.5** also shall be complied with.

5B.6.10.4.2 *Fixing of conduit in chase*

The conduit pipe shall be fixed by means of stapples or by means of non-metallic saddles placed at not more than 800 mm apart or by any other approved means of fixing. Fixing of standard bends or elbows shall be avoided as far as practicable and all curves shall be maintained by sending the conduit pipe itself with along radius which will permit easy drawing in of conductors. At either side of bends, saddles/stapples shall be fixed at a distance of 150 mm from the centre of bends.

5B.6.10.4.3 *Inspection boxes*

Suitable inspection boxes to the nearest minimum requirements shall be provided to permit periodical inspection and to facilitate replacement of wires, if necessary. The inspection/junction boxes shall be mounted flush with the wall or ceiling concrete. Where necessary deeper boxes of suitable dimensions shall be used. Suitable ventilating holes shall be provided in the inspection box covers, where required.

5B.6.10.4.4 The outlet boxes such as switch boxes, regulator boxes and their phenolic laminated sheet covers shall be as per requirements of **5B.6.10.1(h),**

They shall be mounted flush with the wall.

5B.6.10.4.5 *Types of accessories to be used*

All outlets such as switches, wall sockets, etc, maybe either flush mounting type or of surface mounting type.

5B.7 FITTINGS AND ACCESSORIES

5B.7.1 Ceiling Roses and Similar Attachments

5B.7.1.1A ceiling rose or any other similar attachment shall not be used on a circuit the voltage of which normally exceeds 250 V.

5B.7.1.2 Normally, only one flexible cord shall be attached to a ceiling rose. Specially designed ceiling roses shall be used for multiple pendants.

5B.7.1.3A ceiling rose shall not embody fuse terminal as an integral part of it.

5B.7.2 Socket-Outlets and Plugs

Each 16A socket-outlet provided in buildings for the use of domestic appliances such as air conditioner, water cooler, etc, shall be provided with its own individual fuse, with suitable discrimination with backup fuse or miniature circuit-breaker provided in the distribution/sub-distribution board. The socket-outlet shall not necessarily embody the fuse as an integral part of it.

5B.7.2.1 Each socket-outlet shall also be controlled by a switch which shall preferably be located immediately adjacent there to or combined there with**.**

5B.7.2.2 The switch controlling the socket-outlet shall be on the live side of the line.

5B.7.2.3 Ordinary socket-outlet may be fixed at any convenient place at a height above 200mm from the floor level and shall be away from danger of mechanical injury.

NOTE — In situations where a socket-outlet is accessible to children, it is necessary to install an interlocked plug and socket or alternatively a socket-outlet which automatically gets screened by the withdrawal of plug. In industrial premises socket-outlet of rating 20 A and above shall preferably be provided with interlocked type switch.

5B.7.2.4 In an earthed system of supply, a socket-outlet with plug shall be of three-pin type with the third terminal connected to the earth. When such socket outlets with plugs are connected to any current consuming device of metal or any non-insulating material or both, conductors connecting such current consuming devices shall be of flexible cord with an earthing core and the earthing core shall be secured by connecting between the earth terminal of plug and the body of current-consuming devices.

In industrial premises three-phase and neutral socket-outlets shall be provided with a earth terminal either of pin type or scrapping type in addition to the main pins required for the purpose.

5B.7.2.5 In wiring installations, metal clad switch, socket outlet and plugs shall be used for power wiring.

NOTE —A recommended schedule of socket-outlets in a residential building is given below:

Sl No.	*Location*	*Number of 6 A Socket-Outlets*	*Number of 16 A Socket-Outlets*
(1)	(2)	(3)	(4)
i)	Bed room	2 to 6	2
ii)	Living room	2 to 4	2
iii)	Kitchen	2 to 8	2
iv)	Dining room	2 to 4	2
v)	Garage	1	1
vi)	For refrigerator	—	1
vii)	For air conditioner	—	1 for each
viii)	*Verandah*	1 per 10 m^2	1
ix)	Bathroom	1	1

5B.7.3 Lighting Fittings

5B.7.3.1 A switch shall be provided for control of every lighting fitting or a group of lighting fittings. Where control at more than one point is necessary as many two way or intermediate switches may be provided as there are control points.

5B.7.3.2 In industrial premises lighting fittings shall be supported by suitable pipe/conduits, brackets fabricated from structural steel, steel chains or similar materials depending upon the type and weight of the fittings.

5B.7.3.3 No flammable shade shall form a part of lighting fittings unless such shade is well protected against all risks of fire. Celluloid shade or lighting fittings shall not be used under any circumstances.

5B.7.3.4 General and safety requirements for electrical lighting fittings shall be in accordance with Standard practice.

5B.7.3.5 The lighting fittings shall conform to accepted standards.

5B.7.4 Fitting-Wire

The use of fittings-wire shall be restricted to the internal wiring of the lighting fittings. Where fittings-wire is used for wiring fittings, the sub-circuit loads shall terminate in a ceiling rose or box with connectors from which they shall be carried into the fittings.

5B.7.5 Lamp holders

Lamp holders for use on brackets and the like shall be in accordance with accepted standards and all those for use with flexible pendants shall be provided with cord grips. All lamp holders shall be provided with shade carriers. Where centre-contact Edison screw lamp holders are used, the outer or screw contacts shall be connected to the 'middle wire', the neutral, the earthed conductor of the circuit.

5B.7.6 Outdoor Lamps

External and road lamps shall have weatherproof fittings of approved design so as to effectively prevent the ingress of moisture and dust. Flexible cord and cord grip lamp holders shall not be used where exposed to weather. In VERANDAHS and similar exposed situations where pendants are used, these shall be of fixed rod type.

5B.7.7 Lamps

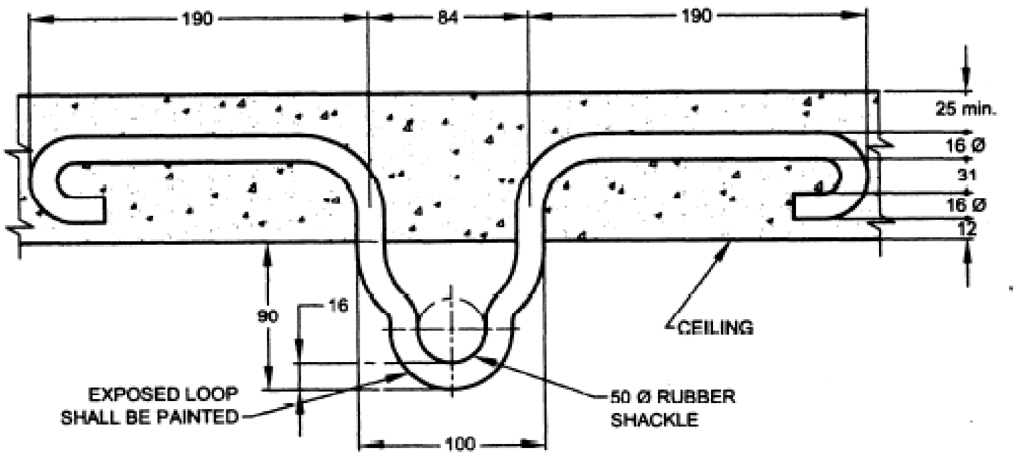
All lamps unless otherwise required and suitably protected, shall be hung at a height of not less than2.5 m above the floor level. All electric lamps and accessories shall conform to accepted standards

a) Portable lamps shall be wired with flexible cord. Hand lamps shall be equipped with a handle of moulded composition or other material approved for the purpose. Hand lamps shall be equipped with a substantial guard attached to the lamp holder or handle. Metallic guards shall be earthed suitably.

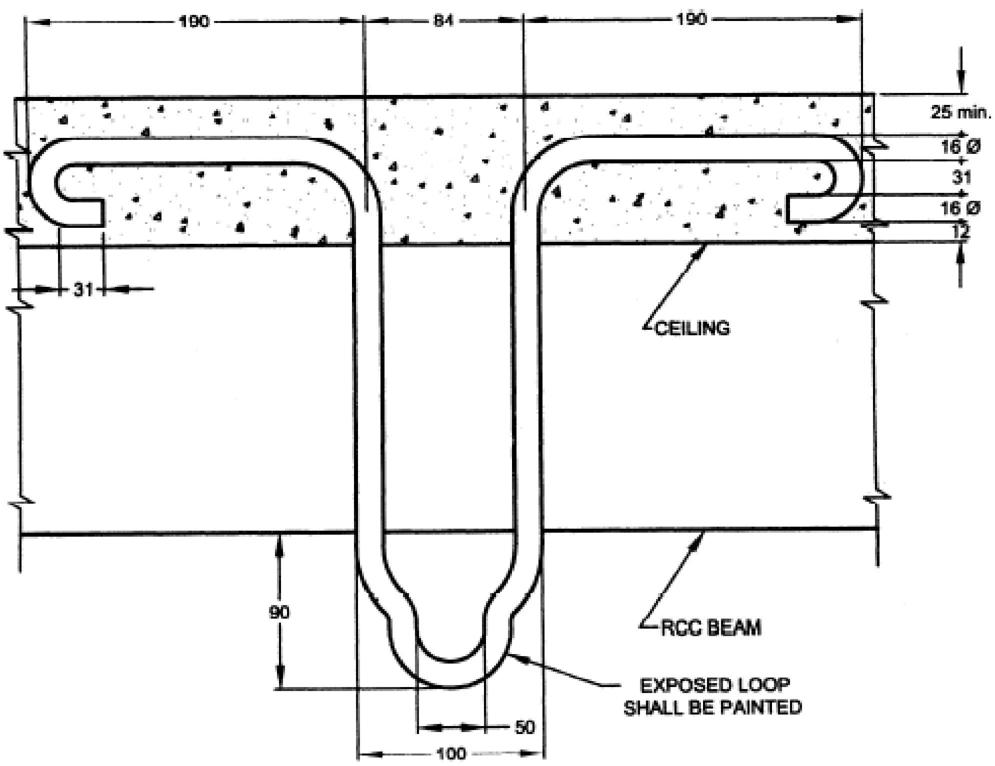
b) A bushing or the equivalent shall be provided where flexible cord enters the base or stem of portable lamp. The bushing shall be of insulating material unless a jacketed type of cord is used.

c) All wiring shall be free from short-circuits and shall be tested for these defects prior to being connected to the circuit.

d) Exposed live parts within porcelain fixtures shall be suitably recessed and so located as to make it improbable that wires will come in contact with them. There shall be a spacing of at least 125 mm between live parts and the mounting plane of the fixture.



2A SLAB



2B SLAB WITH BEAM

a) All dimensions in millimeters

NOTES

1) RCC slab steel reinforcement not shown.

2) Fan clamp shall be placed in position such that its projecting arms in the line of length of beam.

Figure 2: Typical Design of Fan Clamps

5B.7.8 Fans, Regulators and Clamps

5B.7.8.1 *Ceiling Fans*

Ceiling fans including their suspension shall conform to accepted standards and to the following requirements:

a) Control of a ceiling fan shall be through its own regulator as well as a switch in series.

   All ceiling fans shall be wired with normal wiring to ceiling roses or to special connector boxes to which fan rod wires shall be connected and suspended from hooks or shackles with insulators between hooks and suspension rods. There shall be no joint in the suspension rod,

   but if joints are unavoidable then such joints shall be screwed to special couplers of 5 cm minimum length and both ends of the pipes shall touch together within the couplers, and shall in addition be secured by means of split pins; alternatively, the two pipes may be welded. The suspension rod shall be of adequate strength to withstand the dead and impact forces imposed on it. Suspension rods should preferably be procured along with the fan.

b) Fan clamps shall be of suitable design according to the nature of construction of ceiling on which these clamps are to be fitted. In all cases fan clamps shall be fabricated from new metal of suitable sizes and they shall be as close fitting as possible. Fan clamps for reinforced concrete roofs shall be buried with the casting and due care shall be taken that they shall serve the purpose. Fan clamps for wooden beams, shall be of suitable flat iron fixed on two sides of the beam and according to the size and section of the beam one or two mild steel bolts passing through the beam shall hold both flat irons together. Fan clamps for steel joist shall be fabricated from flat iron to fit rigidly to the bottom flange of the beam. Care shall be taken during fabrication that the metal does not crack while hammer to shape. Other fan clamps shall be made to suit the position, but in all cases, care shall be taken to see that they are rigid and safe.

c) Canopies on top and bottom of suspension rods shall effectively conceal suspensions and connections to fan motors, respectively.

d) The lead-in-wire shall be of nominal cross-sectional area not less than 1.5 mm^2 copper and shall be protected from abrasion.

e) Unless otherwise specified, the clearance between the bottom most point of the ceiling fan and the floor shall be not less than 2.4 m. The minimum clearance between the ceiling and the plane of the blades shall be not less than 300 mm**.**

Atypical arrangement of a fan clamp is given in Figure 2.

NOTE – All fan clamps shall be so fabricated that fans revolve steadily**.**

5B.7.8.2 *Exhaust fans*

For fixing of an exhaust fan, a circular hole shall be provided in the wall to suit the size of the frame which shall be fixed by means of rag-bolts embedded in the wall. The hole shall be nearly plastered with cement and brought to the original finish of the wall. The exhaust fan shall be connected to exhaust fan point which shall be wired as near to the hole as possible by means of a flexible cord, care being taken that the blades rotate in the proper direction.

5B.7.9 Attachment of Fittings and Accessories

5B.7.9.1 In wiring other than conduit wiring, all ceiling roses, brackets, pendants and accessories attached to walls or ceilings shall be mounted on substantial teakwood blocks twice varnished after all fixing holes are made in them. Blocks shall not be less than 40 mm deep. Brass screws shall only be used for attaching fittings and accessories to their base blocks.

5B.7.9.2 Where teak or hardwood boards are used for mounting switches, regulators, etc, these boards shall be well varnished with pure shellac on all four sides (both inside and outside), irrespective of being painted to match the surroundings. The size of such boards shall depend on the number of accessories that could conveniently and neatly be arranged. Where there is danger of attack by white ants, the boards shall be treated with suitable anti-termite compound and painted on both sides.

5B.7.10 Interchangeability

Similar part of all switches, lamp holders, distribution fuse-boards, ceiling roses, brackets, pendants, fans and all other fittings shall be so chosen that they are of the same type and interchangeable in each installation.

5B.7.11 Equipment

Electrical equipment which form integral part of wiring intended for switching or control or protection of wiring installations shall conform to the relevant Standards wherever they exist.

5B.7.12 Fannage

5B.7.12.1 Where ceiling fans are provided, the bay sizes of a building, which control fan point locations, play an important part.

5B.7.12.2 Fans normally cover an area of 9 m^2 to 10 m^2 and therefore in general purpose office buildings, for every part of a bay to be served by the ceiling fans, it is necessary that the bays shall be so designed that full number of fans could be suitably located for the bay, otherwise it will result in ill-ventilated pockets. In general, fans in long halls may be spaced at 3 m in both the directions. If building modules do not lend themselves for proper positioning of the required number of ceiling fans, such as air circulators or bracket fans would have to be employed for the areas uncovered by the ceiling fans. For this, suitable electrical outlets shall be provided although result will be disproportionate to cost on account of fans.

5B.7.12.3 Proper air circulation could be achieved either by larger number of smaller fans or smaller number of larger fans. The economics of the system as a whole should be a guiding factor in choosing the number and type of fans and their locations.

5B.7.12.4 Exhaust fans are necessary for spaces, such as community toilets, kitchens and canteens, and godowns to provide the required number of air changes.

5B.7.12.5 Positioning of fans and light fittings shall be chosen to make these effective without causing shadows and stroboscopic effect on the working planes.

5B.8 EARTHING

5B.8.1 General

Earthing shall generally be carried out in accordance with the requirements of Myanmar Electricity Rules.

The main earthing system of an electrical installation must consist of:

a) An earth electrode;

b) A main earthing wire;

c) An earth bar (located on the main switchboard) for the connection of the main earthing wire, protective earthing wires and/or bonding wires within the installation; and

d) A removable link, which effectively disconnects the neutral bar from the earth bar.

NOTE — The requirements of (c) and (d) above must be carried out by the licensed electrician as part of the switchboard installation.

The main earthing wire termination must be readily accessible at the earth electrode.

The main earthing wire connection must:

a) be mechanically and electrically sound;
b) be protected against damage, corrosion, and vibration;
c) not place any strain on the various parts of the connection;
d) not damage the wire or fittings; and
e) be secured at the earth electrode

Use a permanent fitting (like a screwed-down plastic label or copper label, or one that can be threaded onto the cable) at the connection point that is clearly marked with the words: "EARTHING LEAD — DO NOTDISCONNECT" or "EARTHING CONDUCTOR —DO NOT DISCONNECT".

5B.8.1.1 All low voltage equipment shall be earthed by two separate and distinct connections with earth.

Low voltage systems of 400/230 V, 4-wire,3-phase, systems are normally operated with the neutral solidly earthed at source. At low voltage, Myanmar Electricity Regulations require that the neutral be earthed by two separate and distinct connections with earth. Source in the case of a substation (such as 11 kV/400 V) would be the neutral(s) of the transformer(s). Neutral conductor of half the size of the phase conductor was permitted in earlier installations. But with the proliferation of equipment using non-linear devices and consequent increase in harmonics, the neutral will carry a current more than the notional out-of-balance current and as such neutral conductor shall be of the same size as the phase conductor.

In the case of medium and high voltages, the neutral points shall be earthed by not less than two separate and distinct connections with earth, each having its own electrode at the generating station or substation and may be earthed at any other point provided no interference is caused by such earthing. The neutral may be earthed through suitable impedance. Neutral earthing conductor shall be sized at to have a current carrying capacity not less than the phase current.

5B.8.1.2 As far as possible, all earth connections shall be visible for inspection.

5B.8.1.3 Earth system shall be so devised that the testing of individual earth electrode is possible. It is recommended that the value of any earth system resistance shall be such as to conform with the degree of shock protection desired.

5B.8.1.4 It is recommended that a drawing showing the main earth connection and earth electrodes be prepared for each installation.

5B.8.1.5 No addition to the current-carrying system, either temporary or permanent, shall be made which will increase the maximum available earth fault current or its duration until it has been ascertained that the existing arrangement of earth electrodes, earth busbar, etc, are capable of carrying the new value of earth fault current which may be obtained by this addition.

5B.8.1.6 No cut-out, link or switch other than a linked switch arranged to operate simultaneously on the earthed or earthed neutral conductor and the live conductors, shall be inserted on any supply system. This, however, does not include the case of a switch for use in controlling a generator or a transformer or a link for test purposes.

5B.8.1.7 All materials, fittings, etc, used in earthing shall conform to Standard specifications, wherever these exist.

5B.8.1.8 Earthing associated with current-carrying conductor is normally essential for the security of the system and is generally known as system earthing, while earthing of non-current carrying metal work and conductor is essential for the safety of human life, of animals and of property and it is generally known as equipment earthing.

5B.8.2 Earth Electrodes

Earth electrode either in the form of pipe electrode or plate electrode should be provided at all premises for providing an earth system. Details of typical pipe and plate earth electrodes are given in **Fig.3** and **Fig.4.**

Although electrode material does not affect initial earth resistance, care should be taken to select a material which is resistant to corrosion in the type of soil in which it is used. Under ordinary conditions of soil, use of copper, iron or mild steel electrodes is recommended. In case where soil condition leads to excessive corrosion of the electrode, and the connections, it is recommended to use either copper electrode or copper clad electrode or zinc coastal galvanized iron electrode. The electrode shall be kept free from paint, enamel and grease. It is recommended to use similar material for earth electrodes and earth conductors or otherwise precautions should be taken to avoid corrosion.

5B.8.3 As far as possible, all earth connections shall be visible for inspection and shall be carefully made; if they are poorly made or inadequate for the purpose for which they are intended, loss of life and property or serious personal injury may result.

To obtain low overall resistance the current density should be as low as possible in the medium adjacent to the electrodes; which should be so designed as to cause the current density to decrease rapidly with distance from the electrode. This requirement is met by making the dimensions in one direction large compared with those in the other two, thus a pipe, rod or strip has a much lower resistance than a plate of equal surface area. The resistance is not, however, inversely proportional to the surface area of the electrode.

5B.8.4 Equipment and Portions of Installations which shall be Earthed

5B.8.4.1 *Equipment to be Earthed*

Except for equipment provided with double insulation, all the non-current carrying metal parts of electrical installations are to be earthed properly. All metal conduits, trunking, cable sheaths, switchgear, distribution fuse boards, lighting fittings and all other parts made of metal shall be bent together and connected by means of two separate and distinct conductors to an efficient earth electrode.

5B.8.4.2 *Structural Metal Work*

Earthing of the metallic parts shall not be effected through any structural metal work which houses the installation. Where metallic parts of the installation are not required to be earthed and are liable to become alive should the insulations of conductors become defective, such metallic parts shall be separated by durable non-conducting material from any structural work.

5B.8.5 Neutral Earthing

To comply with Myanmar Electricity Rules no fuses or circuit breakers other than a linked circuit breaker shall inserted in an earthed neutral conductor, a linked switch or linked circuit breaker shall be arranged to break or the neutral either with or after breaking all the related phase conductors and. shall positively make (or close) the neutral before making (or closing) the phases.

If this neutral point of the supply system is connected permanently to earth, then the above rule applies throughout the installation including 2-wire final circuits. This means that no fuses may be inserted in the neutral or common return wire. And the neutral should consist of a bolted solid link, or part of a linked switch, which completely disconnects the whole system from the supply. This linked switch must be arranged so that the neutral makes before, and break after the phases.

5B.8.6 System of Earthing

Equipment and portions of installations shall be deemed to be earthed only if earthed in accordance with either the direct earthing system, the multiple earthed neutral system or the earth leakage circuit breaker system. In all cases, the relevant provisions of Myanmar Electricity Rules shall be complied with.

The earthing of electrical installations for nonindustrial and industrial buildings shall be done in accordance with Standard practice (BS 7671).

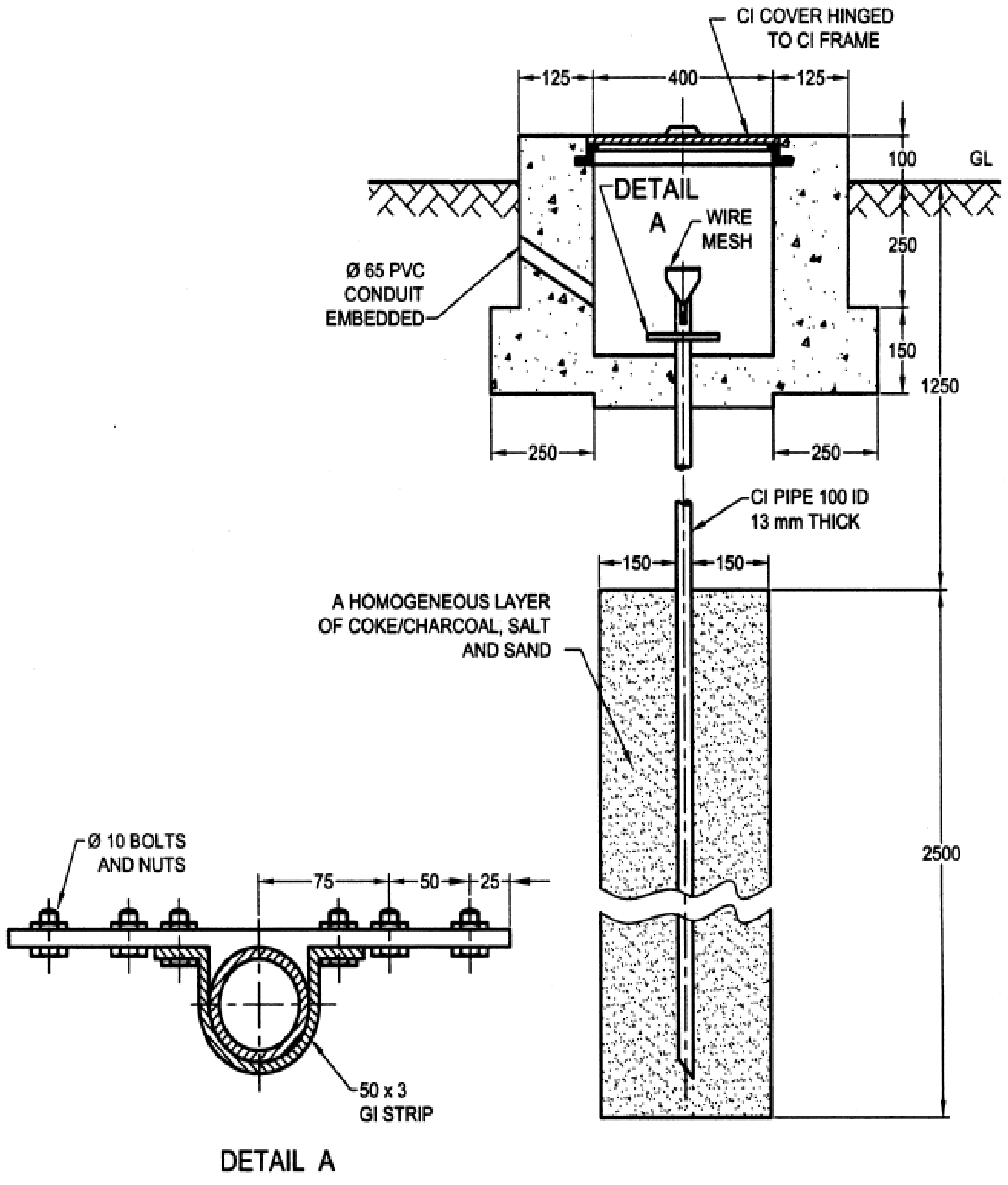
5B.8.7 Classification of Earthing System

The earthing systems are classified as follows:

a) *TN System*— A system which has one or more points of the source of energy directly earth, and the exposed and extraneous conductive parts of the installation are connected by means of protective conductors to the earth points of the source, that is, currents to flow from the installation to the earth points of the source.

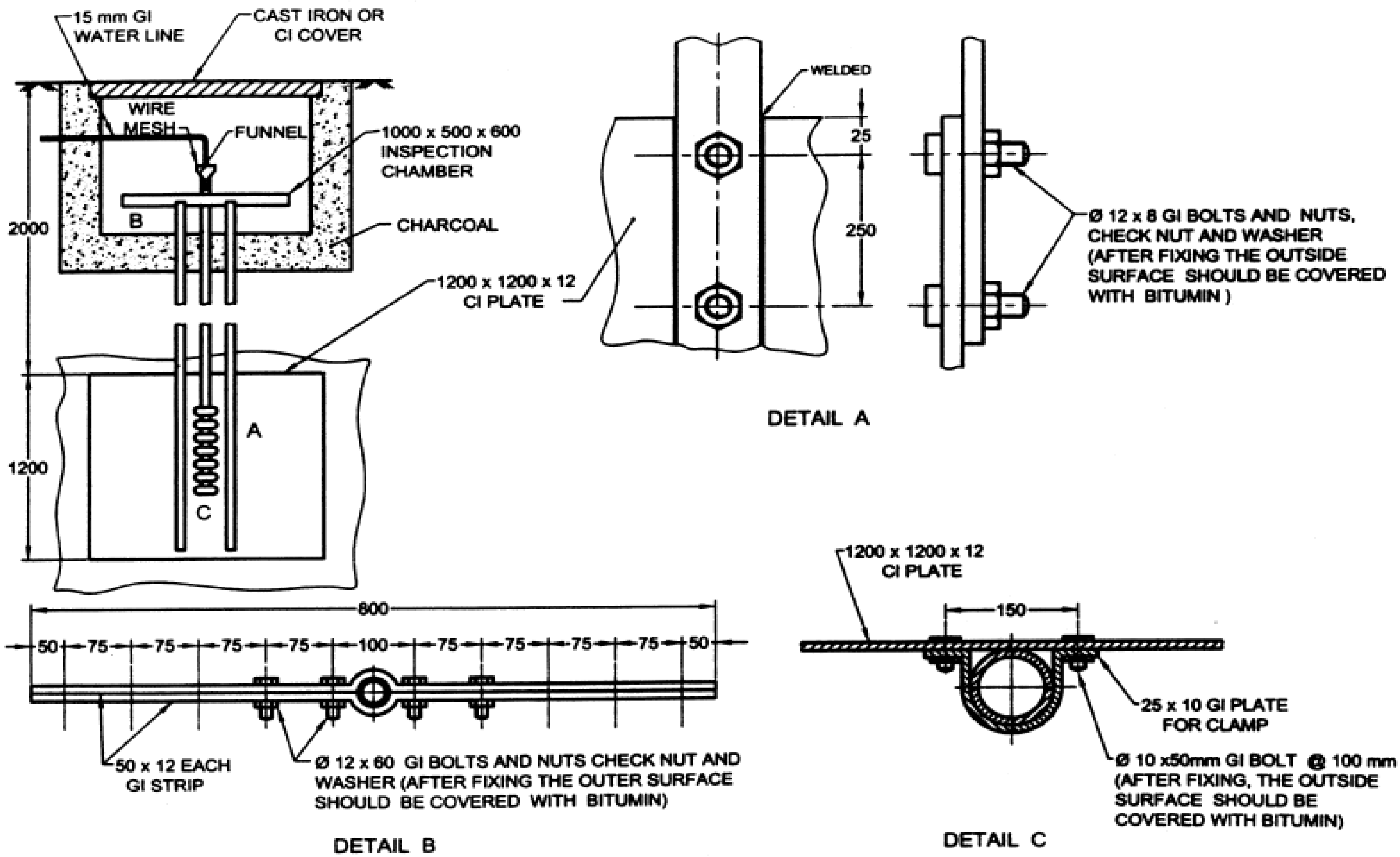
b) *TT System*— A system which has one or more points of the source of energy directly earth, and the exposed and extraneous conductive parts of the installation are connected to a local earth electrodes or electrodes electrically independent of the source earth.

IT System— A system which has source either unearthed or earthed through a high impedance and the exposed conductive parts of the installations are connected to electrically independent earth electrodes.



All dimensions in millimeters

Fig. 3 Typical Arrangement of Pipe Earthing



All dimensions in millimeters

Fig .4 Typical Arrangement of Plate Earthing

5B.9 INSPECTION, TESTING AND VERIFICATION OF INSTALLATION

5B.9.1 General Requirements

5B.9.1.1 Before the completed installation, or an addition to the existing installation, is put into service, inspection and testing shall be carried out in accordance with the Myanmar Electricity Rules. In the event of defects being found, these shall be rectified, as soon as practicable and the installation retested.

5B.9.1.2 Periodic inspection and testing shall be carried out in order to maintain the installation in a sound condition after putting into servic**e.**

5B.9.1.3 Where an addition is to be made to the fixed wiring of an existing installation, the latter shall be examined for compliance with the recommendations of the Code.

5B.9.1.4 The individual equipment and materials which form part of the installation shall generally conform to the relevant Standard Specification wherever applicable.

5B.9.1.5 *Completion Drawings*

On completion of the electric work, a wiring diagram shall be prepared and submitted to the engineer-incharge or the owner. All wiring diagrams shall indicate clearly, the main switch board, the runs of various mains and submains and the position of all points and their controls. All circuits shall be clearly indicated and numbered in the wiring diagram and all points shall be given the same number as the circuit in which they are electrically connected. Also the location and number of earth points and the run of each load should be clearly shown in the completion drawings.

5B.9.2 Inspection of the Installation

5B.9.2.1 *General*

On completion of wiring a general inspection shall be carried out by competent personnel in order to verify that the provisions of this Code and that of Myanmar Electricity Rules, have been complied with. This, among other things, shall include checking whether all equipments, fittings, accessories, wires/cables, used in the installation are of adequate rating and quality to meet the requirement of the load. General workmanship of the electrical wiring with regard to the layout and finish shall be examined for neatness that would facilitate easy identification of circuits of the system, adequacy of clearances, soundness, contact pressure and contact area. A complete check shall also be made of all the protective devices, with respect to their ratings, range of settings and co-ordination between the various protective devices.

5B.9.2.2 *Item to be Inspected*

5B.9.2.2.1 *Substation installations*

In substation installation, it shall be checked whether:

1) The installation has been carried out in accordance with the approved drawings;
2) Phase-to-phase and phase to earth clearances are provided as required;
3) All equipments are efficiently earthed and properly connected to the required number of earth electrodes;
4) The required ground clearance to live terminals is provided;
5) Suitable fencing is provided with gate with lockable arrangements;
6) The required number of caution boards fire-fighting equipments, operating rods, rubber mats, etc, are kept in the substation;
7) In case of indoor substation sufficient ventilation and draining arrangements are made;

8) All cable trenches are provided with non-inflammable covers;
9) Free accessibility is provided for all equipments for normal operation;
10) All name plates are fixed and the equipments are fully painted;
11) All construction materials and temporary connections are removed;
12) Oil-level, busbar tightness, transformer tap position, etc, are in order;
13) Earth pipe troughs and cover slabs are provided for earth electrodes/earth pits and the neutral and LA earth pits are marked for easy identification;
14) Earth electrodes are of GI pipes or CI pipes or copper plates. For earth connections, brass bolts and nuts with lead washers are provided in the pipes/plates;
15) Earth pipe troughs and oil sumps/pits are free from rubbish and dirt and stone jelly and the earth connections are visible and easily accessible;
16) HT and LT panels switchgears are all vermin and damp-proof and all unused openings or holes are blocked properly;
17) The earth bus bars have tight connections and corrosion-free joint surfaces;
18) Operating handle of protective devices are provided at an accessible height from ground;
19) Adequate headroom is available in the transformer room for easy topping-up of oil, maintenance, etc;
20) Safety devices, horizontal and vertical barriers, bus bar covers/shrouds, automatic safety shutters/doors interlock, handle interlock are safe and in reliable operation in all panels and cubicles;
21) Clearances in the front, rear and sides of the main MV and LV and sub-switch boards are adequate;
22) The switches operate freely; the 3 blades make contact at the same time, the arcing horns contact in advance; and the handles are provided with locking arrangements;
23) Insulators are free from cracks, and are clean;
24) In transformers, there is any oil leak;
25) Connections to bushing in transformers for tightness and good contact;
26) Bushings are free from cracks and are clean;
27) Accessories of transformers like breathers, vent pipe, Buchholz relay, etc, are in order;
28) Connections to gas relay in transformers are in order;
29) Oil and winding temperature are set for specific requirements in transformers;
30) In case of cable cellars, adequate arrangements to pump out water that has entered due to seepage or other reasons;
31) All incoming and outgoing circuits of MV and LV panels are clearly and indelibly labeled for identifications;
32) No cable is damaged;
33) There is adequate clearance around the equipments installed; and
34) Cable terminations are proper.

5B.9.2.2.2 *Low voltage installation*

In low voltage installations, it shall be checked whether:

1) All blocking materials that are used for safe transportation in switchgears, contactors, relays, etc, are removed;
2) All connections to be earthing system are feasible for periodical inspection;
3) Sharp cable bends are avoided and cables are taken in a smooth manner in the trenches or alongside the walls and ceilings using suitable support clamps at regular intervals;
4) Suitable linked switch or circuit breaker or lockable push button is provided near the motors/apparatus for controlling supply to the motor/apparatus in an easily accessible location;
5) Two separate and distinct earth connections are provided for the motor/apparatus;
6) Control switch-fuse is provided at an accessible height from ground for controlling supply to overhead travelling crane, hoists, overhead bus bar trunking;
7) The metal rails on which the crane travels are electrically continuous and earthed and bonding of rails and earthing at both ends are done;
8) Four core cables are used for overhead travelling crane and portable equipments, the fourth core being used for earthing, and separate supply for lighting circuit is taken;
9) If flexible metallic hose is used for wiring to motors and other equipment, the wiring is enclosed to the full lengths, and the hose secured properly by approved means;
10) The cables are not taken through areas where they are likely to be damaged or chemically affected;
11) The screens and armours of the cables are earthed properly;
12) The belts of the belt driven equipments are properly guarded;
13) Adequate precautions are taken to ensure that no live parts are so exposed as to cause danger;
14) Ammeters and voltmeters are tested;
15) The relays are inspected visually by moving covers for deposits of dusts or other foreign matter;
16) Wherever bus ducts/rising mains/overhead bus trunking are used, special care should be taken for earthing the system. All tap off points shall be provided with adequately rated protective device like MCB, MCCB, fuses, RCCB / RCD, SPD etc;
17) All equipments shall be weather, dust and vermin proof; and
18) Any and all equipments having air insulation as media shall maintain proper distances between phases; phase to neutral; phase to earth and earth to neutral.

5B.9.2.2.3 *Overhead lines*

For overhead lines it shall be checked whether:

1) All conductors and apparatus including live parts thereof are inaccessible;
2) The types and size of supports are suitable for the overhead lines/conductors used and are in accordance with approved drawing and standards;
3) Clearances from ground level to the lowest conductor of overhead lines, sag conditions, etc, are in accordance with the relevant standard;

4) Where overhead lines cross the roads or cross each other or are in proximity with one another, suitable guarding is provided at road crossings and also to protect against possibility of the lines coming in contact with one another;
5) Every guard wire is properly earthed;
6) The type, size and suitability of the guarding arrangement provided is adequate;
7) Stays are provided suitably on the over-headlines as required and are efficiently earthedor provided with suitably stay insulators of suitable voltages;
8) Anti-climbing devices and Danger Board/Caution Board Notices are provided on all HT supports;
9) Clearances along the route are checked and all obstructions such as trees/branches and shrubs are cleared on the route to the required distance on either side;
10) Clearance between the live conductor and the earthed metal parts are adequate;
11) For the service connections tapped-off from the overhead lines, cut-outs of adequate capacity are provided;
12) All insulators are properly and securely mounted; also they are not damaged.
13) All poles are properly grouted/insulated so as to avoid bending of pole towards tension; and
14) Steel poles, if used shall be properly earthed.

5B.9.2.2.4 *Lighting circuits*

The lighting circuits shall be checked whether:

1) Wooden boxes and panels are avoided in factories for mounting the lighting boards and switch controls, etc;
2) Neutral links are provided in double pole switch-fuses which are used for lighting control, and no protective devices (such as MCB, MCCB, fuses, RCCB / RCD, etc) is provided in the neutral;
3) The plug points in the lighting circuit are all of 3-pin type, the third pin being suitably earthed;
4) Tamper-proof interlocked switch socket and plug are used for locations easily accessible;
5) Lighting wiring in factory area is taken enclosed in conduit and conduit properly earthed, or alternatively, armoured cable wiring is used;
6) A separate earth wire is run in the lighting installation to provide earthing for plug points, fixtures and equipments;
7) Proper connectors and junction boxes are used wherever joints are to be made in conductors or crossover of conductors takes place;
8) Cartridge fuse units are fitted with cartridge fuses only;
9) Clear and permanent identification marks are painted in all distribution boards, switchboards, sub-main boards and switches as necessary;
10) The polarity having been checked and all protective devices (such as MCB, MCCB, fuses, RCCB / RCD, etc) and single pole switches are connected on the phase conductor only and wiring is correctly connected to socket outlets;
11) Spare knockouts provided in distribution boards and switch fuses are blocked;
12) The ends of conduits enclosing the wiring leads are provided with ebonite or other suitable bushes;

13) The fittings and fixtures used for outdoor use are all of weather-proof construction, and similarly, fixtures, fittings and switchgears used in the hazardous area, are of flame-proof application;
14) Proper terminal connectors are used for termination of wires (conductors and earth leads) and all strands are inserted in the terminals;
15) Flat ended screws are used for fixing conductor to the accessories;
16) Use of flat washers backed up by spring washers for making end connections is desirable; and
17) All metallic parts of installation such as conduits, distribution boards, metal boxes, etc have been properly earthed.

5B.9.3 Testing of Installation

5B.9.3.1 *General*

After inspection, the following tests shall be carried out, before an installation or an addition to the existing installation is put into service. Any testing of the electrical installation in an already existing installation shall commence after obtaining permit to work from the engineer-in-charge and after ensuring the safety provisions**.**

5B.9.3.2 *Testing*

5B.9.3.2.1 *Switchboards*

MV and LV switchboards shall be tested in the manner indicated below:

a) All medium voltage switchboards shall be tested for dielectric test as per Standard practice.
b) All earth connections shall be checked for continuity.
c) The operation of the protective devices shall be tested by means of secondary or primary injection tests.
d) The operation of the breakers shall be tested from all control stations.
e) Indication/signaling lamps shall be checked for proper working.
f) The operation of the breakers shall be tested for all interlocks.
g) The closing and opening timings of the breakers shall be tested wherever required for auto-transfer schemes.
h) Contact resistance of main and isolator contacts shall be measured.
i) The specific gravity and the voltage of the control battery shall be measured.

5B.9.3.2.2 *Transformers*

Transformers are tested in the manner indicated below:

a) All commissioning tests shall be in accordance with Standard practice.
b) Insulation resistance on MV and LV windings shall be measured at the end of 1 min as also at the end of 10 min of measuring the polarization index. The absolute value of insulation resistance should not be the sole criterion for determining the state of dryness of the insulation. Polarization index values should form the basis for determining the state of dryness of insulation. For any class of insulation, the polarization index should be greater than 1.5.

5B.9.3.2.3 ***Cables***

Cable installations shall be checked as below:

a) It shall be ensured that the cables conform to the relevant Standards. Tests shall also be done in accordance with Standard practice. The insulation resistance before and after the tests shall be checked.

b) The insulation resistance between each conductor and against earth shall be measured. The insulation resistance varies with the type of insulation used and with the length of cable. The following empirical rule gives reasonable guidance:

Insulation resistance in megaohms

$$= \frac{10 \text{ x Voltage in kV}}{\text{Length in km}}$$

c) Physical examination of cables shall be carried out.

d) Cable terminations shall be checked.

e) Continuity test shall be performed before charging the cable with current.

5B.9.3.2.4 *Motors and other equipments*

The following test is made on motor and other equipment:

The insulation resistance of each phase winding against the frame and between the windings shall be measured. Megger of 500 V or 1 000 V rating shall be used. Star points should be disconnected. Minimum acceptable value of the insulation resistance varies with the rated power and the rated voltage of the motor.

The following relation may serve as a reasonable guide:

$$R_i = \frac{20 \times E_n}{1\,000 + 2P}$$

where

R_i = Insulation resistance in megaohms at 25 °C.

E_n = Rated phase to phase voltage.

P = Rated power in kW.

If the resistance is measured at a temperature different from 25°C, the value shall be corrected to25°C.

The insulation resistance as measured at ambient temperature does not always give a reliable value, since moisture might have been absorbed during shipment and storage. When the temperature of such a motor is raised, the insulation resistance will initially drop considerably, even below the acceptable minimum. If any suspicion exists on this score, motor winding must be dried out.

5B.9.3.2.5 *Wiring installation*

The following tests shall be done:

a) The insulation resistance shall be measured by applying between earth and the whole system of conductor or any section thereof with all fuses in place and all switches closed, and except in earthed concentric wiring, all lamps in position or both poles of installation otherwise electrically connected together, a dc voltage of not less than twice the working voltage, provided that it does not exceed 500 V for low voltage circuits. Where the supply is derived from three –wire (ac or dc) or a poly-phase system, the neutral pole of which is connected to earth either direct or through added resistance the working voltage shall be deemed to be that which is maintained between the outer or phase conductor and the neutral.

b) The insulation resistance in megaohms of an installation measured as in **(a)** shall be not less than 50 divided by the number of points on the circuit, provided that the whole installation need not be required to have an insulation resistance greater than one megaohm.

c) Control rheostats, heating and power appliances and electric signs, may, if desired, be disconnected from the circuit during the test, but in that event the insulation resistance between the case of framework, and all live parts of each rheostat, appliance and sign shall be not less than that specified in the relevant Standard specification or where there is no such specification, shall be not less than half a megaohm.

d) The insulation resistance shall also be measured between all conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or to the neutral on to the other pole of phase conductors of the supply. Such a test shall be made after removing all metallic connections between the two poles of the installation and in these circumstances the insulation resistance between conductors of the installation shall be not less than that specified in **(b)**.

5B.9.3.2.6 *Completion certificate*

On completion of an electrical installation (or an extension to an installation) a certificate shall be furnished by the contractor, counter-signed by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority. One such recommended form is given in **Annex D**.

5B.9.3.2.7 *Earthing*

For checking the efficiency of earthing, the following tests are done:

a) The earth resistance of each electrode shall be measured.
b) Earth resistance of earthing grid shall be measured.
c) All electrodes shall be connected to the grid and the earth resistance of the entire earthing system shall be measured.

These tests shall preferably be done during the summer months.

5B.10 ALLIED/MISCELLANEOUS SERVICES

Requirements relating to various allied services shall be as per 5B.10.1 to 5B.10.9.

5B.10.1 Telecommunication and Information and Communication Technology Services

5B.10.1.1 *Telephone Services*

5B.10.1.1.1 House wiring of telephone subscribers in small buildings may be on the surface of walls or desirably, in a concealed manner through conduits. In large multi storeyed buildings intended for commercial, business and office use as well as for residential purposes, wiring for telephone connections should be done in a concealed manner through conduits. The requirements of telecommunication facilities like telephone connections, private branch exchange and intercommunication facilities, should be planned well in advance so that suitable provisions are made in the building plan in such a way that the demand for telecommunication services in any part of the building at any floor are met at any time during the life of the building.

5B.10.1.1.2 Layout arrangements, methods for internal block wiring and other requirements regarding provisions of space, etc, may be decided depending on the number of phone outlets and other details in consultation with engineer/architect and user.

5B.10.1.2 Information and Communication Technology Services including Computer Networking.

5B.10.2 Public Address System

5B.10.3 Common Antenna System for TV Receivers

5B.10.3.1 In multi-storeyed apartments, houses and hotels where many TV receivers are located, a common master antenna system may preferably be used to avoid mushrooming of individual antennas.

5B.10.3.2 Master antenna is generally provided at the top most convenient point in any building and a suitable room on the top most floor or terrace for housing the amplifier unit, etc, may also be provided in consultation with the architect/engineer.

5B.10.3.3 From the amplifier rooms, conduits should be laid in recess to facilitate drawing co-axial cable to individual flats. Suitable 'Tap Off' boxes may be provided in every room/flat, as required.

5B.10.4 Emergency and Standby Power Supply Systems

5B.10.4.1 *General*

Use of electricity has grown tremendously and for various activities the dependence on electricity has increased to such an extent as to cause serious problems even with loss of electrical power for a few moments. As a result, a wide variety of alternate sources of electricity are being in our built environment.

The different alternative sources of power are the Uninterrupted Power Supply (UPS) System, inverter, CNG/LPG generator sets, diesel/petrol/kerosene oil generator sets, bio-gas generator sets.

In addition to the above, there is a proliferation of power sources, such as solar photo-voltaic cells, wind generators, bio-mass and waste based power plants etc, primarily oriented towards reduction of the environmentally harmful CO2 emissions.

These systems give electricity during the periods of the failure of the conventional grid based public energy system and keep our critical systems in continued operation. However, introduction of more than one source of electrical power introduces questions of safety. For safety from electrical shock to human beings or livestock, the hazard is not just dependent on the main high powered source such as the grid, but the hazard is the same from a low powered source also. Shock from a small 20 W inverter can be as dangerous as a shock from the grid with megawatts of power at the back. As such precautions from the angle of safety apply equally to all sources of power. Electric shock hazards are dependent on the system voltage and as such even a low capacity generator or an inverter (of capacity 100 VA) poses the same level of shock hazard as a multi-kilovolt ampere capacity generator and all protection provisions (such as safety earthing, earth leakage and overload breakers) shall be provided as done for a large capacity system.

Power devices contain fuel, batteries which are points of concentrated sources of energy constrained in a small place. Any unintended improper release of this bottled up energy can unleash devastating consequences, such as fire and as such care is required in location which houses any of these sources of electrical power and its associated components.

5B.10.4.2 Uninterrupted Power Supply (UPS) System

UPS is an electrical device providing an interface between the mains power supply and sensitive loads (computer systems, instrumentation, etc). The UPS supplies sinusoidal a.c. power free of disturbances and within strict amplitude and frequency tolerances. It is generally made up of a rectifier/charger and an inverter together with a battery for backup power in the event of a mains failure with virtually no time lag.

In general UPS system shall be provided for sensitive electronic equipment like computers, printers, fire alarm panel, public address system equipment, access control panel, EPABX, etc, with the following provisions:

a) Isolation transformers may be provided in many UPS systems to provide higher grade of power supply quality to the loads fed by the UPS.

b) UPS shall have dedicated neutral earth pits. This earth pit shall be interconnected with other earth pits below soil for equipotential bonding.

c) Adequate rating of protective devices such as MCB, MCCB, fuses, RCCB/RCD, etc, shall be provided at both incoming and outgoing sides.

d) UPS room shall be provided with adequate ventilation and/or air conditioning as per requirement.

e) For all 3 phase UPS, 4 pole CB (circuit breaker) shall be used and for all 1 phase UPS, Double Pole CB shall be used

5B.10.4.3 Inverter

In general inverter system shall be provided for house lighting, shop lighting, etc.

NOTE — While a UPS system is provided to maintain power supply without any break even in the event of a failure of the incoming power supply, an inverter system is provided where a short break is acceptable.

Inverter systems also have a battery bank to supply power during the failure of the main power supply and the battery charged through a rectifier. The following provisions shall apply to inverter systems:

a) Adequate rating of protective devices such as MCB, MCCB, fuses, RCCB/RCD, etc, shall be provided at both incoming and outgoing sides.

b) Earthing shall be done properly.

c) Adequate ventilation space shall be provided around the battery section of the inverter.

d) Care shall be taken in circuit design to keep the connected load in such a manner that the demand at the time of mains failure is within the capability of the inverter.

NOTE — If the inverter fails to take over the load at the time of the mains failure, the purpose of providing the inverter and battery backup is defeated.

5B.10.4.4 The following provisions shall apply to both inverter and UPS systems:

a) Circuits which are fed by the UPS or inverter systems should have suitable marking to ensure that a workman does not assume that the power is off, once he has switched off the mains from the DB for maintenance.

b) Electric shock hazards are dependent on the system voltage and as such even a low capacity generator or an inverter (of capacity 100 VA) poses the same level of shock hazard as a multi-kilovolt ampere capacity generator and all protection provisions (such as safety earthing, earth leakage and overload breakers) shall therefore be provided as done in case of a large capacity system.

c) UPS and inverter systems should be provided with protection to shut the output during abnormal conditions, such as overload or short circuit. Such systems may also have the choice of auto-restoration after a preset time delay and an ultimate lock-out after a number of restoration attempts. Warning should be displayed wherever the possibility of automatic restoration is possible.

d) Batteries that go with UPS and inverter systems are required to be placed in well ventilated spaces as oxygen and hydrogen gasses are produced in the batteries, which unless ventilated, can cause explosive conditions.

e) The flooring for the battery room should be with acid (or alkali as the case may be) resistant tiles or coating.

5B.10.4.5 Standby Generating Set (less than 5 kVA)

In general, small standby generating sets (using either diesel or petrol or kerosene or LPG or CNG) may be provided for small installations, such as offices, shops, small scale industry, hostels, etc, which shall comply the following requirements:

a) These shall be located outside in open areas.

b) There shall be no risk of fire due to presence of such equipment in the premise.

c) They shall be in reach of authorized persons only.

d) Adequate firefighting equipment shall be provided near such installations.

e) Exhaust from these shall be disposed in such a way so as not to cause health hazard. NOTE — Installation of a set in a closed space poses the hazard of accumulation of the exhaust gasses which contains harmful gases such as carbon monoxide, and also reduction of oxygen in the air in the enclosure.

f) These shall have acoustic enclosure, or shall be placed at a location so as not to cause noise pollution.

g) Adequate ventilation shall be provided around the installation.

h) Protective devices such as MCB, MCCB, fuses, RCCB/RCD, etc, with adequate rating shall be provided.

i) Separate and adequate body and neutral earthing shall be done.

j) Cumulative capacity shall not exceed 10 kVA.

5B.10.5 Building Management System

A building management/automation system may be considered to be provided for controlling of some and monitoring of all parameters of heating, ventilation and air conditioning system (HVAC); electrical; plumbing; fire fighting; low voltage system, such as telephone, TV; etc. This not only leads to reduction of energy consumption, it also generates data leading to better operation practice and systematic maintenance scheduling. The total overview provided by a building automation system, with a capability to oversee a large number of operating and environmental parameters on real time basis leads to introduction of measures which further leads to reduction in energy consumption.

It also helps in reduction in skilled manpower requirement for operation and maintenance of large complexes. This system can further be linked to other systems such as fire alarm system, public address system, etc for more effective running of services. This system can be used for analysis and controlling of all services in a particular complex, leading to efficient and optimum utilization of available services.

5B.10.6 Security System

Security system may comprise an integrated closed circuit television system, access control system, perimeter protection systems, movement sensors, etc. These have a central control panel, which has a defined history storage capacity. This main control panel may be located near to the fire detection and alarm system. These may be considered for high security areas or large crowded areas or complexes. High security areas may consider uncorded, high-resolution, black and white cameras in place of coloured cameras. These cameras may be accompanied or automatically controlled with movement sensors. Cameras may be linked to access controls so that proper recording of the movement at the points of access to high security areas is maintained. Access control may be provided for entry to high security areas. The systems may have proximity card readers, magnetic readers, etc.

5B.10.7 Car Parking Area

5B.10.7.1 Electrical Vehicle Charging

Adequate electrical provisioning should be made for electric vehicle charging in designated spaces for electric car parks in enclosed/covered car parking. These electrical outlets should be fed from a separate distribution board located near such outlets for electric car parks. Distribution board and outlets should be protected and metered.

5B.10.7.2 Car Park Management System

Wherever car park management system is provided in multi-level parking or other parking lots with features of boom barriers, pay and display machines (manned or unmanned type) and parking guidance system (for displaying number of car spaces vacant on various floors, direction of entry and exit, etc), the electrical provisions for the same shall be adequately backed with UPS for protection of vehicle and for efficient car park management.

5B.10.8 Solar Photovoltaic Power Generating System

5B.10.8.1 General

Solar energy, which is available in two forms, heat and light, is a renewable and inexhaustible natural resource and can supplement/augment the depleting fossil fuel resources. Greenhouse gases and pollutant emissions which result from fossil fuel generation can also be offset by solar photovoltaic power generation. Most parts of the country receive good solar radiation of 4 to 7 kWh/m2 per day and almost 300 sunny days in a year making solar PV system one of the most preferred renewable energy source in the country.

5B.10.8.2 Solar PV power generating system consists of components and subsystems that are used to convert incident solar radiation directly into electrical energy. The energy converter (namely, solar photovoltaic cells which convert solar energy directly into d.c. electric power) does not have moving parts and has a comparatively long lifetime. Also, it can be used in decentralized/distributed mode.

PV cells are made of light-sensitive semiconductor materials that use photons to dislodge electrons to drive an electric current. The available cell technology used in construction of solar PV is single crystal or mono crystalline silicon/poly-crystalline or multi-crystalline silicon/amorphous thin film. Individual PV cells are interconnected to form a PV module. This takes the form of a panel for easy installation.

The electrical parameters of the input of a subsystem should be compatible with the output electrical parameters of a preceding subsystem(s).

Most solar PV systems can be mounted on a building or installed on ground. For buildings, they are either mounted on the roof or integrated into the building facade (BIPV).

5B.10.8.3 Types of Solar PV Generating System

When photovoltaic modules are exposed to sunlight, they generate electricity in d.c. waveform. A d.c./a.c inverter then converts the d.c into a.c. or stabilizes d.c. for further distribution. The PV power generating systems can broadly be classified into two categories, namely, stand-alone (with a.c. output or with d.c. output) and grid connected system (see Fig. 5).

5B.10.8.3.1 Stand alone solar PV system (see Fig. 6)

Stand alone solar PV generating system is an independent power production system that is not connected to the grid and can thus be designed free from grid code requirements. This system is also known as off-grid system. Off-grid solar PV systems are applicable for areas where there is no available power grid, such as remote villages, forests, off-shore islands, ships. But they may also be installed within the city in situations where it is inconvenient or too costly to tap electricity from the power grid.

An off-grid solar PV system needs deep cycle rechargeable batteries, such as lead-acid, nickel cadmium or lithium-ion batteries to store electricity for use under conditions where there is little or no output from the solar PV system, such as during the night.

5B.10.8.3.2 Grid connected solar PV system (see Fig. 7)

A grid connected solar PV generating system is interconnected with an existing electric power grid, subject to grid requirements. This system is also known as grid-tied system. A building has two parallel power supplies, one from the PV solar system and the other from the power grid. The combined power supply feeds all the loads connected to the main a.c. distribution board. The ratio of solar PV supply to power grid supply varies, depending on the size of the solar PV system. Whenever the solar PV supply exceeds the building's current demand, excess electricity is exported into the grid. When there is no sunlight to generate PV electricity at night, the power grid will feed all the building's demand. A grid-connected system can be an effective way to reduce dependence on utility power during the day, increase renewable energy production, and improve the environment.

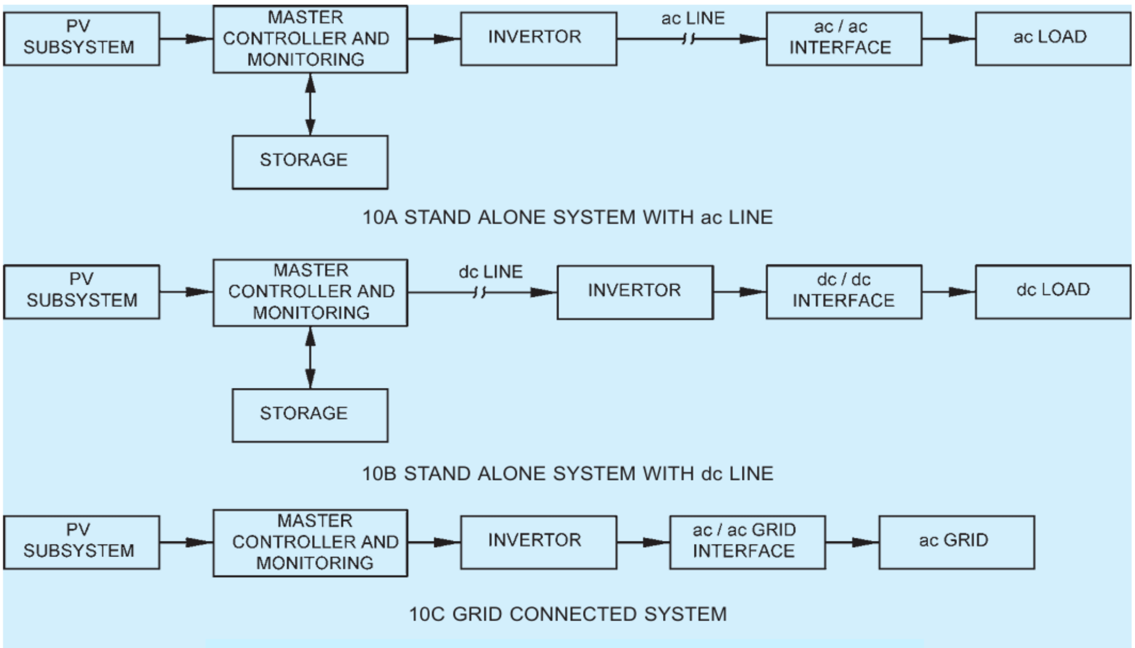


Fig. 5 PV Power Generating System and Major

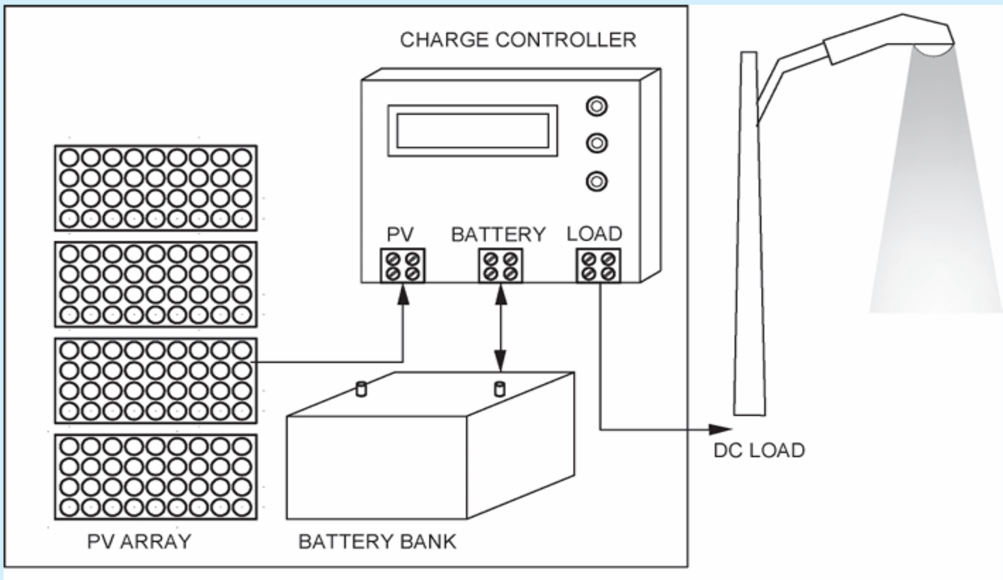


Fig. 6 Stand Alone Solar PV System

5B.10.8.3 When designing solar PV system, care should be taken to address design aspects relating to earthing, short circuit protection, lightning protection and switching control. This shall be done in accordance with 'Solar Photovoltaic (PV) Power Supply Systems' of National Electrical Code, 2011. Earthing and lightning protection of solar PV systems shall be done in accordance with the procedure laid down in 8 and 11, respectively.

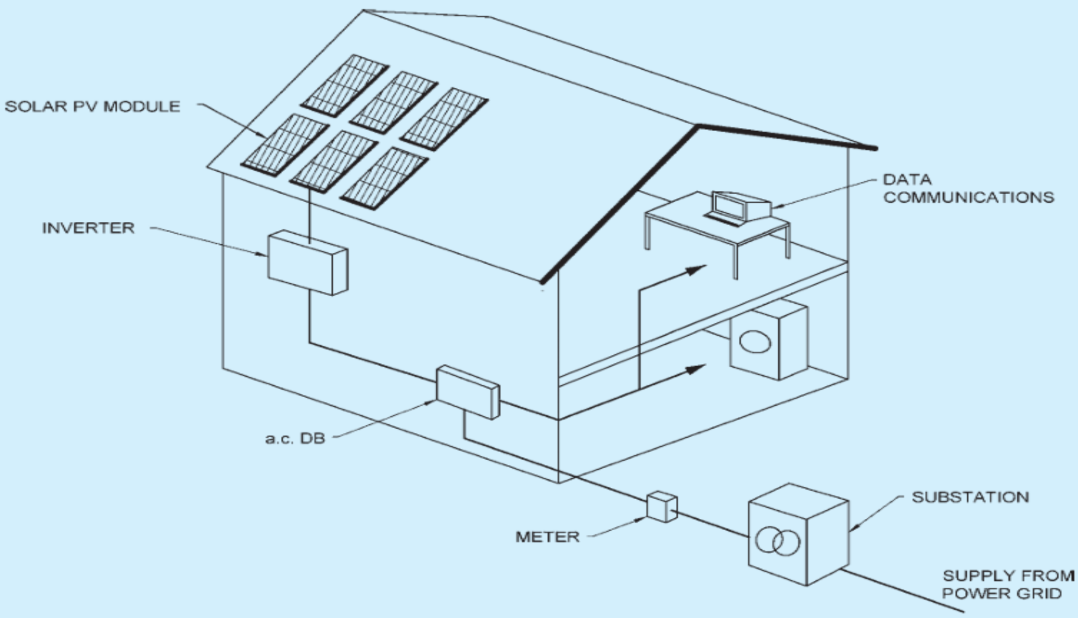
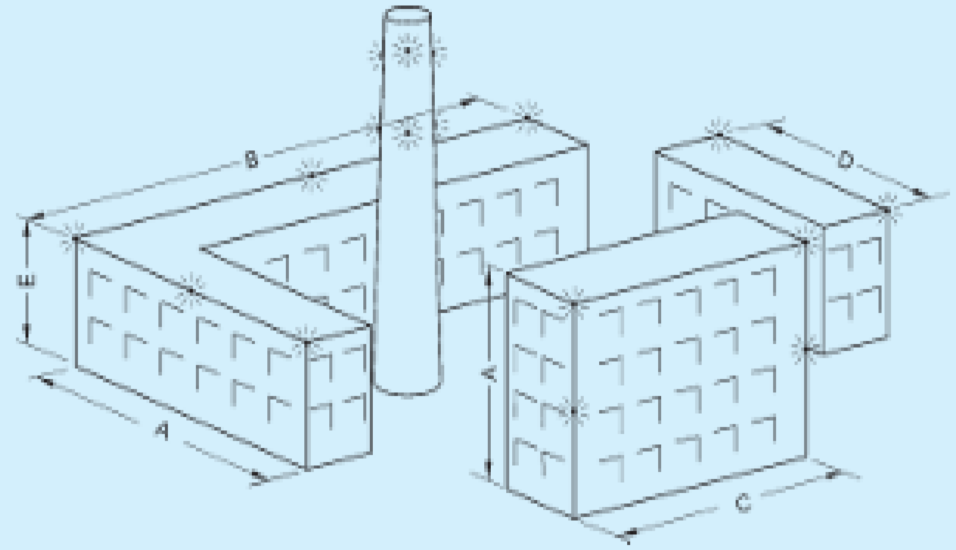
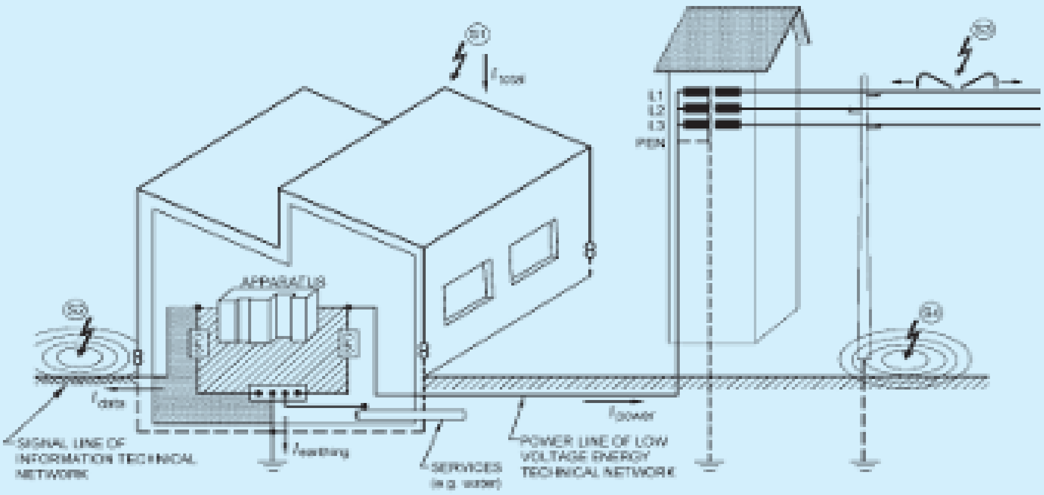


Fig. 7 Grid Connected Solar PV System



A, B = 45 m - 90 m
C, D, E < 45 m

FIG. 8 TYPICAL ARRANGEMENT OF AVIATION OBSTACLE LIGHTS IN CASE OF GROUP OF BUILDINGS



Key
S1 Flash to the structure
S2 Flash near the structure
S3 Flash to the service connected to the structure
S4 Flash near the service connected to the structure

FIG. 9 BASIC EXAMPLE OF DIFFERENT SOURCE OF DAMAGE TO A STRUCTURE AND LIGHTNING CURRENT DISTRIBUTION WITHIN A SYSTEM

5B.10.9 Aviation Obstacle Lights

High-rise buildings and structures such as chimneys and towers are potential hazards to aircraft. The provision of aviation obstacle lights (AOL) on tall buildings/structures is intended to reduce hazards to aircraft by indicating their presence. AOLs, low, medium or high intensity obstacle lights, or a combination of such lights, shall be provided on buildings of different heights as per the requirements of Annex 14 to the Convention on International Civil Aviation, Volume I Aerodrome Design and Operations, International Civil Aviation Organization (ICAO). A general arrangement of AOLs in case of group of buildings is given in Fig. 8.

5B.11 LIGHTNING PROTECTION OF BUILDINGS

5B.11.1 Lightning Protection Level (LPL)

Based on the risk assessment if protection is necessary, lightning protection is divided into four levels (LPL I to IV) which helps in designing and implementing protection measures for an economical implementation. LPL I provides the maximum protection and is expensive, whereas, LPL IV provides the least protection and is less expensive. Recommended lightning protection level (LPL) for typical buildings is given in Table 5 for guidance.

Complete system for protection of structures against lightning, including their internal systems and contents, as well as persons, in general consisting of an LPS and SPM shall be installed to avoid damages to structures, accidents, severe injuries and (may be even) deaths of humans due to direct or indirect lightning. Both protection measures should complement each other.

Before proceeding with the detailed design of a lightning protection, the following essential steps should be taken:

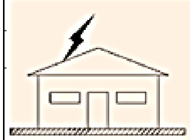
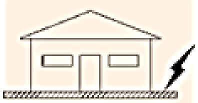
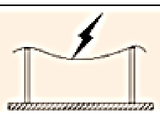
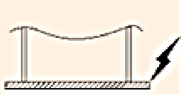
a) Decide whether or not the structure needs protection and, if so, what are the special requirements by making all calculations.

b) Ensure a close liaison between the architect/ engineer, the builder, the lightning protective system engineer, and the appropriate authorities throughout the design stages (see also Note).

c) Agree the procedures for testing and future maintenance.

NOTE — Modern buildings with electronic equipment need protection from radiated surges of lightning. To achieve this, structural steel of the building is also sometimes used as a part of lightning protection system {see good practice. In such cases, lightning protection measures shall be included in the structural drawing, particularly for foundation.

Table 3: Source and Type of Damage and Type of Loss

Sl No.	Point of Strike	Source of Damage	Structure		Service (Metal Lines such as Power, Telephone, etc)	
			Type of Damage	Type of Loss	Type of Damage	Type of Loss
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1)		S1	D1	L1, L4[2)]		
			D2	L1, L2, L3, L4	D2	L'2, L'4
			D3	L1[1)], L2, L4	D3	L'2, L'4
2)		S2	D3	L1[1)], L2, L4		
3)		S3	D1	L1, L4[2)]		
			D2	L1, L2, L3, L4	D2	L'2, L'4
			D3	L1[1)], L2, L4	D3	L'2, L'4
4)		S4	D3	L1[1)], L2, L4	D3	L'2, L'4

1) Only for structures with risk of explosion, and for hospitals or other structures where failures of internal systems immediately endangers human life.
2) Only for properties where animals may be lost.

Table 4: Recommended LPL for Typical Buildings

SI No. (1)	Application (2)	LPL (3)
i)	Computer data centres, military applications, high rise hotels/hospitals, nuclear power stations, airports, essential services such as telecom	I
ii)	Low rise hospitals/hotels, ex-zones in the industry and chemical sector, fuel retail outlets/gas stations/compressor stations and similar installations	II
iii)	Schools, banks, residential buildings, temples, churches, mosques, community halls, etc	III

NOTE — Detailed risk assessment should be done before execution.

5B.11.2 Lightning Protection

5B.11.3 Lightning Protection System (LPS)

The main and most effective measure for protection of structures against physical damage is considered to be the lightning protection system (LPS). It usually consists of both external and internal lightning protection systems.

An external LPS which consists of air-termination system, down-conductor system and earthing system is intended to,

a) intercept a lightning flash to the structure (with an air-termination system),

b) conduct the lightning current safely towards earth (using a down-conductor system), and

c) disperse the lightning current into the earth (using an earth-termination system).

An internal LPS comprises equipotential bonding or a separation distance (and hence electrical insulation) between the external LPS components and other electrically conducting elements internal to the structure.

Both external and internal protection systems should complement each other. Class of LPS denotes the classification of an LPS according to the lightning protection level for which it is designed. Four classes of LPS (I, II, III and IV) are defined as a set of construction rules, based on the corresponding LPL. Each set includes level-dependent (for example, rolling sphere radius, mesh width etc.) and level-independent (for example, cross-sections, materials, etc) construction rules.

Main protection measures against injury to living beings due to touch and step voltages are intended to,

1) reduce the dangerous current flowing through bodies by insulating exposed conductive parts, and/or by increasing the surface soil resistivity; and
2) reduce the occurrence of dangerous touch and step voltages by physical restrictions and/or warning notices.

The type and location of an LPS should be carefully considered in the initial design of a new structure, thereby enabling maximum advantage to be taken of the electrically conductive parts of the structure. By doing so, design and construction of an integrated installation is made easier, the overall aesthetic aspects can be improved, and the effectiveness of the LPS can be increased at minimum cost and effort.

Access to the ground and the proper use of foundation steelwork for the purpose of forming an effective earth termination may well be impossible once construction work on a site has commenced. Therefore, soil resistivity and the nature of the earth should be considered at the earliest possible stage of a project. This information is fundamental to the design of an earth-termination system and may influence the foundation design work for the structure.

Regular consultation between LPS designers and installers, architects/civil engineer and builders is essential in order to achieve the best result at minimum cost. If lightning protection is to be added to an existing structure, every effort should be made to ensure that it conforms to the principles of this Code. The design of the type and location of an LPS should take into account the features of the existing structure.

5B.11.3.1 Air-Termination System

5B.11.3.1.1 Air-termination system is a part of an external LPS using metallic elements such as rods, mesh conductors or catenary wires intended to intercept lightning flashes. The probability of penetration by a lightning current on a structure is considerably decreased by the presence of a properly designed air termination system. Air-termination systems can be composed of any combination of the following elements:

a) Vertical rods (offers certain angle of protection);
b) Catenary wires; and
c) Meshed/Grid conductors.

All types of air-termination systems shall be positioned in accordance with **5B.11.3.1.2**. The individual air terminations rods should be connected together at roof level to ensure current division. Radioactive air terminals shall not be allowed. Any other kind of air terminal like dissipation system/ESE air-terminal/CSE air-terminal shall not be acceptable.

5B.11.3.1.2 Positioning

Air-termination components installed on a structure shall be located at corners, exposed points and edges (especially on the upper level of any facades) in accordance with one or more of the following methods {see also Figs. 10 to 14 in conjunction with:

a) Protection angle method;
b) Rolling sphere method; and
c) Mesh method.

The protection angle method is suitable for simple shaped buildings but it is subject to limits of air termination height indicated in Table 6. The mesh method is a suitable form of protection where plane/ pitch roof surfaces are to be protected. The rolling sphere method is suitable in all cases.

5B.11.3.1.3 Roof mounted electrical/electronic equipment (for example, chillers, antennas, cameras and bill boards) need vertical air-termination to avoid direct flashover. All parts of lightning protection should maintain separation distance from these electrical/electronic equipment. Power and data connection to these equipment should have proper Class I and Class II SPD's (see **11.4.5**) to avoid failures. Overhead cables such as cable TV lines from one building to the other should be avoided.

5B.11.3.1.4 Unearthed metallic roofs should be avoided. Metallic roofs shall be connected either to steel reinforcement or to other earthed steel parts of the building satisfying the requirements of number of down conductors (see **11.3.2**). Small buildings with metallic roofs less than 100 m2 shall be earthed at least not less than 2 places.

5B.11.3.1.5 *Structures of height less than 60 m and more than 60 m*

On structures lower than 60 m in height, generally flashes to the side may not occur, hence air-termination protection on sides will not be required (see Fig. 15A).

On structures taller than 60 m, flashes to the side may occur, especially to points, corners and edges of surfaces. In general, the risk due to these flashes is low, but electrical and electronic equipment on walls or outside structures may be destroyed even by lightning flashes with low current peak values.

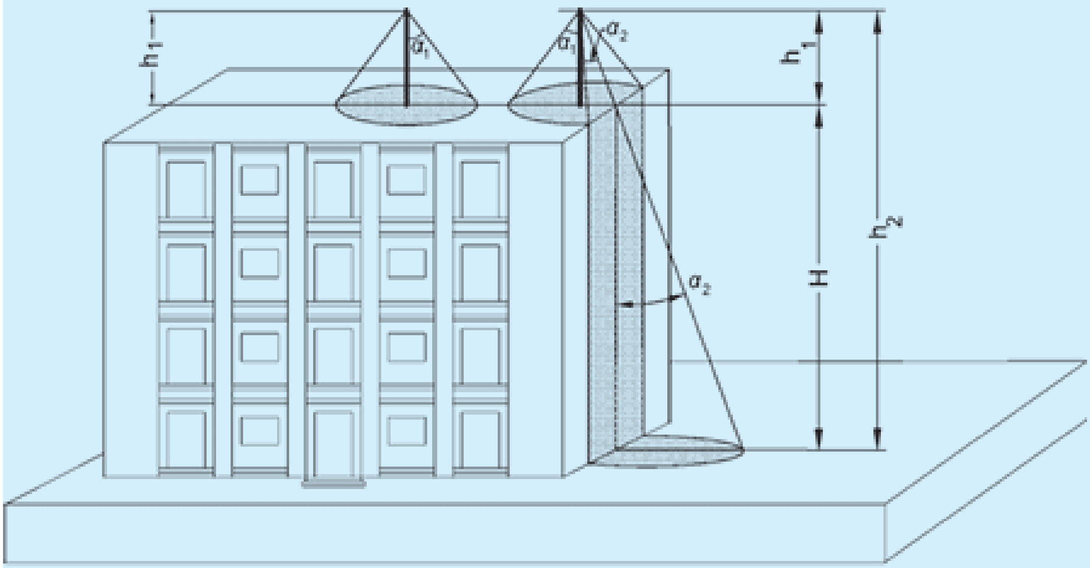
An air-termination system shall be installed to protect the upper part of tall structures (that is, typically the topmost 20 percent of the height of the structure as far as this part exceeds 60 m in height) and the equipment installed on it. The rules for positioning the air termination systems on these upper parts of a structure shall meet at least the requirements for LPL IV with emphasis on the location of air-termination devices on corners, edges, and significant protrusions (such as balconies, viewing platforms, etc (see Fig. 15B).

5B.11.3.1.6 *Buildings with roof top solar PV and water heaters*

Vertical air-terminals are required for protecting roof mounted installations such as solar PV, water heaters, chillers as well as water tanks. Protection angle should be considered as per Table 5. Vertical air-terminals need to be connected to the air-termination mesh/down conductors. Metal support structure of these installations shall be bonded to the air-termination mesh/down-conductors. Class I/Class II surge protection devices (SPDs) should be installed in the electrical lines to protect the installations inside the building (typically d.c. SPD for solar PV output at inverter or junction box level and a.c. SPD for inverter output and mains input). The roof top PV system or 240 V a.c. water heaters or any other equipment should not pose any safety risk related to lightning protection and protection of overall building may be reviewed by the expert after installation of roof top PV system. Necessary measures may then be required to complete the lightning protection arrangement.

Table 5: Maximum Values of Mesh Size and Protection Angle Corresponding to the Class of LPS

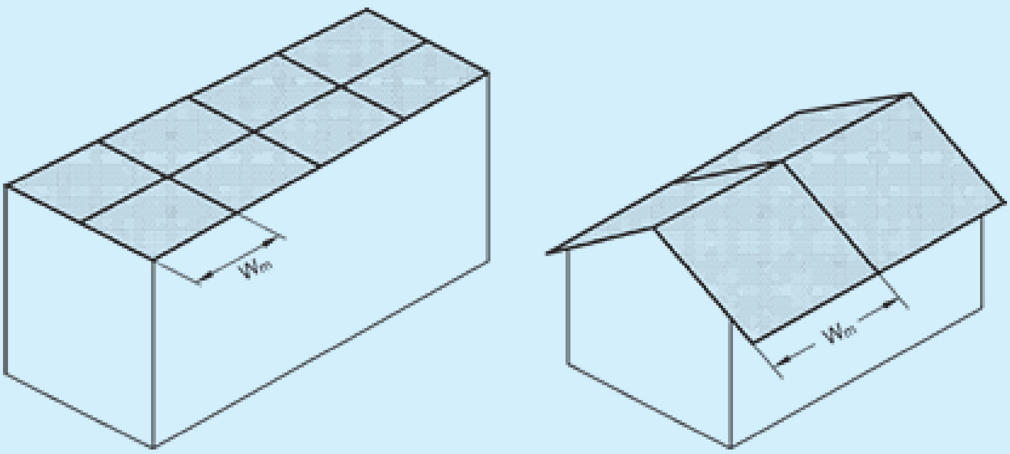
Sl No.	Class of LPS	Mesh Size m	Rolling Sphere Radius r m	Protection Angle with respect to Height 10 m	 20 m	 30 m	 45 m	 60 m
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	I	5 × 5	20	45	23	← Cannot be used →		
ii)	II	10 × 10	30	54	38	23	← Cannot be used →	
iii)	III	15 × 15	45	62	48	36	3	Cannot be used
iv)	IV	20 × 20	60	65	54	45	34	23



Key

H	Height of the building over the ground reference plane
h_1	Physical height of an air-termination rod
h_2	Height of the air-termination rod over the ground (= $h_1 + H$)
α_1	The protection angle corresponding to the air-termination height, $h = h_1$, being the height above the roof surface to be measured (reference plane)
α_2	The protection angle corresponding to the height, h_2 (= $H + h_1$)

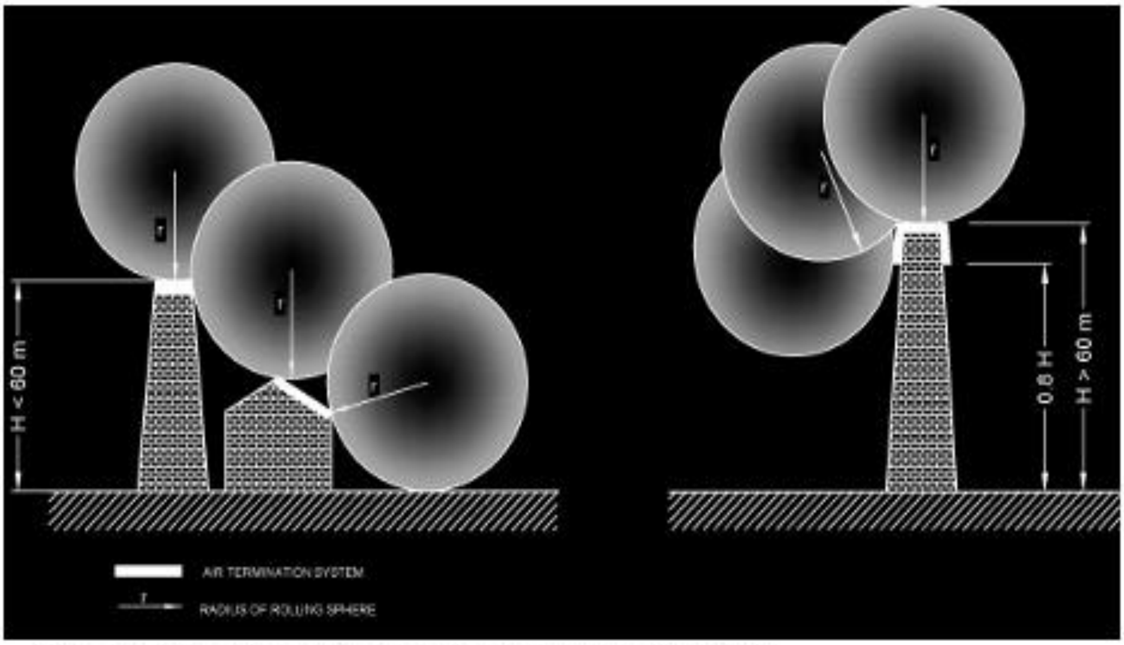
FIG. 10 PROTECTION ANGLE METHOD OF AIR-TERMINATION DESIGN FOR DIFFERENT HEIGHTS ACCORDING TO TABLE 6



W_m – Mesh size

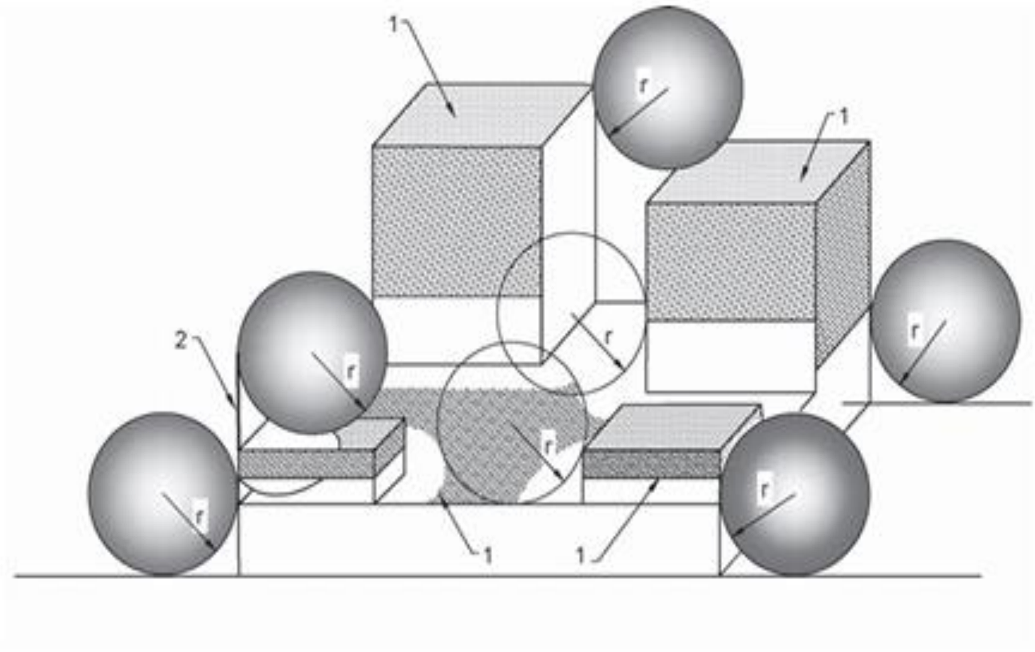
NOTE — The mesh size should comply with table 6.

FIG. 11 DESIGN OF AIR-TERMINATION SYSTEM ACCORDING TO MESH METHOD



NOTE — The rolling sphere, *r* should comply with the selected class of LPS (*see* Table 6).

FIG. 12 DESIGN OF AIR-TERMINATION SYSTEM ACCORDING TO THE ROLLING SPHERE METHOD

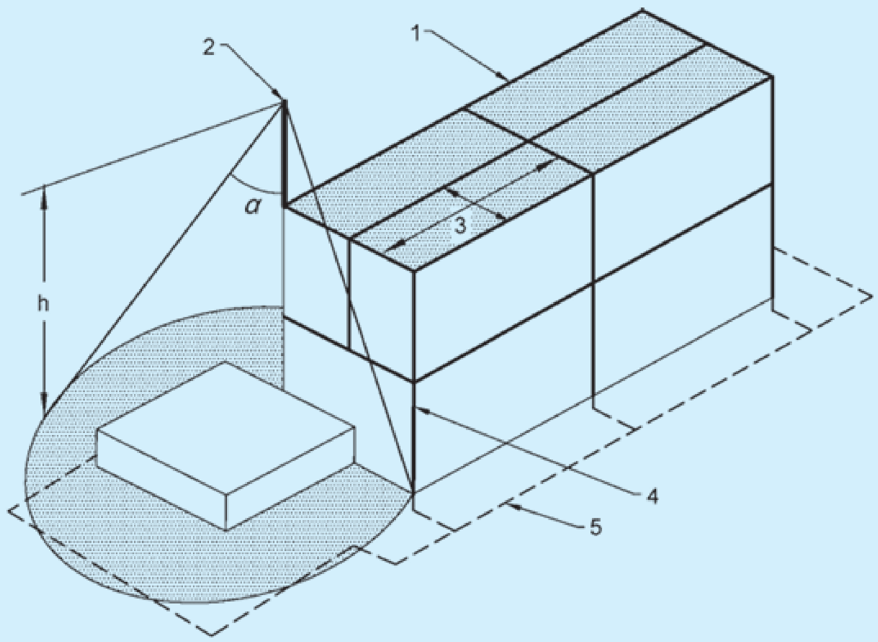


Key

1 Shaded areas are exposed to lightning interception and need protection according to Table 6
2 Mast on the structure
r Radius of rolling sphere according to Table 6

NOTE — Protection against side flashes is required {*see* good practice [8-2(45)] for details}.

FIG. 13 DESIGN OF AIR-TERMINATION CONDUCTOR NETWORK FOR A STRUCTURE WITH COMPLICATED SHAPE



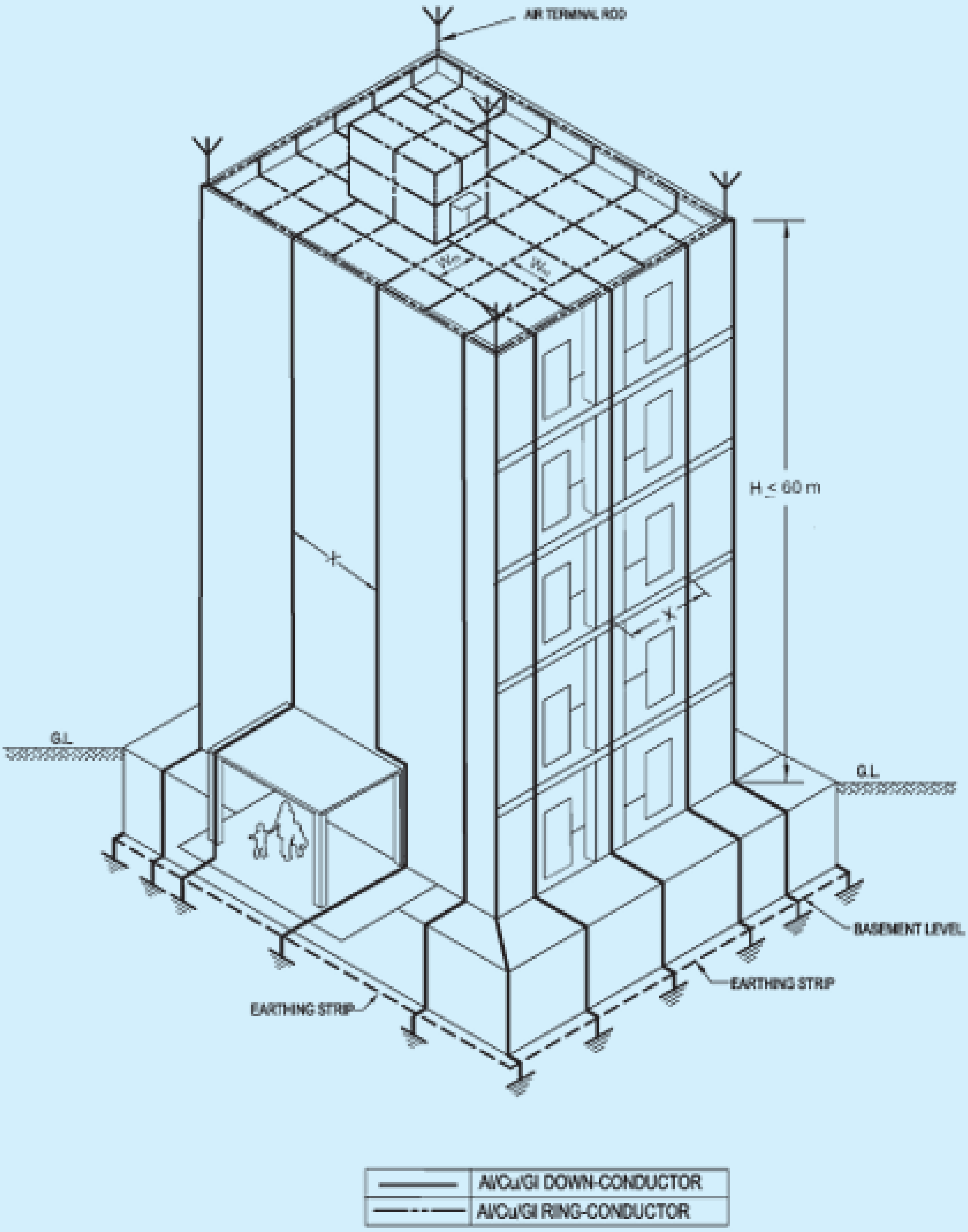
Key

1 Air-termination conductor (also called as mesh/Faraday cage). *See* Table 6 for mesh size
2 Air-termination rod
3 Mesh size
4 Down-conductor
5 Earthing system with ring conductor
h = Height of the air-terminal above ground level
α = Protection angle

FIG. 14 Design of an LPS Air-Termination According to the Protection Angle Method, Mesh Method and General Arrangement of Air-Termination Elements

5B.11.3.1.7 *Large solar PV power plants/farms*

Vertical air-terminals for PV modules based on LPL III/IV connected directly to the frame shall protect against direct lightning impact in case of large solar PV power plants/farms. A design according to rolling sphere method should be done for zone of protection (for example, 1 m rod at 0.5 m height from panel at four corners provides protection to approximately 12m× 9 m area). Maximum height of the air termination rod above the panel should be restricted to less than 0.5 m considering the influence of shadow of air-terminal in current generation. To reduce step potential, structures should be interconnected with underground earth mats/isolating spark gaps, wherever necessary. The short circuit current/expected fault current should be taken into consideration while designing earthing arrangement or while selection of the suitable SPD so as to withstand the same. The provisions should be made to avoid possible d.c. arcing to avoid fire hazards and for the safety of the working personnel.



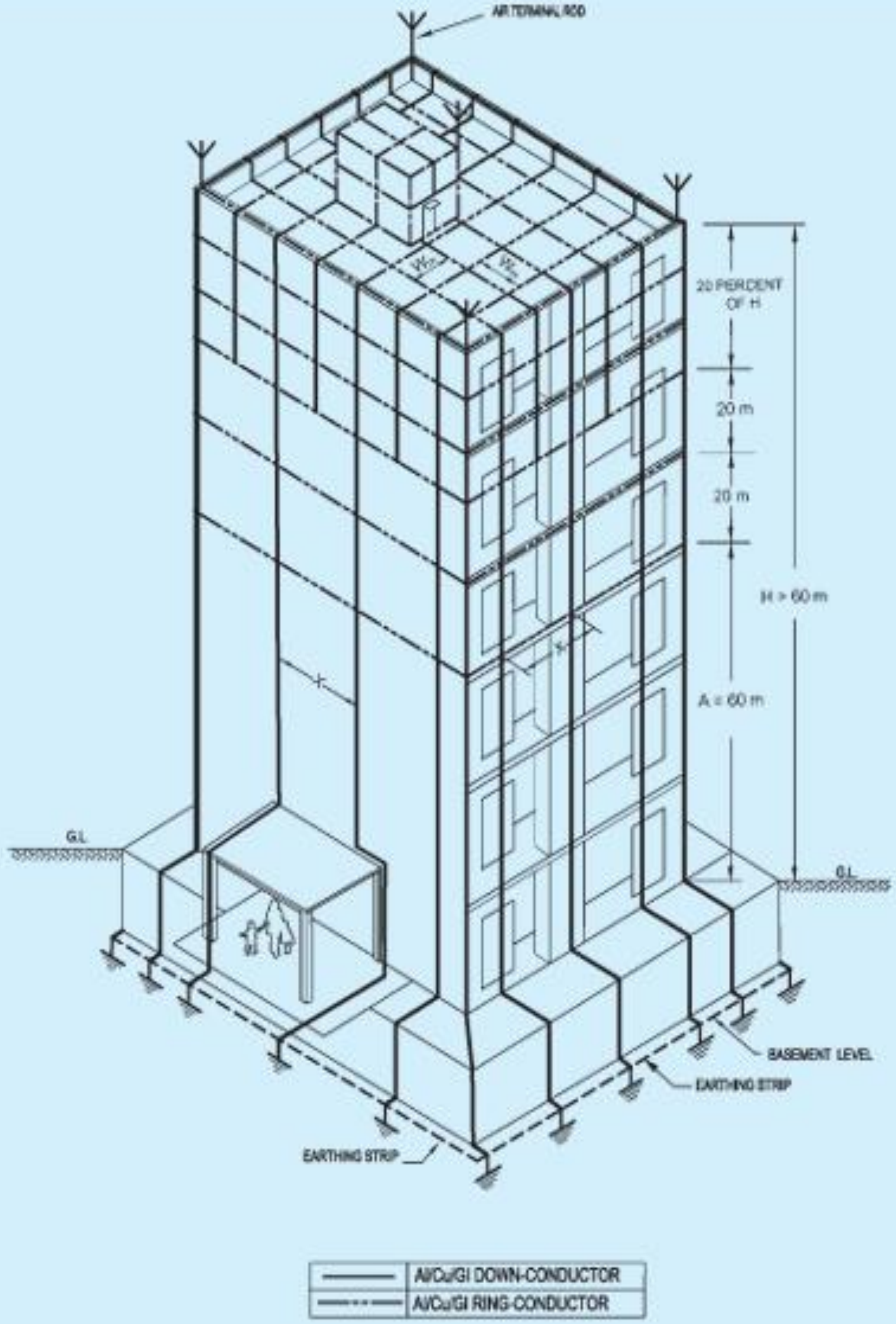
NOTES

1 Mesh size, W_m shall be as per Table 6.

2 Down-conductor spacing, X, shall be as per Table 7.

15A TYPICAL LIGHTNING PROTECTION SYSTEM FOR BUILDINGS OF HEIGHT, H ≤ 60 m

FIG. 15 — Continued)



NOTES

1 Mesh size, W_m shall be as per Table 6.

2 Down-conductor spacing, X, shall be as per Table 7.

15B TYPICAL LIGHTNING PROTECTION SYSTEM FOR BUILDINGS OF HEIGHT, H > 60 m

FIG. 15 Typical Lightning Protection System for Buildings

5B.11.3.1.8 *Buildings with roof top telecom towers*

The metallic tower itself will act as air-termination. Antennas mounted above these towers (if antenna mounted below to the top of tower by more than 1 m, then no air-terminal is required on top of tower) need air-terminals connected to the main structure. The main structure shall be connected to the air-termination conductors for the balance of the building if available. Two separate down-conductors with a size of minimum 150 mm2 should be used in addition to regular down conductors to make the bonding between tower and ring earthing. In order to avoid uncontrolled flash overs and also to protect equipment, which may be mounted on the tower itself, special cable with increased dielectric strength as down-conductor should be used. Since these down-conductors are shielded, the area of cross-section will be significantly lower than 50 mm2 but not less than 16 mm2, which is sufficient enough to discharge the lightning current.

Every power, coaxial, data and other metallic lines connected between the telecom installation and the other parts of the building shall be protected with Class 1 and Class 2 SPD. It should be ensured that SPDs during their operation do not impede fire safety.

5B.11.3.1.9 *Lightning protection for multi-storeyed car park roofs/helipads*

Air-termination studs (see Fig. 16) may be used for lightning protection for multi-storeyed car park roofs/ helipads. Air-termination studs used can be connected to the reinforcement steel of a concrete roof. In the case of roofs where a connection to the reinforcement cannot be made, the roof conductors can be laid in the seams of the carriageway slabs and air-termination studs can be located at the mesh joints. The mesh width shall not exceed the value corresponding to the protection class given in Table 6. The persons and vehicles on this parking area are not protected against direct lightning.

5B.11.3.2 Down-conductor System

Down-conductor system is a part of an external LPS intended to conduct lightning current from the air termination system to the earth-termination system. In order to reduce the probability of damage due to lightning current flowing in the air-termination system, the down-conductors shall be arranged in such a way that from the point of strike to earth,

a) several parallel current paths exist;

b) the length of the current paths is kept to a minimum; and

c) equipotential bonding to conducting parts of the structure is performed.

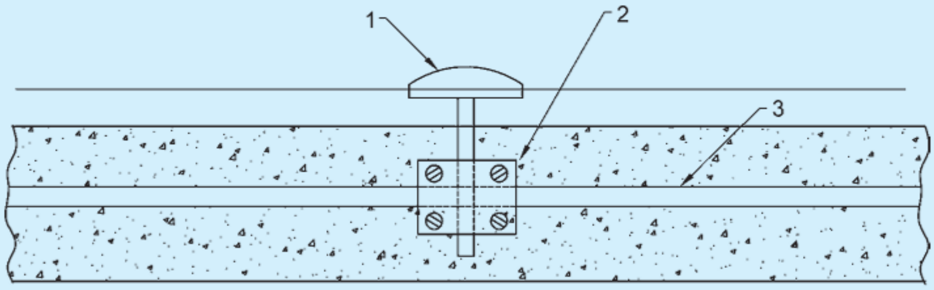
5B.11.3.2.1 Typical values of the distance between down conductors are given in Table 6. These values can be used for horizontal ring conductors installed for a tall building more than 60 m height. The minimum number of down-conductors shall be 2 (diagonally opposite to each other) for building with an area less than 100 m^2.

Table 6: Minimum Distance Between Down-Conductors

SI No. (1)	Class of LPS (2)	Distance (3)
i)	I	10
ii)	II	10
iii)	III	15
iv)	IV	20

5B.11.3.2.2 Down-conductors shall be installed so that, as far as practicable, they form a direct continuation of the air-termination conductors. It shall be installed straight and vertical such that they provide the shortest and most direct path to earth. The formation of sharp bends and loops shall be avoided. Every down conductor should be connected to a Type B ring/ foundation earthing. Connection of down-conductor to a Type A earthing is allowed only in case of space constraints or existing buildings, where installation is difficult.

5B.11.3.2.3 While routing the down-conductors, separation distance need to be calculated based on good practice and maintained from live parts/services.



Key
1 Air-termination stud
2 Steel conductor connecting to several bars of the reinforcement steel
3 Steel reinforcement to concrete

FIG. 16 Typical Air-Termination Studs Used on Car Park Roofs

5B.11.3.2.4 Lateral connection of down-conductors at ground level and every 10 m to 20 m of height as a ring conductor as per below table is considered to be good practice. The installation of as many down-conductors as possible, at equal spacing around the perimeter interconnected by ring conductors, reduces the probability of dangerous sparking and facilitates the protection of internal installations. This condition is fulfilled in metal framework structures and in reinforced concrete structures in which the interconnected steel is electrically continuous.

5B.11.3.2.5 Routing of down-conductors (insulated or uninsulated) through electrical and other service shafts are not allowed as it can create fire and explosion during lightning.

5B.11.3.2.6 Separation distance is the distance required between air-terminals/lightning down-conductor and any conductive/metallic/electrical/ electronic part of a building to avoid uncontrolled flashover. Separation distance (S), in m should be calculated as per the following formula:

$$S = \frac{K_i \text{ x } K_c \text{ x } L}{K_m}$$

where

K_i = depends on the selected LPL (see Table 8);

K_m = depends on the electrical insulation material (see Table 9);

K_c = depends on the partial lightning current flowing on the air-termination and the down conductor (see Table 10); and

l = length, in m along the air-termination and the down-conductor from the point where the separation distance is to be considered, to the nearest equipotential bonding point or the earth-termination.

5B.11.3.2.6.1 Cable with increased dielectric strength and tested for lightning current discharge may be used to avoid specific separation distance to live parts of the building.

5B.11.3.2.7 The down-conductor shall be supported on structure like column at every 1 m using suitable clamps or connectors or exothermic welding. The clamps or connectors or exothermic welding shall be tested for the lightning current as per selected LPL. Reference may be made to table given below and good practice for supporting details:

Sl No.	*Arrangement*	*Fixing Centres for Tape, Stranded and Soft Drawn Round Conductors* mm	*Fixing Centres for Round Solid Conductors* mm
(1)	(2)	(3)	(4)
i)	Horizontal conductors on horizontal surfaces	1 000	1 000
ii)	Horizontal conductors on vertical surfaces	500	1 000
iii)	Vertical conductors from the ground to 20 m	1 000	1 000
iv)	Vertical conductors from 20 m and thereafter	500	1 000

NOTES

1 This table does not apply to built -in type fixings, which may require special considerations.

2 Assessment of environmental conditions (that is, expected wind load) should be undertaken and fixing centres different from those recommended may be found to be necessary.

5B.11.3.2.8 At the structures, which cannot be punctured for holding the down-conductors, like tin roofs, glass structures, etc, the down-conductors should be supported with adhesive type clamps tested for weather durability and for withstanding lightning currents as per selected LPL.

5B.11.3.2.9 The wind speed shall be taken into account while mounting the air-termination and down-conductor system.

5B.11.3.3 *Earth-termination System*

Earth-termination system is a part of an external LPS which is intended to conduct and disperse lightning current into the earth. When dealing with the dispersion of the lightning current (high frequency behaviour) into the ground, whilst minimizing any potentially dangerous over-voltages, the shape and dimensions of the earth-termination system are the important criteria. In general, a low earthing resistance (if possible lower than 10 ohm when measured at low frequency) is recommended. From the viewpoint of lightning protection, a single integrated structure earth termination system is preferable and is suitable for all purposes (that is, lightning protection, power systems and telecommunication systems).

Type A earth-termination comprising of vertical/ horizontal conductor or Type B earth-termination comprising of ring earthing/foundation earthing shall be used satisfying the requirements of this Code as well as good practice.

Table 7: Isolation of External LPS – Approximated Values of Coefficient, K_c

SI No. (1)	Number of Down conductors, n (2)	K_c (3)
i)	1 (only in case of an isolated LPS)	1
ii)	2	0.66
iii)	3 and more	0.44

NOTE — Values of Table 8 apply for all Type B earthing arrangements and for Type A earthing arrangements, provided that the earth resistance of neighbouring earth electrodes do not differ by more than a factor of 2. If the earth resistance of single earth electrodes differ by more than a factor of 2, Kc = 1 is to be assumed.

Table 8: Isolation of External LPS — Values of Coefficient, K_i

SI No. (1)	Class of LPS (2)	K_i (3)
i)	I	0.08
ii)	II	0.06
iii)	III and IV	0.04

Table 9: Isolation of External LPS — Values of coefficient, K_m

SI No. (1)	Material (2)	K_m (3)
i)	Air	1
ii)	Concrete, bricks, wood	0.5

NOTES

1 When there are several insulating materials in series, it is a good practice to use the lower value for Km.

2 In using other insulating materials, construction guidance and the value of Km should be provided by the manufacturer.

5B.11.3.3.1 Type A earthing

Length of the earth electrode depends on the soil resistivity and class of LPS for details and Table 11 for vertical earth electrode}. For Type A, minimum number of earth electrodes should be 2.

5B.11.3.3.2 Type B earthing

This type of arrangement comprises either a ring conductor external to the structure to be protected, in contact with the soil for at least 80 percent of its total length, or a foundation earth electrode. Such earth electrodes may also be meshed. For the ring earth electrode (or foundation earth electrode), the area enclosed by the ring earth electrode (or foundation earth electrode) shall be not less than the value of Type A earthing as given in Table 10.

Table 10: Minimum Length of Vertical Earth Electrode

SI No. (1)	**Class of LPS**	**Typical Length of Each Vertical Earth Electrode Based on Soil Resistivity** m			
		Up to 500 Ω-m	1000 Ω-m	2000 Ω-m	3000 Ω-m
(1)	(2)	(3)	(4)	(5)	(6)
i)	I	2.5	10	25	40
ii)	II	2.5	5	15	25
iii)	III	2.5	2.5	2.5	2.5
iv)	IV	2.5	2.5	2.5	2.5

5B.11.3.3.3 In structures where only electrical systems are provided, a Type A earthing arrangement may be used, but a Type B earthing arrangement is preferable. In structures with electronic systems, a Type B earthing arrangement is recommended.

5B.11.3.3.4 In industrial and commercial structures, the ring earth electrode around the structure or the ring earth electrode in the concrete at the perimeter of the foundation, should be integrated with a meshed network under and around the structure, having a mesh width of typically 5 m. This greatly improves the performance of the earth-termination system. If the basement's reinforced concrete floor forms a well-defined interconnected mesh and is connected to the earth termination system, typically at every 5 m, the same will also be suitable.

5B.11.3.3.5 For buildings without steel reinforced foundation (brickwork/stones) a Type B earth termination (ring earthing) shall be installed.

5B.11.3.3.6 Where large numbers of people frequently assemble in an area adjacent to the structure to be protected, further potential control for such areas should be provided. More ring earth electrodes should be installed at distances of approximately 3 m from the first and subsequent ring conductors. Ring electrodes further from the structure should be installed more deeply below the surface, that is, those at 4 m from the structure at a depth of 1 m, those at 7 m from the structure at a depth of 1.5 m and those at 10 m from the structure at a depth of 2 m. These ring earth electrodes should be connected to the first ring conductor by means of radial conductors.

5B.11.3.3.7 For buildings integrating structural steel as down-conductor and earth-termination, earth resistivity measurements are not required. Proper drawings should be made based on the actual installation and submitted to authorities if necessary. See also good practice.

5B.11.3.4 *Use of Natural Components*

Natural components are conductive components installed in a building not specifically for lightning protection which can be used to provide the function of one or more parts of the LPS.

Natural components made of conductive materials, which will always remain in/on the structure (for example, interconnected steel-reinforcement, metal framework of the structure, steel roof, metal facade, handrails, etc) should be used as parts of an LPS such as air-termination, down-conductor and earthing, if it satisfies the requirement according to good practices. Bonding of different metallic installations in the building should be done to avoid dangerous potential differences which results in flashover. This integrated method is not only economical but does not influence or spoil the aesthetics of the building. It also reduces the failure of electronic equipment inside the building from radiated lightning effects.

In case of natural down-conductors combined with foundation earth electrodes, test joints are not required and earth resistance measurements are not necessary.

5B.11.3.4.1 *Continuity of steelwork in reinforced concrete structures*

Steelwork within reinforced concrete structures is considered to be electrically continuous provided that the major part of interconnections of vertical and horizontal bars are welded or otherwise securely connected. Connections of vertical bars shall be welded, clamped or overlapped a minimum of 20 times their diameters and bound or otherwise securely connected. For new structures, the connections between reinforcement elements shall be specified by the designer or installer, in cooperation with the builder and the civil engineer.

For structures utilizing steel reinforced concrete (including pre-cast, pre-stressed reinforced units), the electrical continuity of the reinforcing bars shall be determined by electrical testing between the uppermost part and ground level (see Fig. 17). The overall electrical resistance should not be greater than 0.2 Ω, measured using test equipment suitable for this purpose. If this value is not achieved, or it is not practical to conduct such testing, the reinforcing steel shall not be used as a natural down-conductor. In this case it is recommended that an external down-conductor be installed. In the case of structures of pre-cast reinforced concrete, the electrical continuity of the reinforcing steel shall be established between individual adjacent pre-cast concrete units.

5B.11.3.4.2 *Bonding network*

A low impedance bonding network is needed to avoid dangerous potential differences between all equipment inside the building. Moreover, such a bonding network also reduces the magnetic field, thereby reduces the radiated surges inside the building and provides more protection for electrical/electronic equipment.

This can be realized by a meshed bonding network integrating conductive parts of the structure, or parts of the internal systems, and by bonding metal parts or conductive services at the boundary of each LPZ directly or by using suitable SPDs.

The bonding network can be arranged as a three dimensional meshed structure with a typical mesh width of 5 m (see Fig. 18 and Fig. 19). This requires multiple interconnections of metal components in and on the structure (such as concrete reinforcement, elevator rails, cranes, metal roofs, metal facades, metal frames of windows and doors, metal floor frames, service pipes and cable trays). Bonding bars (for example, ring bonding bars, several bonding bars at different levels of the structure) and magnetic shields of the LPZ shall be integrated in the same way.

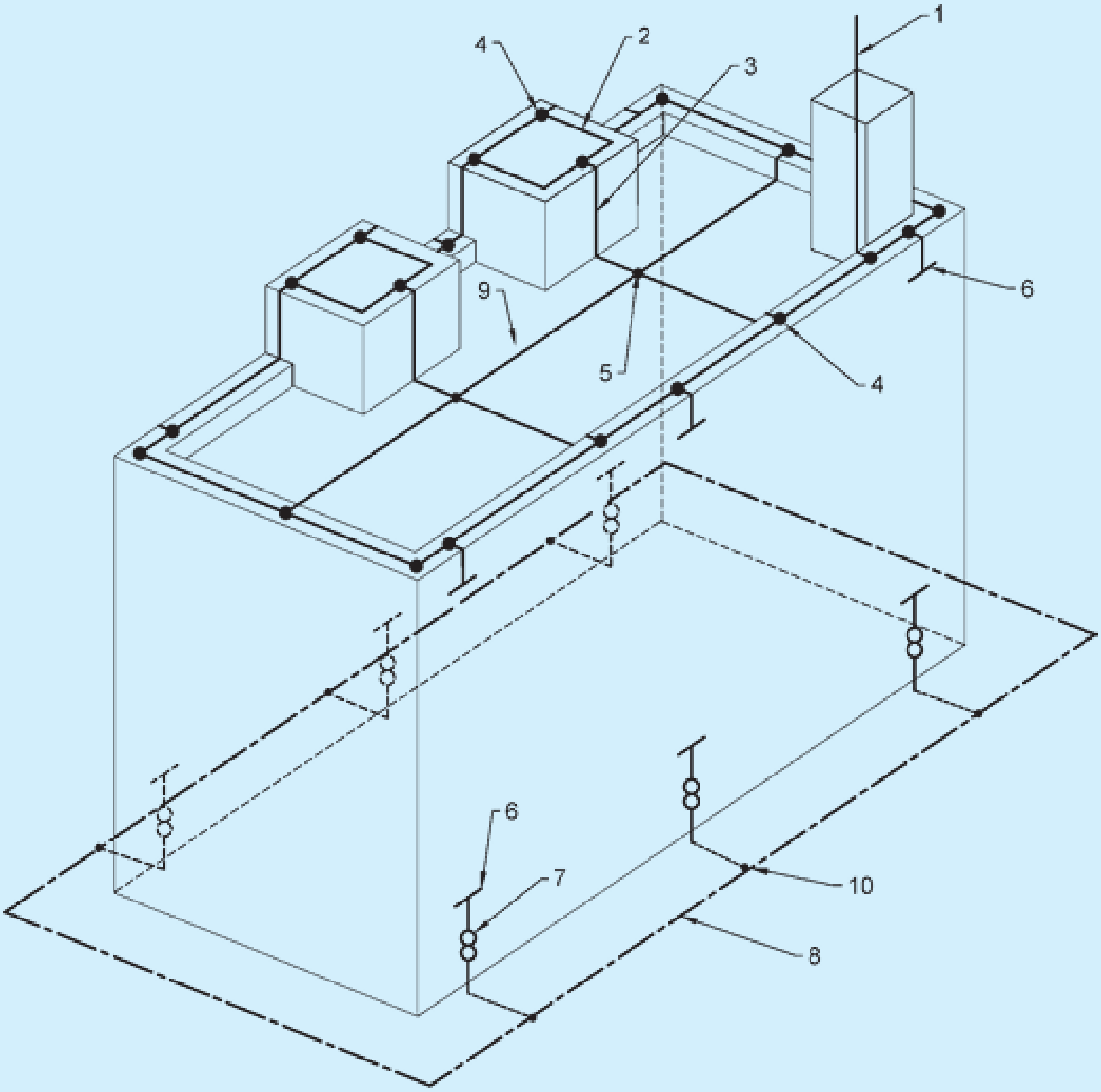
Conductive parts (for example, cabinets, enclosures, racks) and the protective earth conductor (PE) of the internal systems shall be connected to the bonding network.

5B.11.3.5 *Materials and Dimensions*

Copper and aluminium are recommended for exposed areas on installations required to have a long life. Galvanized steel may be preferred for temporary installations such as exhibition centres. Although it is a common practice to use material in the form of strip for horizontal air-terminations, down-conductors and bonds, it is more convenient to use round material, particularly as it facilitates the making of bends in any plane. If different materials are used in an installation, care should be taken to avoid galvanic corrosion by the use of bi-metallic connectors. See Tables 11 to 12 for details.

5B.11.3.6 Protection measures against injury to living beings due to touch voltage and step voltage shall be provided in accordance with good practice.

5B.11.3.7 Inspection of the LPS shall be done as per the good practice.

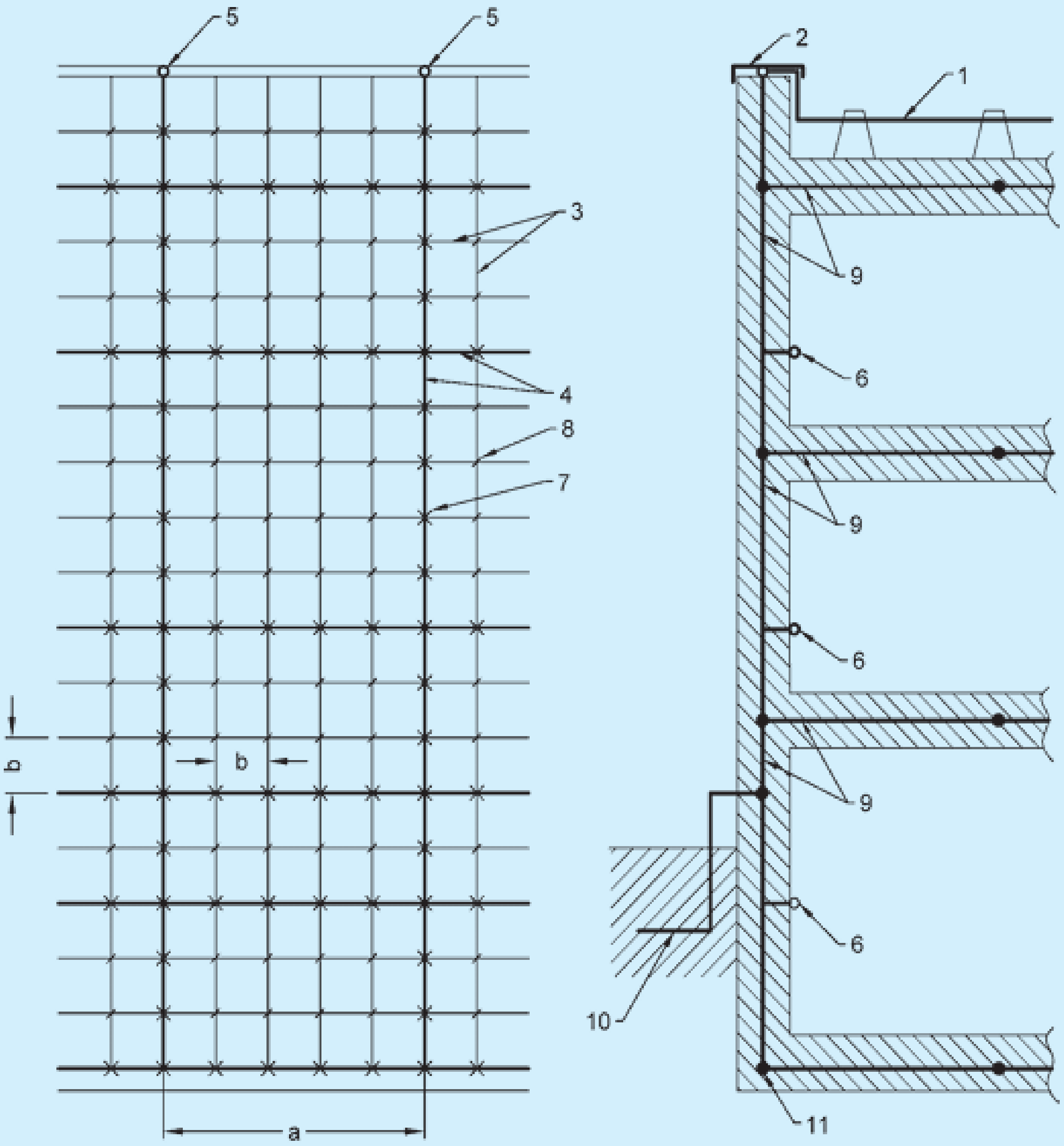


Key

1 Air-termination rod
2 Horizontal air-termination conductor
3 Down-conductor
4 T-type joint
5 Cross type joint
6 Connection to steel reinforcing rods {*see* **E-4.3.3** and **E-4.3.6** of good practice [8-2(45)]}
7 Test joint
8 Type B earthing arrangement, ring electrode
9 Flat roof with roof fixtures
10 T-type joint — corrosion resistant

NOTE — The steel reinforcement of the structure should comply with available Indian Standards. All dimensions of the LPS should comply with the selected protection level.

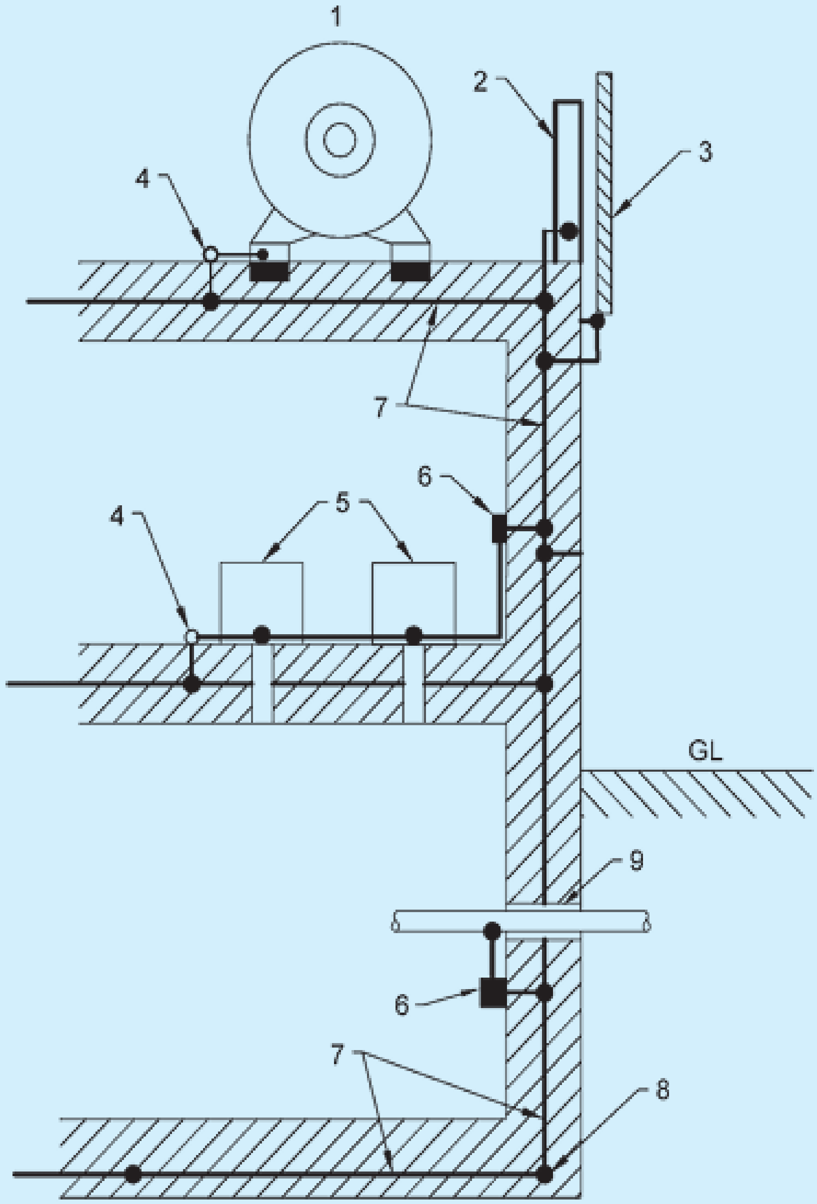
FIG. 17 CONSTRUCTION OF EXTERNAL LPS ON A STRUCTURE OF STEEL-REINFORCED CONCRETE USING THE REINFORCEMENT OF THE OUTER WALLS AS NATURAL COMPONENTS



Key

1 Air-termination conductor
2 Metal covering of the roof parapet
3 Steel reinforcing rods
4 Mesh conductors superimposed on the reinforcement
5 Joint of the mesh conductor
6 Joint of the internal bonding bar
7 Connection made by welding or clamping
8 Arbitary connection
9 Steel reinforcement in concrete (with super imposed mesh conductors)
10 Ring earthing electrode (if any)
11 Foundation earthing electrode
a Typical distance of 5 m for superimposed mesh conductor
b Typical distance of 1 m for connecting this mesh with the reinforcement

FIG. 18 UTILIZATION OF REINFORCING RODS OF A STRUCTURE FOR EQUIPOTENTIAL BONDING



Key

1 Electric power equipment
2 Steel girder
3 Metal covering of the facade
4 Bonding joint
5 Electrical or electronic equipment
6 Bonding bar
7 Steel reinforcement in concrete (with superimposed mesh conductors)
8 Foundation earthing electrode
9 Common inlet for different services

FIG. 19 EQUIPOTENTIAL BONDING IN A STRUCTURE WITH STEEL REINFORCEMENT

Table 11: LPS Materials and Conditions of Use[1)]

Sl No.	Material	Use			Corrosion		
		In Open Air	In Earth	In Concrete	Resistance	Increased by	May be destroyed by galvanic coupling with
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Copper	Solid	Solid	Solid	Good in many environments	Sulphur compounds Organic materials	—
		Stranded	Stranded	Stranded			
		—	As coating	As coating			
ii)	Hot galvanized steel[2), 3) and 4)]	Solid	Solid	Solid	Acceptable in air, in concrete and in benign soil	High chlorides content	Copper
		Stranded[5)]		Stranded[5)]			
iii)	Steel with electro-deposited copper	Solid	Solid	Solid	Good in many environments	Sulphur compounds	
iv)	Stainless steel	Solid	Solid	Solid	Good in many environments	High chlorides content	—
		Stranded	Stranded	Stranded			
v)	Aluminium	Solid	Unsuitable	Unsuitable	Good in atmospheres containing low concentrations of sulphur and chloride	Alkaline solutions	Copper
		Stranded					

1) This table gives general guidance only. In special circumstances more careful corrosion immunity considerations are required.
2) Galvanized steel may be corroded in clay soil or moist soil.
3) Galvanized steel in concrete should not extend into the soil due to possible corrosion of the steel just outside the concrete.
4) Galvanized steel in contact with reinforcement steel in concrete may, under certain circumstances, cause damage to the concrete.
5) Stranded conductors are more vulnerable to corrosion than solid conductors. Stranded conductors are also vulnerable where they enter or exit earth/concrete positions. This is the reason why stranded galvanized steel is not recommended in earth.

5B.11.4 Protection of Electrical/Electronic Systems within Structures

5B.11.4.1 The internal LPS shall avoid the occurrence of dangerous sparking within the structure to be protected due to lightning current flowing in the external LPS or in other conductive parts of the structure. Dangerous sparking between different parts can be avoided by means of equipotential bonding or electrical insulation between the parts.

Permanent failure of electrical and electronic systems can be caused by the lightning electromagnetic impulse (LEMP) via:

a) Conducted and induced surges transmitted to equipment via connecting wiring; and

b) The effects of radiated electromagnetic fields directly into equipment itself.

Surges to the structure can originate from sources external to the structure or from within the structure itself, and

1) surges which originate externally from the structure are created by lightning flashes striking incoming lines or the nearby ground, and are transmitted to electrical and electronic systems within the structure via these lines.

2) surges which originate internally within the structure are created by lightning flashes striking the structure itself or the nearby ground. Surges can also originate internally within the structure from switching effects (for example, switching of inductive loads).

The coupling can arise from different mechanisms such as,

i) resistive coupling (for example, the earth impedance of the earth-termination system or the cable shield resistance); and

ii) magnetic field coupling (for example, caused by wiring loops in the electrical and electronic system or by inductance of bonding conductors).

In general electrical and electronic systems are subject to damage from a lightning electromagnetic impulse (LEMP). The wave shapes of lightning impulse and surges are given in good practices [8-2(46)] and [8-2(48)]. The lightning current parameters given under 11.2 may also be referred. LEMP protection measures (SPM) need to be provided to avoid failure of internal systems. The design of SPM should be carried out by experts in lightning and surge protection who possesses a broad knowledge of installation practices of lightning protection systems.

5B.11.4.2 *Lightning Protection Zone Concept*

Protection against LEMP is based on the lightning protection zone (LPZ) concept. The zone containing systems to be protected shall be divided into LPZs. These zones are theoretically assigned part of space (or of an internal system) where the LEMP severity is compatible with the withstand level of the internal system. Successive zones are characterized by significant changes in the LEMP severity. The boundary of an LPZ is defined by the protection measures employed.

Table 12: Material, Configuration and Minimum Cross-Sectional Area of Air-Termination Conductors And Rods, Earth Lead-in Rods and Down-Conductors[1)]

Sl No.	Material	Configuration	Minimum Cross-Sectional Area mm^2
(1)	(2)	(3)	(4)
i)	Copper, Tin plated Copper	Solid tape	50
		Solid round[2)]	50
		Stranded[2)]	50
		Solid round[3)]	176
ii)	Aluminium	Solid tape	70
		Solid round	50
		Stranded	50
iii)	Aluminium alloy	Solid tape	50
		Solid round	50
		Stranded	50
		Solid round[3)]	176
iv)	Copper coated aluminium alloy	Solid round	50
v)	Hot dipped galvanized steel	Solid tape	50
		Solid round	50
		Stranded	50
		Solid round[3)]	176
vi)	Copper coated steel	Solid round	50
		Solid tape	50
vii)	Stainless steel	Solid tape[4)]	50
		Solid round[4)]	50
		Stranded	50
		Solid round[3)]	176

1) Mechanical and electrical characteristics as well as corrosion resistance properties shall meet the requirements of the IEC 62561 series.

2) 50 mm^2 (8 mm diameter) may be reduced to 25 mm^2 in certain application where mechanical strength is not an essential requirement. Consideration should in this case, given to reducing the space between fasteners.

3) Applicable for air-termination rods and earth lead-in rods. For air-termination rods where mechanical stress such as wind loading is not critical, a 9.5 mm diameter, 1 m long rod may be used.

4) If the thermal and mechanical considerations are important, then these values should be increased to 75 mm^2.

5B.12 ELECTRICAL INSTALLATIONS FOR CONSTRUCTION AND DEMOLITION SITES

5B.12.1 General

5B.12.1.1 Electrical hazards are a major cause of serious injury and even death in construction sites. Accidents also cause loss of productivity and destroy the morale of workers. The need to use electricity and electrical/ electronic equipment has been constantly increasing. Without these gadgets productivity and quality of work will suffer. Therefore the use of electricity and the use of gadgets has to increase. Such increase requires a proper electrical distribution system in the work site.

5B.12.1.2 To ensure continuous supply of power during the construction activity and maintain productivity, site security, etc, the city power supply may required to be supplemented by on-site standby power generation. Some gadgets require continuity of power supply without interruption, thereby requiring UPS systems. In a typical large construction site there may be a large temporary distribution network combined with more than one source of electricity, which can make the system quite complex from the safety point of view.

5B.12.1.3 Problem may also arise in case of lack of required training to workers in the safe use of the tools and equipment that they are required to handle in a system with multiple sources of power supply. In case of use of imported equipment which may be manufactured to their own standards, problems may arise, such as, during connection and inter-connection of equipment and tools and mismatch of plugs and sockets.

5B.12.1.4 Practical guidance to employers, designers, manufacturers, importers, suppliers (including hirers), electrical contractors and electricians on eliminating or reducing the risk of electrocution and electric shock to any person is necessary.

5B.12.1.5 Even though awareness exists about good practices, the same may be compromised at times in the name of speed or economy or due to ignorance and neglect. The materials, equipment, tools, cables, switchgear used in the temporary installation face far more severe environmental working conditions. Use of discarded switchgear, cables, etc, at the construction sites compounds the risk to workmen from shock and fire. The laid down standard need to be followed during construction and demolition meticulously as in the case of permanent installations during building use.

5B.12.2 Installation and Removal of Construction Wiring

All construction wiring work shall be installed by an appropriately registered electrical worker as required by The Myanmar Electricity Act, 2003 and only by electrical workmen holding licence of the appropriate level of competence depending on the voltage, local generation, etc. The installation should be inspected prior to commissioning and at regular intervals by the Engineer-in-Charge (if he is qualified to inspect electrical installations) or by his representative, who should be competent to inspect an installation.

5B.12.3 Provision of Indicating and Recording Instruments and Meters

Measurement is a prerequisite to analyze the performance. Construction site switchboards should have adequate instrumentation (such as, ammeters, PF meters, voltmeters, energy meters) on different branches of the distribution system so that any abnormal condition or overload is noticed. Considering the nature of varying activity in a construction site, frequent visual and instrument based inspections are necessary keeping record of the same.

5B.12.4 RCCB/RCD

Following shall be ensured in construction and demolition sites:

a) Every electric supply to which electrical plant can be connected should incorporate an RCCB/RCD so as to protect persons who may come into contact with the electrical plant against electric shock.

b) The RCCB/RCD(s) should have a rated tripping current not exceeding 30 mA and should have the capacity to carry the load current required by the appliances permitted to be connected in that branch circuit or feeder.

c) Where construction work supply can only be obtained from a permanent wiring socket outlet, RCCB/RCD should be connected at the socket outlet.

d) Sub-mains supplying site sheds should incorporate an RCCB/RCD having a rated tripping current not exceeding 100 mA.

e) Every non-portable RCCB/RCD device on the worksite shall be trip tested by the built-in push button test monthly, and performance tested for operation before being put into service and thereafter at least once every 12 months. It shall also be subjected to an imbalance of current not less than the rated residual current and shall trip in a time not exceeding 6 s.

f) Every portable RCCB/RCD device on the worksite shall be trip tested by the built-in push button test. The test shall be done prior to use and each day while in use; and it shall be performance tested for operation before being put into service and thereafter at least once every 3 months. It shall also be subjected to an imbalance of current not less than the rated residual current and shall trip in a time not exceeding 6 s.

g) Results of RCCB/RCD tests shall be recorded and kept on site or made available for audit and kept for a minimum period of 5 years [excluding the daily push button test for portable RCCB/RCD(s)].

h) Portable RCCB/RCD(s) when tested shall be fitted with a durable, non-reusable, non metallic tag. The tag shall include the following information:

   1) The name of the person or company who performed the tests; and

   2) The test or retest date. The recommended colour coding for tags on tested RCCB/RCD, which is prescribed below should be indicated by its colour representing the period when the test was performed:

January – March	: Red
April – June	: Green
July – September	: Blue
October – December	: Yellow

i) Portable generators should be fitted with RCDs and the RCDs should be fitted with core balance earth leakage protection having a rated tripping current not exceeding 30 mA.

j) Personal hoists used on construction sites shall be supplied from a separate final sub-circuit originating from the main switchboard; and be suitably identified by marking this supply, the RCD/MCB feeding it.

5B.12.5 Temporary Supply Switchboards

All temporary supply switchboards used on building, construction and demolition sites shall be of robust construction and either securely attached to a pole, post wall or other structure which may be of stable freestanding design and,

a) where installed in outdoor locations, should be constructed and maintained to IP23 (or higher) rating so that safe operation is not affected by the weather;

b) switchboards should incorporate the support and elevation of cables and flexible extension cords;

c) switchboard enclosures shall be provided with an insulated or covered tie-bar or similar arrangement for the anchorage of the cables or flexible cords in order to prevent strain and mechanical damage at the termination of the cables or cords;

d) switchboards should be provided with a door and locking facility. The doors should be designed and attached in a manner that will not damage any flexible cord connected to the board and should protect the switches from mechanical damage;

e) the door should be provided with signs (in English, Hindi and at least one local language) stating, 'KEEP CLOSED — LEADS THROUGH BOTTOM';

f) switchboards should have an insulated slot (with edges suitably shaped or covered with plastic or rubber trims to avoid damaging the cable insulation/sheath) at the bottom for the passage of leads;

g) switchboards should be attached to a permanent wall or suitable portable or temporary structure in an elevated position suitable for easy access and least interference with the activity in the area.

h) if the floor in that area is likely to be wet, additional precautions are necessary and an insulated platform should preferably be provided for access to operation of switches. Personal protective equipment such as gloves should be available, placed near the switchboard, as an alternative.

i) a clearance of at least 1.0 m should be maintained in front of all switchboards;

j) the contractor or nominated persons should ensure that all power circuits are isolated or made inaccessible so as to eliminate the risk of fire, electric shock or other injury to persons after completion of the daily work;

k) switchboards shall be legibly and indelibly marked with a set of numbers or letters or both which uniquely identify the switchboard from others on a site;

l) switchboards shall be marked to indicate the presence of live parts in accordance with symbols such as the following drawing:

m) chart indicating first aid measures for electric shock management should be placed near the switchboard;

n) 'Lock Out and Tag Out' procedures as adopted should be displayed;

o) the switchboard should be lighted properly to ensure its identification and safe working; and

p) all switchboards should have their identification names (or/and numbers) so that and communication/instructions about them are unambiguous.

5B.12.6 Cables Used in Worksite Installations

5B.12.6.1 Worksite poses a number of hazards to the cables. The conditions are severe compared to those in permanent installations. Cables face dust, moisture, abrasives and even impact unlike those in permanent installations. Extra care should be taken to frequently inspect the cables and discard cables which show signs of damage as a damaged insulation combined with moisture can be dangerous.

5B.12.6.2 Cables are likely to be run over by vehicles. Suitable protection by a steel pipe or hume pipe or steel plate, whichever is appropriate, is required. Dragging of cables damages their sheath/insulation and may also cut a few strands of the conductor due to stretching, effectively reducing the current carrying capacity.

5B.12.6.3 Overhead installation of cables is a common practice. Such installations should use a GI wire to carry the weight of the cable without causing the stretching of the cable. The carrier GI wire should be earthed. Unarmoured cables shall not be installed on metallic roofs or similar structures unless suitably protected against mechanical damage.

Overhead wiring should be positioned to avoid crossing roadways or accessways where cranes, high loads, or heavy machinery may travel. Where it is not possible to avoid accessways an effective means shall be provided to minimize the risk of the vehicular contact with the aerial wiring system. This condition may be satisfied by the placement of flagged catenary wires or cables of suitable material across the accessway 6 m on either side of the overhead wiring and 0.6 m below the lowest point of the overhead electrical cables or lower.

All aerial conductors installed on construction and demolition sites shall be insulated. Cables supported by means of a catenary shall be stranded or shall be flexible cables affording double insulation or the equivalent of double insulation. Construction wiring (including switchboards) shall be visually inspected at intervals not exceeding 6 weeks.

5B.12.7 Extension Cords and Fittings

5B.12.7.1 It shall be ensured that 3-pin plugs and cord extension sockets used on flexible extension cords and portable power tools are either of non-rewirable (moulded) or transparent type. Cables that are normally used for fixed wiring should not be used as flexible extension cords.

5B.12.7.2 Flexible extension cords shall not be located with plug socket connections in wet places or places where they may be subject to damage by liquids. Fittings for flexible cables or flexible extension cords shall be wired identically and the identity of phase, neutral and earth connections are preserved in a like manner. Bending radius limits for cables should be strictly ensured; else internal breakage of strands can occur leading to reduction of capacity, spot heating, etc.

Flexible extension cords used in multi-storeyed building construction works shall be confined to the same floor as the power source, except in case of formwork; external staging; lift or service shafts; and stairwells. Extension cords shall be confined to not more than one storey above or below the location of the switchboard and be mechanically protected in the transition area between storeys and in places where damage is likely to occur.

The recommended maximum length of a 230 V cord extension is given below:

Sl No.	*Cord Extension Set Rating* A	*Conductor Area* mm^2	*Maximum Length of Flexible Cord* m
(1)	(2)	(3)	(4)
i)	10	1.0	25
		1.5	35
		2.5	60
ii)	15	1.5	25
		2.5	40
iii)	20	2.5	30
		4.0	50

5B.12.7.3 Joints in temporary wiring shall be avoided. Unavoidable joints should be made with suitable crimped ferrule and insulated with PVC tape on individual core joints and further protected by a sleeve or a covering of tape. Combination of teflon tape followed by PVC tape is recommended where exposure to water is anticipated.

5B.12.7.4 Construction wiring shall be readily distinguishable from permanent wiring by using cable of a different colour or by attaching iridescent yellow tape spaced at intervals not exceeding 5 m and stamped with the words ‘construction wiring’.

5B.12.8 Electrical Plant in Service Testing

Electrical plant shall be inspected and tested in accordance with the following:

a) Movable electrical plant that is hand held or portable during operation or moved between operations and is subject to damage or harsh environment shall be examined and tested every 3 months.

b) All other electrical plant used for construction purposes shall be inspected and tested at intervals not exceeding 6 months.

c) When any equipment inspected or tested in accordance with (a) and (b) is found to be unsatisfactory, it shall be withdrawn from service immediately and have a label attached to it, ‘Warning against Further Use’. Electrical plant found to be unsatisfactory shall not be returned to service until it has been repaired and retested.

d) The inspection and testing specified should be carried out by an authorized/qualified person.

e) The results of the inspection of electrical plant should be recorded and kept on site or made available for inspection by authorities. Information recorded shall include,

   1) the name of the person or company who performed the tests;

   2) the test or retest date; and

   3) identification of faulty equipment and action taken to repair or remove it from use.

5B.12.9 Lighting

Following in respect of lighting shall be ensured in construction and demolition sites:

a) Access lighting — Adequate artificial lighting should be installed to illuminate the work area, if there is insufficient natural lighting. Lamps in luminaires shall be protected against mechanical damage. Luminaires installed as part of the permanent electrical installation in site accommodation, may not require further mechanical protection. Sufficient battery powered lighting shall be installed in stairways and passageways to allow safe access and exit from the area if there is insufficient natural lighting. If there is a loss of supply to the normal lighting in the area, it should be ensured that battery powered lighting has sufficient capacity to operate for one hour to allow persons to exit the building safely. Temporary wiring supplying lighting circuits should be connected to the designated lighting circuits of the switchboard.

b) Task lighting — Portable luminaires shall be provided with the appropriate ingress protection (IP) rating. Task lighting in many construction site may have to move continuously in steps as the work progresses. The lighting system should also be shifted in suitable steps instead of simply extending the cables without any consideration for safety. Hand held additional lights, if any, should be taken from a socket protected by a RCCB/RCD of 30 mA setting just like hand held tools.

c) Lift and service shaft lighting — Lift and service shaft lighting may have either construction wiring or permanent wiring. Fluorescent lighting should be used. The lights should be located on the floor above or below the work area. It shall be ensured that the emergency lighting has sufficient battery capacity to operate for a minimum of 1 h, if there is a loss of supply to the normal lighting in the area.

d) Lighting in means of egress — Sufficient battery powered lighting shall be installed in stairways and passageways to allow safe access and exit from the area if there is insufficient natural lighting. If there is a loss of supply to the normal lighting in the area it shall be ensured that battery powered lighting has sufficient capacity to operate for sufficient time to allow persons to exit the building safely.

e) Illumination of signs and warning boards — Sufficient lighting should be available to illuminate the sign boards and warning boards. These lights may also be a part of the lighting set for means of egress.

5B.12.10 Transportable Construction Buildings (Site Sheds)

Electrical installations to transportable construction buildings shall comply with the following:

a) If supply is by means of a flexible cord, the same shall not be taken from one transportable building to another transportable building;

b) The flexible cord supplying a transportable building should not be more than 15 m in length;

c) Each amenity in the building shall be connected/supplied by a flexible cord to a final sub-circuit protected by an RCCB/RCD device with a rated tripping current not exceeding 30 mA; these flexible cords should be protected from mechanical damage and power outlets in site sheds should be used to supply power to the equipment and lighting within the shed only; and

d) Socket-outlets installed on the outside of transportable building shall be used only to supply power to the following:

   1) Electrical equipment and lighting immediately adjacent to those transportable buildings.

2) Other transportable buildings when the socket-outlet is part of an interconnecting system and the flexible cord supplying those transportable buildings has a maximum length of 15 m.

5B.12.11 Lock-Out and Tag-Out Practices

Whenever an electrician is to work on a branch feeder from the switchboard it becomes necessary that the switch feeding the feeder on which work is done is to be switched-off and should be kept switched-off till the same electrician decides to switch on after completion of work either for testing or for putting the section back into service. To ensure that during the period an electrician is working on a feeder or the equipment it feeds, the practice is to put a ‘Tag’ on the concerned switch. The tag will carry details about which authorized worker has put the tag and when and who is authorized to remove it. This is a very critical operating practice for maintenance of the electrical system and following it is of particular importance in the case of temporary installations, where such requirements arise more often than in permanent installations.

Lock-out procedure shall be similar to the above but the difference is that the relevant switch is kept locked in off position and the key is kept by the person or the team leader who will be working on the feeder. The system should also maintain a register where the activities of this nature and the details of action (repair, transfer of the end equipment to a new location, addition of a new appliance on the feeder, etc) are recorded.

5B.12.12 Standard Operating and Maintenance Practices in Sites with More than One Source of Electricity

5B.12.12.1 In medium and large construction sites it is common to use local generation of electricity by a diesel generating set. The reasons may be lack of dependable local/city distribution system for continuous power supply, high cost of temporary connection charges, restrictions on use of certain equipment like welding transformers on temporary connection, etc. Apart from DG sets for power requirement of site construction equipment, there may be office equipment with computers, site laboratory equipment which require un interruptible power supply. Shock hazards depend on the voltage of the system and the consequent current flow through the body. As such shock risk associated with all these sources is the same.

5B.12.12.2 Wherever an alternative power supply is provided, proper protocols shall be adopted for the supply from different systems and the associated change over switch or contactors. Risk increases due to existence of more than one source of power supply. System schematics, operating practice and essential interlock between the different sources of power should be displayed and followed systematically. Earthing for each system should be provided. Changeover switches should be of 4-pole in order to ensure that earth leakage protections operate properly with each one of the power sources. The system should also maintain a register where the activities related to each source of power is recorded and the actions to be taken are provided.

5B.12.13 Earthing or Grounding

5B.12.13.1 Earthing or grounding is an essential prerequisite for any electrical system from the aspect of safety of personnel, equipment, appliances and for avoidance of fire due to short-circuit or of feeding energy to a short circuit originating from any other cause consequent to damage to insulation by the fire.

5B.12.13.2 The standard earthing practice is applicable to temporary installations also. The earthing sets installed at the initial development of the site can be planned to be retained as earthing sets for use even after the completion of the building for the permanent installation.

5B.12.13.3 The minimum requirement of earthing for any temporary electrical installation is given hereunder for easy adherence to the basic minimum. It is recommended to follow the earthing requirements given in 8.

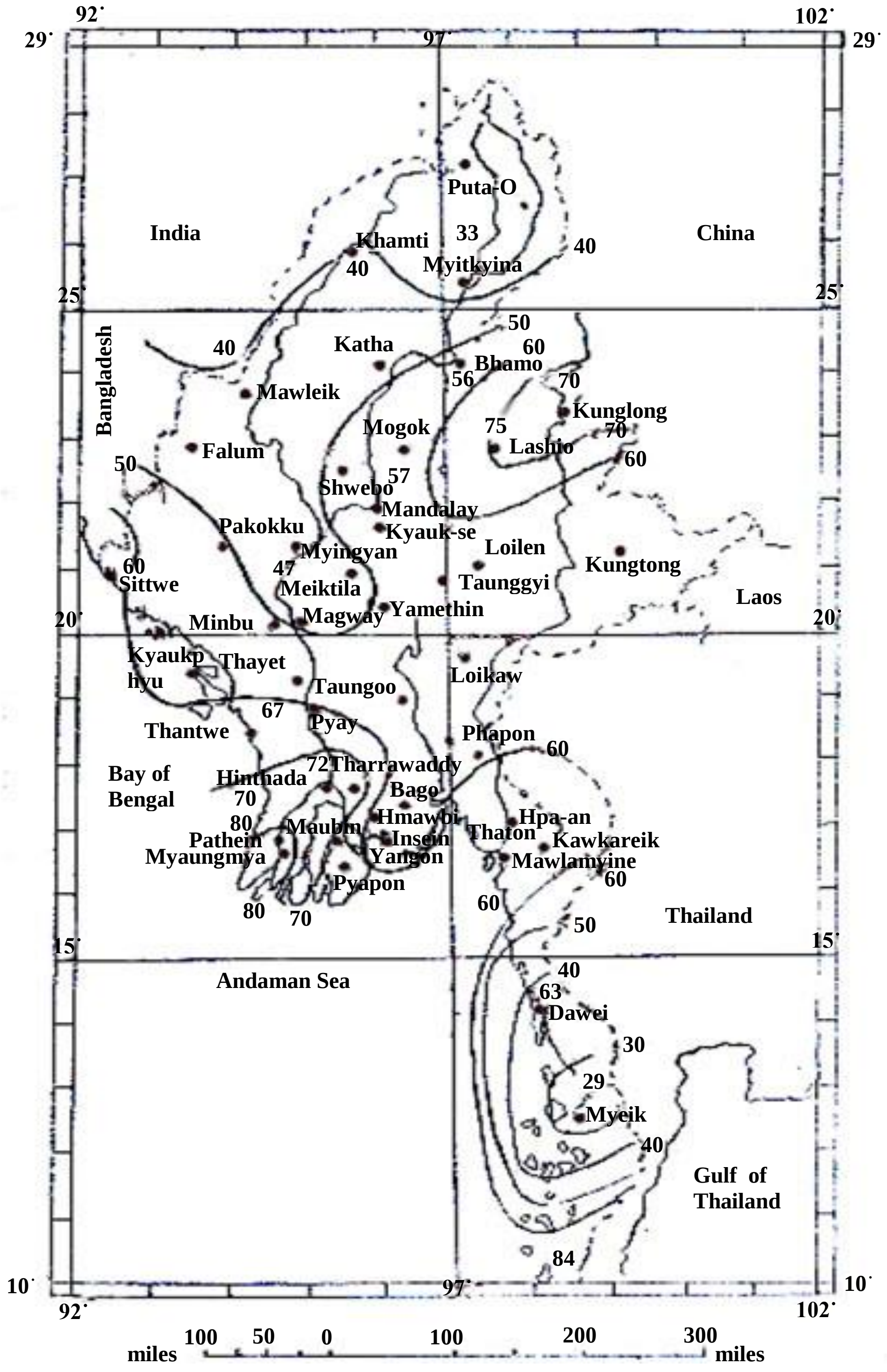
5B.12.13.3.1 The neutral of the system of each source or generator shall be having two distinct connection to two distinct earthing sets. All metal parts associated with electrical equipment are required to be connected to earth. The minimum requirement is the provision of two pipe earthing sets each with a pipe of 2.5 m length and separated by at least 2.5 m between them and connected to the source neutral by a conductor of cross-section more than half the size used for the phase conductor.

5B.12.13.3.2 Earth continuity shall be maintained all over the site wherever electricity is made available and the earth continuity conductor shall have a cross-section at least more than that used for the phase conductor.

5B.12.13.3.3 Wherever the requirements of earthing and use of RCD or RCCB cannot be satisfactorily met with at any site and electrical hand tools are required to be used, low voltage (< 50 V) appliances or self-contained battery operated tools shall be used as a safe alternative. This applies to work under damp or water logged areas also.

MYANMAR

PLACES FOR AVERAGE NUMBER OF THUNDERSTORMS DAYS IN A YEAR



(CONTOUR MAP NEED TO BE UP-DATED)

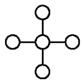
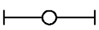
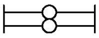
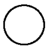
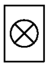
Figure - 5

ANNEX A

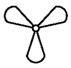
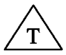
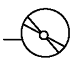
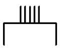
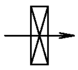
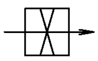
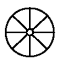
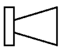
[Clause (2.2)]

DRAWING SYMBOLS RECOMMENDED FOR ELECTRICAL INSTALLATION IN BUILDING

A-Lighting Apparatus

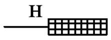
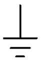
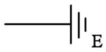
SR NO	SYMBOL	DESCRIPTION	SR NO	SYMBOL	DESCRIPTION
1		LAMP	7		CHANDELIER LIGHT
2		FLUORESCENT LAMP, SINGLE, BARE TYPE	8		SPOT LIGHT
3		FLUORESCENT LAMP, DOUBLE, BARE TYPE	9		FLOOD LIGHT
4		DOWN LIGHT	10		BULK HEAD LAMP
5		WALL BRACKET LIGHT	11		EMERGENCY LAMP
6		LIGHTING OUTLET	12	 WT	WATER TIGHT LIGHT FITTING

B-Fans

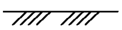
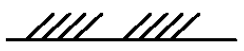
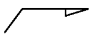
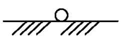
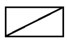
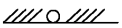
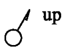
SR NO	SYMBOL	DESCRIPTION	SR NO	SYMBOL	DESCRIPTION
1		CEILING FAN	7		TELEPHONE OUTLET
2		OSCILLATING FAN, CEILING TYPE	8		TELEVISION OUTLET
3		OSCILLATING FAN, WALL TYPE	9		DATA NETWORK OUTLET
4		EXHAUST FAN, WALL TYPE	10		AMPLIFYING EQUIPMENT
5		EXHAUST FAN, CEILING TYPE	11		SIREN
6		FAN REGULATOR	12		HORN ON HOOTER

D- Electrical Circuit Diagram

SR NO	SYMBOL	DESCRIPTION	SR NO	SYMBOL	DESCRIPTION
1		TRANSFORMER	18		CONNECTING LINK, open
2		AUTO TRANSFORMER	19		JUNCTION, CONNECTION POINT
3		CURRENT TRANSFORMER	20		TERMINAL
4		FUSE	21		JUNCTION OF CONDUCTOR
5	mcb	MINIRATURE CIRCUIT BREAKER	22	123456	TERMINAL BLOCK
6	MCCB	MOULDED CASE CIRCUIT BREAKER	23		CONDUCTOR
7		SWITCH (Mechanical)	24	3	THREE CONDUCTOR
8		CIRCUIT BREAKER	25	3N~50Hz 380V 3x120 + 1x50	THREE PHASE CIRCUIT, 50Hz, 380V, Three conductors of $120mm^2$ with neutral of $50mm^2$
9		DISCONNECTOR (Isolator)	26		THREE CONDUCTOR IN CABLE
10		2 WAY DISCONNECTOR (Isolator) with off position in the centre	27		CABLE SEALING END, Show with 1no 3core cable
11		SWITCH DISCONNECTOR (Onload isolating switch)	28		CABLE SEALING END, Show with 3nos one core cable
12		CONTACTOR (Contact open in the unoperated position	29		MOTOR STARTER, General symbol
13		CONTACTOR (Contact close in the unoperated position	30		STARTER, Operated in steps
14		FUSE SWITCH	31		STARTER, Operated with star-deta
15		FUSE DISCONNECTOR (Fuse Isolator)	32		STARTER, Operated with auto transformer
16		FUSE SWITCH DISCONNECTOR (Onload isolating fuse switch)	33		STARTER, Operated in direct on line with contactor
17		CONNECTING LINK, closed	34		STARTER, Operated with starter regulator with thyristors
35		MACHINE, General symbol *Star mark shall be replaced by a letter designation as follow C Synchronous convertor G Generator GS Synchronous generator M Motor MS Synchronous motor	41		FAULT
			42		FLASH OVER
			43		CLOCK
36		FAN	44		SIGNAL LAMP
37	H	HEATER	45		SWITCH, General

SR NO	SYMBOL	DESCRIPTION	SR NO	SYMBOL	DESCRIPTION
38		STORAGE WATER HEATER	46		SWITCH WITH PILOT LAMP
39		BELL	47		SWITCH, two pole
40		EARTH, GROUND	48		EARTH POINT

E- Wiring and Distribution

SR NO	SYMBOL	DESCRIPTION	SR NO	SYMBOL	DESCRIPTION
1		GENERAL WIRING	7		WIRING GOING DOWNWARDS
2		WIRING ON SURFACE	8		WIRING GOING THROUGH
3		WIRING UNDER SURFACE	9		CIRCUIT MAIN
4		WIRING IN CONDUIT ON SURFACE	10		DISTRIBUTION BOARD
5		WIRING IN CONDUIT UNDER SURFACE (CONCEALED)	11		SUB-DISTRIBUTION BOARD
6		WIRING GOING UPWARDS	12		MAIN PANEL

F- Lightning Protection Apparatus

SR NO	SYMBOL	DESCRIPTION
1		LIGHTNING FINAL
2	T	TEST TERMINAL BOX
3	LA	EARTH FOR LIGHTNING SYSTEM
4	— — — —	CONDUCTOR

G-Fire Alarm Apparatus

SR NO	SYMBOL	DESCRIPTION
1	S	SMOKE DETECTOR
2	H	HEAT DETECTOR
3	C	MANUAL OPERATED FIRE ALARM
4		AUTOMATIC FIRE DETECTOR SWITCH
5		FIRE ALARM BELL
6	S	FIRE ALARM INDICATOR

H- Wiring Accessories

SR NO	SYMBOL	DESCRIPTION	SR NO	SYMBOL	DESCRIPTION
1		SINGLE POLE SWITCH	10		5-10A SOCKET OUTLET
2		DOUBLE POLE SWITCH	11		5-10A SWITCHED SOCKET OUTLET
3		PULL-CORD SWITCH	12		13A SOCKET OUTLET
4		2 WAY SWITCH	13		13A SWITCHED SOCKET OUTLET
5		INTERMEDIATE SWITCH	14		15A SOCKET OUTLET
6	D	DIMMER SWITCH	15		15A SWITCHED SOCKET OUTLET
7		TIME SWITCH	16		5-10A INTERLOCKING SWITCHED SOCKET OUTLET
8		PUSH BUTTON	17		13A INTERLOCKING SWITCHED SOCKET OUTLET
9		BELL	18		15A INTERLOCKING SWITCHED SOCKET OUTLET

Note - All socket outlets are with earthing.

ANNEX B

[Clause 5B.4.2.4(b)]

AREA REQUIRED RECOMMENDED FOR TRANSFORMER ROOM AND SUBSTATION FOR DIFFERENT CAPACITIES

B-l The requirement for area for transformer room and substation for different capacities of transformers is given below for guidance:

Sr No	Capacity of Transformer(s) KVA	Total Transformer Room Area Minimum, m^2	Total Substation Area (In Coming, MV, LV Panels, Transformer Room but Without Generators), Minimum, m^2	Suggested Minimum Face Width, m
i)	1 x 160	14.0	90	9.0
ii)	2 x 160	28.0	118	13.5
iii)	1 x 250	15.0	91	9.0
iv)	2 x 250	30.0	121	13.5
v)	1 x 400	16.5	93	9.0
vi)	2 x 400	33.0	125	13.5
vii)	3 x 400	49.5	167	18.0
viii)	2 x 500	36.0	130	14.5
ix)	3 x 500	54.0	172	19.0
x)	2 x 630	36.0	132	14.5
xi)	3 x 630	54.0	176	19.0
xii)	2 x 800	39.0	135	14.5
xiii)	3 x 800	58.0	181	14.0
xiv)	2 x 1000	39.0	149	14.5
xv)	3 x 1000	58.0	197	19.0

NOTES

1 The above dimensions are overall area required for substation excluding generating set.

2 The clear height required for substation equipment shall be minimum of 3.0 m below the soffit of the beam.

3 The area and height required for transformer room given in the above table are for general guidance only and may be finally fixed according to actual requirements.

ANNEX C

[Clause 5B.4.2.4(i)]

ADDITIONAL AREA REQUIRED RECOMMENDED FOR GENERATOR IN ELECTRIC SUBSTATION

C-l The requirement of additional area for generator in electric substation for different capacities of generators is given below for guidance:

Sr. No	Capacity KW	Area m^2	Clear Height below the soffit of the Beam M
(1)	(2)	(3)	(4)
i)	25	56	3.6
ii)	48	56	3.6
iii)	100	65	3.6
iv)	150	72	4.6
v)	248	100	4.6
vi)	350	100	4.6
vii)	480	100	4.6
viii)	600	110	4.6
ix)	800	120	4.6
x)	1000	120	4.6
xi)	1250	120	4.6
xii)	1600	150	4.6

NOTE — The area and height required for generating set room given in the above table are for general guidance only and may be finally fixed according to actual requirements.

ANNEX D

CHECKLIST FOR INSPECTION, HANDING OVER AND COMMISSIONING OF VARIOUS EQUIPMENT OF SUBSTATION

E-1 Typical format for checklist for inspection, handing over and commissioning of HV cables is given below.

NOTE — Format given below covers a basic minimum check list; it should be augmented for specific and special cases. The checklist has to be repeated for each HV cable.

HV CABLE INSPECTION, HANDING OVER AND COMMISSIONING DETAILS

A) DETAILS OF WORK

1) Scope of works :
2) Handed over by :
3) Taken over by :
4) Date of commissioning :
5) Date of handing over :
6) Details of enclosures :

Sr. No	Description	Applicable	Not Applicable
(1)	(2)	(3)	(4)
i)	Quality check list		
ii)	Site test report		
iii)	As built GA drawing/layout		
iv)	Manufacturer's test certificates		
v)	Operation and maintenance manual		

Handed over by	Taken over by
Authorized signatory	Authorized signatory

B) QUALITY CHECK LIST

Item: Installation of HV Cables

Make:

Sr. No	Tests Parameters	Bench Mark	Actual Observations	Remark
(1)	(2)	(3)	(4)	(5)
i)	Cable size			
ii)	Voltage grade			
iii)	Type of material			
iv)	Check for routing			
v)	Meggering using 2.5 kV insulation tester			
	R-Y			
	Y-B			
	B-R			
	R-E			
	Y-E			
	B-E			
vi)	Minimum width of trench			
vii)	Minimum depth of trench			
viii)	Hume pipes us			
ix)	Hume joints with collar properly aligned and packed with 75 mm of cement concrete			
x)	Cable laying with suitable rollers			
xi)	Bending radius			
xii)	Cable tagging			
xiii)	Hi-Pot test (18 kV)			
xiv)	Sealing of cable ends, if not being terminated			
xv)	immediately Trench closing			

C) HI-POT TEST REPORT

1) Date of testing:
2) Equipment details:

   Cable details

   Location :

Panel No. :

Size :

3) Insulation Resistance Test (Value in MΩ, using 5 kV Megger):

Reference	Measured Values MΩ	
	Before	After
R-E		
Y-E		
B-E		
R-Y		
Y-B		
B-R		

4) Winding Resistance Test:

Applied Voltage kV	Measured Current mA
R = Y + B + E	
Y = B + R + E	
B = R + Y + E	

5) Remarks

E-2 Typical format for checklist for handing over and commissioning of HV panels is given below.

NOTE — Format given below covers a basic minimum check list; it should be augmented for specific and special cases. The checklist has to be repeated for each HV panel.

HV PANEL INSPECTION, HANDING OVER AND COMMISSIONING DETAILS

Project:

Owner:

Package:

Contractor:

A) HANDING OVER DETAILS

1) Scope of works :

2) Panel name and number :

3) Location :

4) Handed over by :

5) Taken over by :

6) Date of commissioning :

7) Date of handing over :

8) Details of enclosures :

Sr. No	Description	Applicable	Not Applicable
(1)	(2)	(3)	(4)
i)	Quality check list		
ii)	Site test report		
iii)	As built GA drawing/layout		
iv)	Manufacturer's test certificates		
v)	Operation and maintenance manual		

Handed over by	Taken over by
Authorized signatory	Authorized signatory

B) QUALITY CHECK LIST

Item: HV panel

Make:

Relevant Indian Standard:

As-built Drawing No:

Sr. No	Tests Parameters	Bench Mark	Actual Observations
(1)	(2)	(3)	(4)
	Physical Checks for: Circuit Breaker		
i)	Dimension enclosure		
ii)	Gauge		
iii)	Paint		
iv)	Degree of protection		
v)	Front doors		
vi)	Back cover		
vii)	Extension type enclosure		
viii)	Type of circuit breaker		
ix)	Number of circuit breakers		

Sr. No	Tests Parameters	Bench Mark	Actual Observations
(1)	(2)	(3)	(4)
x)	Type of surge arresting device included in the circuit breakers		
xi)	Earthing terminal		
xii)	Front plate with view glass		
xiii)	Space for mounting of current transformers		
xiv)	Space for mounting of potential transformers		
xv)	Cable entry		
xvi)	Interlocking with isolator		
xvii)	Earthing switch for cable in cable chamber		
xviii)	Earthing switch interlock with circuit breaker only it can be operated in 'OFF' condition		
xix)	Low voltage plug and socket		
xx)	Vents for breaker/busbar/cable chambers		
xxi)	Insulation level		
xxii)	Toggle switch		
xxiii)	Ammeter selector switch		
xxiv)	Voltmeter selector switch		
xxv)	Trip/Neutral/Close		
xxvi)	Local/remote selector switch		
xxvii)	LED lamps		
xxviii)	Mechanical operation		
xxix)	Remote operation		
xxx)	Local operation		
xxxi)	Interlocking with isolator Meters		
xxxii)	Voltmeter		
xxxiii)	Ammeter		
xxxiv)	Tri vector meter		
xxxv)	Power factor meter		
xxxvi)	Frequency meter Specification Checks for		
xxxvii)	Rated current		

Sr. No	Tests Parameters	Bench Mark	Actual Observations
(1)	(2)	(3)	(4)
xxxviii)	Rated voltage		
xxxix)	Rated short circuit breaking capacity		
xl)	Contact resistance		
xli)	Control wiring		
xlii)	All control circuits		
	Alarm and trip for OTI/WTI/Buchholz/ PRV		
xliii)	SF6 pressure alarm and trip operation test		

C) COMMISSIONING REPORT

Customer:

Project:

Contractor:

Panel Name:

Location:

Breaker Details:

INSULATION TEST (MΩ):

R-Y	Y-B	B-R	R-E	Y-E	B-E	R-N	Y-N	B-N

RELAY SETTINGS:

Over Current, Earth Fault and Undervoltage Relay	
CT ratio: Earth fault >Settings: I_o> Settings: Under voltage relay:	

GENERAL CHECKS:

Breaker ‘ON’/’OFF’	
Meters reading	
Indicating lamps	
Control supply	

E-3 Typical format for checklist for handing over and commissioning of transformers is given below.

NOTE — Format given below covers a basic minimum check list; it should be augmented for specific and special cases. The checklist has to be repeated for each transformer.

TRANSFORMER INSPECTION, HANDING OVER AND COMMISIONING DETAILS

Project:

Owner:

Package:

Contractor:

A) HANDING OVER DETAILS

1) Scope of works :
2) Transformer No. :
3) Location :
4) Handed over by :
5) Taken over by :
6) Date of commissioning :
7) Date of handing over :
8) Details of enclosures :

Sr. No	Description	Applicable	Not Applicable
(1)	(2)	(3)	(4)
i)	Quality check list		
ii)	Site test report		
iii)	As built GA drawing/layout		
iv)	Manufacturer's test certificates		
v)	Operation and maintenance manual		

Handed over by — Taken over by

Authorized signatory — Authorized signatory

B) QUALITY CHECK LIST

Item: Transformer

Make:

Relevant Indian Standard:

As-built Drawing No:

Sr. No	Tests Parameters	Bench Mark	Actual Observations
(1)	(2)	(3)	(4)
	Physical Checks for: Circuit Breaker		
i)	Transformer Sl No.		
ii)	Dimension of enclosure		
iii)	Enclosure – Degree of protection		
iv)	Gauge		
v)	Paint		
vi)	Provision for lifts and jacking		
vii)	Wheels		
viii)	Locking facility for wheel		
ix)	Enclosure door (if applicable)		
x)	Enclosure door interlock wiring		
xi)	Removable case for access of taps		
xii)	Earthing terminal		
xiii)	Disconnecting type chamber for cable termination		
xiv)	LT side flanges (Bus ducts/Cables/ Overhead)		
xv)	Oil temperature indicator (relay unit)		
xvi)	Winding temperature indicator (relay unit)		
xvii)	Marshalling box winding and door switch		
xviii)	Thermistors for alarm and trip		
xix)	Separate neutral earthing chamber		
xx)	Rating and diagram plate		
xxi)	Tap changing options name plate		
xxii)	Oil level in conservator tank		
xxiii)	Oil level in breather cup		
xxiv)	Operation of PRV		
xxv)	Oil leakage (if applicable)		
xxvi)	Clearances around transformer		
xxvii)	Body earthing resistance		

Sr. No	Tests Parameters	Bench Mark	Actual Observations
(1)	(2)	(3)	(4)
xxviii)	Neutral earthing resistance Specification checks for:		
xxix)	Rating of transformer		
xxx)	Type		
xxxi)	Winding conductor		
xxxii)	Primary voltage		
xxxiii)	HV winding connections		
xxxiv)	Secondary voltage		
xxxv)	LV side connections		
xxxvi)	Vector symbol		
xxxvii)	System of supply		
xxxviii)	Impedance percentage		
xxxix)	Oil temperature rise		
xl)	Winding temperature rise		
xli)	Tap changing		
xlii)	Tapping range		
xliii)	Insulation type		
xliv)	Type of cooling		
xlv)	Vector group test		
xlvi)	Polarity test		
xlvii)	Magnetizing test		
xlviii)	Tan delta test (as per capacity)		
xlix)	Breakdown voltage test:		
	Oil sample – I (Top)		
	Oil sample – II (Bottom)		

C) COMMISSIONING REPORT

Customer:

Project:

Contractor:

Transformer Number:

Location:

Rating:

INSULATION TEST (MΩ):

R-Y	Y-B	B-R	R-E	Y-E	B-E	R-N	Y-N	B-N

RELAY SETTINGS:

Transformer Protection Relay **(WTI Scanner):** Winding temperature alarm set Winding temperature trip set **(OTI Scanner):** Oil temperature alarm set Oil temperature trip set	
Buchholz Relay	

GENERAL CHECKS:

Breaker ‘ON’/’OFF’	
Meters reading	
Indicating lamps	
Control supply	

E-4 Typical format for checklist for handing over and commissioning of MV/LV panel is given below.

NOTE — Format given below covers a basic minimum check list; it should be augmented for specific and special cases. The checklist has to be repeated for each MV/LV panel.

MV/LV PANEL INSPECTION, HANDING OVER AND COMMISIONING DETAILS

Project:

Owner:

Package:

Contractor:

A) HANDING OVER DETAILS

1) Scope of works :

2) Panel name :

3) Location :

4) Handed over by :

5) Taken over by :

6) Date of commissioning :

7) Date of handing over :

8) Details of enclosures :

Sr. No	Description	Applicable	Not Applicable
(1)	(2)	(3)	(4)
i)	Quality check list		
ii)	Site test report		
iii)	As built GA drawing		
iv)	Manufacturer’s test certificates		
v)	Operation and maintenance manual		

Handed over by	Taken over by
Authorized signatory	Authorized signatory

B) QUALITY CHECK LIST

Item: MV/LV Panel

Make:

Relevant Indian Standard:

As-built Drawing No:

Sr. No	Tests Parameters	Bench Mark	Actual Observations
(1)	(2)	(3)	(4)
	Physical Checks for:		
i)	Dimension enclosure		
ii)	Paint		
iii)	Degree of protection		
iv)	Front doors		
v)	Back cover		
vi)	Earthing terminal		
vii)	Front plate with view glass		

Sr. No	Tests Parameters	Bench Mark	Actual Observations
(1)	(2)	(3)	(4)
viii)	Cable entry		
ix)	Indication lamps		
x)	Check for any damages		
xi)	Check for rubber beading for the panel sections		
xii)	Coupling of panel		
xiii)	Coupling of busbars		
xiv)	Coupling of earth bus		
xv)	Number of shipping sections		
xvi)	Fish plate tightening		
xvii)	Any damages in busbar supports		
xviii)	Make of MCCB		
	Specification Checks For		
xix)	Rated current		
xx)	Rated voltage		
xxi)	Rated short circuit capacity		
	Circuit Breaker:		
xxii)	Current rating		
xxiii)	Interlocks with other CB/relay		
xxiv)	Compartment		
xxv)	End terminals segregation		
	Bus bar:		
xxvi)	Earth bus bar		
xxvii)	Main bus bar		
xxviii)	Link bus bar		
xxix)	Bus bar sleeve		
	3 Phase – Potential transformer:		
xxx)	Make		
xxxi)	Ratio		
xxxii)	Class		

Sr. No	Tests Parameters	Bench Mark	Actual Observations
(1)	(2)	(3)	(4)
xxxiii)	Serial Nos.		
	Current transformer:		
xxxiv)	Make		
xxxv)	Ratio		
xxxvi)	Class		
xxxvii)	Serial No’s		
	Multi digital meter:		
xxxviii)	Make		
xxxix)	Input voltage		
xl)	Input current		
	Wiring:		
xli)	For potential transformer		
xlii)	For current transformer		
xliii)	Incomer		
xliv)	Outgoing		

C) COMMISSIONING REPORT

Customer:

Project:

Contractor:

Panel Name:

Location:

Breaker Details:

INSULATION TEST (MΩ):

R-Y	Y-B	B-R	R-E	Y-E	B-E	R-N	Y-N	B-N

RELAY SETTINGS:

GENERAL CHECKS:

Breaker ‘ON’/’OFF’	
Meters reading	
Indicating lamps	
Control supply	

ANNEX E

CHECKLIST FOR INSPECTION, HANDING OVER AND COMMISSIONING OF EARTHING PITS

F-1 Typical format for checklist for inspection, handing over and commissioning of earthing pits is given below:

Project:

Owner:

Package:

Contractor:

A) HANDING OVER DETAILS

1) Scope of works :
2) Handed over by :
3) Taken over by :
4) Date of commissioning :
5) Date of handing over :
6) Details of enclosures :

Sr. No	Description	Applicable	Not Applicable
(1)	(2)	(3)	(4)
i)	Quality check list		
ii)	Site test report		
iii)	As built GA drawing		

Handed over by — Taken over by

Authorized signatory — Authorized signatory

B) QUALITY CHECK LIST

Item: Installation of earthing pit

As-built Drawing No:

Sr. No	Tests Parameters	Bench Mark	Actual Observations	Remark
(1)	(2)	(3)	(4)	(5)
1)	Material (Cu/GI/Copper bonded) and size			
2)	Depth of the pit			
3)	Check for length of pipe/rod and size of the plate and strip			
4)	For copper earthing, brazing done on both surfaces before jointing; and on one side in case of exothermic welding			
5)	Packing of pit by sand, salt and charcoal/earth enhancing material Bending radius			
6)	Check connection for tightness			
7)	Check for distance between earth pits			
8)	Interconnection of earth strips			
9)	Earth enhancing material used in earth pits			

C) TEST REPORT: EARTH PIT

Date of testing :

Equipment details :

Earth pit

1) Location :
2) Serial No. :
3) Earth pit No . :
4) Type of earthing :
5) Description :
6) Size of earth conductor :

Earth Pit Test: Values (Ω)

Ref	Measured Values Ω
Pit	
Width grid	

ANNEX F

(Clause 5B. 9.3.2.6)

FORM OF COMPLETION CERTIFICATE

I/We certify that the installation detailed below has been installed by me/us and tested and that to the best of my/our knowledge and belief, it complies with *MYANMAR Electricity Rules,*

Electrical Installation at --

Voltage and system of supply

Particulars of Works:

a) Internal Electrical Installation
No. Total Load Type of system of wiring
i) Light point
ii) Fan point
iii) Plug point
3-pin 6 A
3-pin 16 A

b) Others Description hp/kW Type of starting
1) Motors:
i)
ii)
iii)
2) Other plants:

c) If the work involves installations of overhead line and/or underground cable
1) i) Type and description of over headline.
ii) Total length and number of spans.
iii) No. of street lights and its description.
2) i) Total length of underground cable and its size:
ii) No. of joints:
End joint:
Tee joint:
Straight through joint:

Earthing:
i) Description of earthing electrode
ii) No. of earth electrodes
iii) Size of main earth lead

Test Results:
a) Insulation Resistance

i) Insulation resistance of the whole system of conductors to earth------------Megaohms.

ii) Insulation resistance between the phase conductor and neutral
Between phase R and neutral ………….. Megaohms.
Between phase Y and neutral ………….. Megaohms.
Between phase B and neutral ………….. Megaohms.

iii) Insulation resistance between the phase conductors in case of polyphase supply.
Between phase R and phase Y ………….. Megaohms

Between phase Y and phase B ………….. Megaohms

Between phase B and phase R ………….. Megaohms

b) Polarity test:

   Polarity of non-linked single pole branch switches

c) Earth continuity test:

   Maximum resistance between any point in the earth continuity conductor including metal conduits and main earthing lead-------------- Ohms.

d) Earth electrode resistance:

   Resistance of each earth electrode.

   i) ……………… Ohms.
   ii) ……………… Ohms.
   iii) ……………… Ohms.
   iv) ……………… Ohms.

e) Lightning protective system.

   Resistance of the whole of lightning protective system to earth before any bonding is effected with earth electrode and metal in/on the structure ………………Ohms.

Signature of Supervisor	Signature of Contractor
Name and Address	Name and Address
………………………	………………………
………………………	………………………
………………………	………………………
………………………	………………………

LIST OF STANDARDS

The following list records those standards which are acceptable standards ‘in the fulfillment of the requirements of the Code. The latest version of a standard shall be adopted at the time of the enforcement of the Code. The standards listed may be used by the Authority as a guide in conformance with the requirements of the referred clauses in the Code.

(i) Myanmar Electricity Rules.
(ii) Indian Electricity Rules 1956

	IS No.	*Title*
(1)	5216	Recommendations on safety procedures and practices in electrical work:
	(Part 1):1982	General (first revision)
	(Part 2):1982	Life saving techniques (first revision)
(2)	10118 (Part 2):1982	Code of practice for selection, installation and maintenance of switchgear and control gear: Part 2 Selection.
(3)	1646:1997	Code of practice for fire safety of buildings (general): Electrical Installations (second revision)
(4)	732:1989	Code of practice for electrical wiring installation (third revision)
(5)	8828.1996	Electrical accessories - Circuit - breakers for over current protection for Household and similar installations (second Revision)
(6)	2667:1988	Fittings for rigid steel conduits for electrical wiring (first revision)
	3419:1989	Fittings for rigid non-metallic conduits (second revision)
	9537	Conduits for electrical installations:
	(Part 1):1980	General requirements
	(Part 2):1981	Rigid steel conduits
	(Part 3):1983	Rigid plain conduits of insulating materials

References may be made to the following publications for better applying and understanding of the requirements of the Code

IEC	60085	Electrical insulation-Thermal classification
IEC	60127	Miniature fuses
IEC	60227	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750V
IEC	60228	Conductors for insulated cables
IEC	60238	Edison screw lamp holders

IEC	60245	Rubber insulated cables of rated voltages up to and including 450/750V
IEC	60269	Low-voltage fuse
IEC	60309	Plugs, socket-outlets and couplers for industrial purposes
IEC	60364	Low-voltage electrical installations /Electrical installation of building
IEC	60423	Conduit systems for cable management-Outside diameters of conduits for electrical installation and threads for conduits and fittings
IEC	60439	Low-voltage switchgear and control gear assemblies
IEC	60529	Degree of protection provided by enclosures (IP Code)
IEC	60669	Switches for household and similar fixed electrical installations
IEC	60755	General requirements for residual current operated protective devices
IEC	60898	Electrical accessories-Circuit-breakers for overcurrent protection for household and similar installations
IEC	60947	Low-voltage switchgear and control gear
IEC	61008	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)
IEC	61009	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)
IEC	61084	Cable trunking and ducting systems for electrical installations
IEC	61140	Protection against electric shock-Common aspects for installation and equipment
IEC	61386	Conduit system for cable management
IEC	61643	Low-voltage surge protective devices
IEC	62305	Protection against lightning
IEE	519	IEEE recommended practices and requirement for harmonic control in electrical power system.

BS EN	50310	Application of equipotential bonding and earthing in buildings with information technology equipment
BS EN	60598	Luminaires
BS EN	61534	Power track systems
BS	31	Specification-steel conduit and fittings for electrical wiring
BS	88	Low-voltage fuses/Cartridge fuses for voltages up to and including 1000V a.c and 1500V d.c

BS	88 Part 2	Low-voltage fuses. Supplementary requirements for fuses for use by authorized persons fuses mainly for industrial application). Examples of standardized systems of fuses A to I
BS	88 Part 6	Cartridge fuses for voltages up to and including 1000V a.c. and 1500V d.c Specification of supplementary requirements for fuses of compact dimensions for use in 240/415V a.c. industrial and commercial electrical installations.
BS	1363	13A plugs, socket-outlets, adaptors and connection units
BS	3676	Switches for household and similar fixed electrical installations
BS	4444	Guide to electrical earth monitoring and protective conductor proving
BS	4568	Specification-for steel conduit and fittings with metric threads of ISO form for electrical installations
BS	4607	Non-metallic conduits and fittings for electrical installations
BS	4662	Boxes for flush mounting of electrical accessories requirements and test methods and dimensions
BS	5266	Emergency lighting
BS	5839	Fire detection and fire alarm systems for buildings
BS	6004	Electric cables. PVC insulated, non-armoured cables for voltages up to and including 450/750V, for electric power, lighting and internal wiring
BS	6007	Electric cables. Single core unsheathed heat resisting cables for voltage up to and including 450/750 V for internal wiring
BS	6231	Electrical cables. Single core PVC insulated flexible cables for rated voltage 600/1000 V for switchgear and control gear wiring
BS	6346	Electric cables. PVC insulated, armoured cables for voltage of 600/1000Vand 1900/3300V
BS	6500	Electric cables, Flexible cords rated up to 300/500V, for use with appliances and equipment intended for domestic, office and similar environments
BS	6724	Electric cables, Thermosetting insulated, armoured cables for voltages of 600/1000 V and 1900/3300V, having low emission of smoke and corrosive gases when affected by fire
BS	7211	Electric cables. Thermosetting insulated, nonarmoured cables for voltages up to and including 450/750V, for electric power, lighting and internal wiring, and having low emission of smoke and corrosive gases when affected by fire

BS	7671	Requirements for electrical installations. IEE Wiring Regulations. Eighteenth Edition
BS	7919	Electric cable. Flexible cables rated up to 450/750V,for use with appliances and equipment intended for industrial and similar environments.
SS	555	Protection Against Lighting
CP	5	Code of practice for Electrical Installation

References may be made to the following publications for the common personal protective equipment and tools used for electrical work.

References

International Energy Conservation Code (Updated)

International Green Construction Code (Updated)

MNBC -2025 TECHNICAL WORKING GROUP (TWG-5B)
Participants List

1.	Daw Than Than Nwet	Group Leader
2.	U Aung Thein	Deputy Group Leader
3.	U Aye Win	Member
4.	U Myint Thein	Member
5.	U Kyi Hlaing Win	Member
6.	U Win Myint	Member
7.	U Thein Lin	Member
8.	U Tin Oo	Member
9.	Daw Nan Loon Aung	Member
10.	Dr.Lae Yee Win	Member
11.	Daw Tha Zin Han	Member
12.	U Than Lwin	Member
13.	U Thiha Soe	Secretary

MYANMAR

NATIONAL

BUILDING

CODE

2025

PART5C

INSTALLATION OF LIFTS AND ESCALATORS

MYANMAR NATIONAL BUILDING CODE - 2025

PART 5C BUILDING SERVICES

Installation of Lifts and Escalators

CONTENTS

MYANMAR NATIONAL BUILDING CODE - 2025
PART 5C BUILDING SERVICES
Installation of Lifts and Escalators

5C.1 SCOPE

5C.1.1 This Section covers the essential requirements for the installation, operation and maintenance and also inspection of lifts (passenger lifts, goods lifts, hospital lifts, service lifts and dumb waiters) and escalators so as to ensure safe and satisfactory performance.

5C.1.2 This Section gives information that should be exchanged among the architect, the consulting engineer and the lift / escalator manufacturer from the stage of planning to installation including maintenance.

5C.2 TERMINOLOGY

For the purpose of this Section, the following definitions shall apply.

5C.2.1A lift (Elevator) , is a Type of vertical transport equipment that efficiently moves people or goods between floor of a building , vessel or other structures .

5C.2.1.1Automatic Rescue Device – A device meant to bring a lift stuck between floors due to loss of power, to the nearest level and open the doors in order to allow trapped passengers to be evacuated. Such a device may use some form of internal auxiliary power source for such purpose, complying with all the safety requirements of a lift during normal run. The speed of travel is usually lower than the normal speed. In the case of manual doors on reaching the level, the device shall allow the door to be opened and in case of power operated doors the device shall automatically open the door.

5C.2.1.2Bottom Car Runby – The distance between the car buffer striker plate and the striking surface of the car buffer when the car is in level with the bottom terminal landing.

5C.2.1.3 Bottom Counterweight Runby– The distance between the counter weight buffer striker plate and the striking surface of the counterweight buffer when the car is in level with the top terminal landing.

5C.2.1.4 Buffer – A device designed to stop a descending car or counter weight beyond its normal limit of travel by storing or by absorbing and dissipating the kinetic energy of the car or counterweight.

5C.2.1.5 Oil Buffer – A buffer using oil as a medium which absorbs and dissipates the kinetic energy of the descending car or counterweight.

5C.2.1.6 Oil buffer stroke – The oil displacing movement of the buffer plunger or piston, excluding the travel of the buffer plunger accelerating device.

5C.2.1.7 Spring Buffer – A buffer which stores in a spring the kinetic energy of the descending car or counterweight.

5C.2.1.8 Spring buffer load rating – The load required to compress the spring by an amount equal to its stroke.

5C.2.1.9Spring buffer stroke – The distance, the contact end of the spring can move under a compressive load until the spring is compressed solid.

5C.2.1.10Call Indicator – A visual and audible device in the car to indicate to the attendant the lift landings from which calls have been made.

5C.2.1.11Car Bodywork – The enclosing bodywork of the lift car which comprises the sides and roof and is built upon the car platform.

5C.2.1.12Car Door Electric Contact – An electric device, the function of which is to prevent operation of the driving machine by the normal operating device unless the car door is in the closed position.

5C.2.1.13Car Frame – The supporting frame or sling to which the platform of the lift car, its safety gear, guide shoes and suspension ropoes are attached.

5C.2.1.14Car Platform – The part of the lift car which forms the floor and directly supports the load.

5C.2.1.15Bottom Car Clearance – The clear vertical distance from the pit floor to the lowest structural or mechanical part, equipment or device installed beneath the car platform aprons or guards located within 300mm, measured horizontally from the sides of the car platform when the car rests on its fully compressed buffers.

5C.2.1.16Top Car Clearance – The shortest vertical distance between the top of the car crosshead, or between the top of the car where no crosshead is provided, and the nearest part of the overhead structure or any other obstruction when the car floor is level with the top terminal landing.

5C.2.1.17Top Counterweight Clearance – The shortest vertical distance between any part of the counterweight structure and the nearest part of the overhead structure or any other obstruction when the car floor is level with the bottom terminal landing.

5C.2.1.18Control –The system governing starting, stopping direction of motion, acceleration, speed and retardation of moving member.

5C.2.1.19Single-Speed Alternating Current Control – A control for a driving machine induction motor which is arranged to run at a single-speed.

5C.2.1.20Two-speed Alternating Current Control – A control for a two-speed driving machine induction motor which is arranged to run at two different synchronous speeds either by pole changing of a single motor or by two different armatures.

5C.2.1.21Rheostatic Control – A system of control which is accomplished by varying resistance or reactance or both in the armature or field circuit or both of the driving machine motor.

5C.2.1.22Variable Voltage Motor Control (Generator Field Control) – A system of control which is accomplished by the use of an individual generator for each lift wherein the voltage applied to the driving machine motor is adjusted by varying the strength and direction of the generator field.

5C.2.1.23Electronic Devices – A system of control which is accomplished by the use of electronic devices for driving the lift motor at variable speed.

5C.2.1.24Alternating Current Variable Voltage (ACVV) Control – A system of speed control which is accomplished by varying the driving and braking torque by way of voltage variation of the power supply to the driving machine induction motor.

5C.2.1.25Alternating Current Variable Voltage Variable Frequency (ACVVVF) Control – A system of speed control which is accomplished by varying the voltage and frequency of the power supply to the driving machine induction motor.

5C.2.1.26Solid-State d.c, Variable Voltage Control – A solid state system of speed control which is accomplished by varying the voltage and direction of the power supply to the armature of driving machine d.c motor.

5C.2.1.27Counterweight – A weight or series of weights to counter-balance the weight of the lift car and part of the rated load.

5C.2.1.28Deflector Sheave – An idler pulley used to change the direction of a rope lead.

5C.2.1.29Door, Centre Opening Sliding – A door which slides horizontally and consists of two or more panels which open from the centre and are usually so interconnected that they move simultaneously.

5C.2.1.30Door, Mid-Bar Collapsible – A collapsible door with vertical bars mounted between the normal vertical members.

5C.2.1.31Door, Multipanel – A door arrangement whereby more than one panel is used such that the panels are connected together and can slide over one another by which means the clear opening can be maximized for a given shaft width. Multipanels are used in centre opening and two sliding doors.

5C.2.1.32 Door, Single Slide – A single panel door which slides horizontally.

5C.2.1.33Door, Two Speed Sliding – A door which slides horizontally and consists of two or more panels, one of which moves at twice the speed of the other.

5C.2.1.34Door, Vertical Bi-parting – A door which slides vertically and consists of two panels or sets of panels that move away from each other to open and are so interconnected that they move simultaneously.

5C.2.1.35Door, Vertical Lifting – A single panel door, which slides in the same plane vertically up to open.

5C.2.1.36Door, Swing – A swinging type single panel door which is opened manually and closed by means of a door closer when released.

5C.2.1.37Door Closer – A device which automatically closes a manually opened door.

5C.2.1.38Door Operator – A power-operated device for opening and closing doors.

5C.2.1.39Dumb Waiters – A lift with a car which moves in guides in a vertical direction; has a net floor area of 1sqm meter, total inside height of 1.2 meter, whether or not provided with fixed or removable shelves; has a capacity not exceeding 250kg and is exclusively used for carrying materials and shall not carry any person.

5C.2.1.40Electrical and Mechanical Interlock – A device provided to prevent simultaneous operation of both up and down relays.

5C.2.1.41Electro – Mechanical Lock – A device which combines in one unit, electrical contact and a mechanical lock jointly used for the landing and /or car doors.

5C.2.1.42Emergency Stop Push or Switch – A push button or switch provided inside the car designed to open the control circuit to cause the lift car to stop during emergency.

5C.2.1.43Gearless Machine – A lift machine in which the motive power is transmitted to the driving sheave from the motor without intermediate reduction gearing and has the brake drum mounted directly on the motor shaft.

5C.2.1.44Goods Lift – A lift designed primarily for the transport of goods, but which may carry a lift attendant or other person necessary for the loading or unloading of goods.

5C.2.1.45Guide Rails – The members used to guide the movement of a lift car or counterweight in a vertical direction.

5C.2.1.46Guide Rails Fixing – The complete assembly comprising the guide rails bracket and its fastenings.

5C.2.1.47Guide Rails Shoe – An attachment to the car frame or counterweight for the purpose of guiding the lift car or counterweight frame.

5C.2.1.48Hoisting Beam – A beam, mounted immediately below the machine room ceiling, to which lifting tackle can be fixed for raising or lowering parts of the lift machine.

5C.2.1.49Hospital lift – A lift normally installed in a hospital/dispensary clinic and designed to accommodate one number bed / stretcher along its depth, with sufficient space around to carry a minimum of three attendants in addition to the lift operator.

5C.2.1.50Landing Call Push – A push button fitted at a lift landing, either for calling the lift car, or for actuating the call indicator.

5C.2.1.51Landing Door – The hinged or sliding portion of a lift well enclosure, controlling access to a lift car at a lift landing.

5C.2.1.52Landing Zone – A space extending from a horizontal plane 400 mm below a landing to a plane 400 mm above the landing.

5C.2.1.53Levelling Device, Lift Car – Any mechanism which either automatically or under the control of the operator, moves the car within the Levelling zone towards the landing only, and automatically stops it at the landing.

5C.2.1.54Levelling Device, One Way Automatic – A device which corrects the car level only in case of under run of the car but will not maintain the level during loading and unloading.

5C.2.1.55Levelling Device, Two Way Automatic Maintaining – A device which corrects the car level on both under run and over-run and maintains the level during loading and unloading.

5C.2.1.56 Levelling Device, Two Way Automatic Non-Maintaining – A device which corrects the car level on both under run and over run but will not maintain the level during loading and unloading.

5C.2.1.57Levelling Zone – The limited distance above or below a lift landing within which the Levelling device may cause movement of the car towards the landing.

5C.2.1.58Lift – An appliance designed to transport persons or materials between two or more levels in a vertical or substantially vertical direction by means of a guided car or platform. The word 'elevator' is also synonymously used for 'lift'.

5C.2.1.59Lift Car – The load carrying unit with its floor or platform, car frame and enclosing body work.

5C.2.1.60Lift Landing - That portion of building or structure used for discharge of passengers or goods or both into or from a lift car.

5C.2.1.61Lift Machine – The part of the lift equipment comprising the motor and the control gear therewith, reduction gear (if any), brake(s) and winding drum or sheave, by which the lift car is raised or lowered.

5C.2.1.62Lift Pit – The space in the lift well below the level of the lowest lift landing served.

5C.2.1.63Lift Well – The unobstructed space within an enclosure provided for the vertical movement of the lift car(s) and any counterweight(s), including the lift pit and the space for top clearance.

5C.2.1.64Lift Well Enclosure – Any structure which separats the lift well from its surroundings.

5C.2.1.65Operation – The method of actuating the control of lift machine.

5C.2.2 Operation

5C.2.2.1 Automatic Operation – A method of operation in which by a momentary pressure of a button the lift car is set in motion and caused to stop automatically at any required lift landing.

5C.2.2.2Non-Selective Collective Automatic Operation – Automatic operation by means of one button in the car for each landing level served and one button at each landing, wherein all stops registered by the momentary actuation of landing or car buttons are made irrespective of the number of buttons actuated or of the sequence in which the buttons are actuated. With this type of operation, the car stops at all landings for which buttons have been actuated making the stops in the order in which the landings are reached after the buttons have been actuated but irrespective of its direction of travel.

5C.2.2.3Selective Collective Automatic Operation – Automatic operation by means of one button in the car for each landing level served and by up and down buttons at the landings, wherein all stops registered by the momentary actuation of the car made as defined under non-selective collective automatic operation, but wherein the stops registered by the momentary actuation of the landing buttons are made in the order in which the landings are reached in each direction of travel after the buttons have been actuated. With this type of operation, all 'up' landing calls are answered when the car is travelling in the up direction and all 'down' landing calls are answered when the car is travelling in the down direction, except in the case of the uppermost or lowermost calls which are answered as soon as they are reached irrespective of the direction of travel of the car.

5C.2.2.4Single Automatic Operation – Automatic operation by means of one button in the car for each landing level served and one button at each landing so arranged that if any car or landing button has been actuated, the actuation of any other car or landing operation button will have no effect on the movement of the car until the response to the first button has been completed.

5C.2.2.5Group Automatic Operation – Automatic operation of two or more non-attendant lifts equipped with power-operated car and landing doors. The operation of the car is co-ordinated by a supervisory operation system including automatic dispatching means whereby selected car at designated dispatching points automatically close their doors and proceed on their trips in a regulated manner.

Typically, it includes one button in each car for each floor served and up and down buttons at each landing (single button at terminal landings). The stops set up by the momentary actuation of the car buttons are made automatically in succession as a car reaches the corresponding landings irrespective of its directions of travel or the sequence in which the buttons are actuated. The stops set up by the momentary actuation of the landing buttons may be accomplished by any lift in the group, and are made automatically by the first available car that approaches the landing in the corresponding direction.

5C.2.2.6Car Switch Operation – Method of operation by which the movement of lift car is directly under the operation of the attendant by means of a handle.

5C.2.2.7Signal Operation – Same as collective operation, except that the closing of the door is initiated by the attendant.

5C.2.2.8Double Button (Continuous Pressure) Operation – Operation by means of buttons or switches in the car and the landings any of which may be used to control the movement of the car as long as the button or switch is manually pressed in the actuating position.

5C.2.2.9Operating Device – A car switch, push button or other device employed to actuate the control.

5C.2.3 Others:

5C.2.3.1Overhead Beams – The members, usually of steel, which immediately support the lift equipment at the top of the lift well.

5C.2.3.2Over Speed Governor – An automatic device which brings the lift car and /or counter weight to rest by operating the safety gear in the event of the speed in a descending direction exceeding a predetermined limit.

5C.2.3.3Passenger Lift – A lift designed for the transport of passengers.

5C.2.3.4Position and/or Direction Indicator – A device which indicates on the lift landing or in the lift car or both, the position of the car in the lift well or the direction or both in which the lift car is travelling.

5C.2.3.5Rated Load (Lift) – The maximum load for which the lift car is designed and installed to carry safely at its rated speed.

5C.2.3.6Rated Load (Escalator) – The load which the escalator is designed and installed to lift at the rated speed.

5C.2.3.7Rated Speed (Lift) – The mean of the maximum speed attained by the lift car in the upward and downward direction with rated load in the lift car.

5C.2.3.8Retiring Cam – A device which prevents the landing doors from being unlocked by the lift car unless it stops at a landing.

5C.2.3.9Roping Multiple – A system of roping where, in order to obtain a multiplying the factor from the machine to the car, multiple falls of rope are run around sheave on the car or counterweight or both. It includes roping arrangement of 2 to 1.3 to 1 etc.

5C.2.3.10Safety Gear – A mechanical device attached to the lift car or counterweight or both, designed to stop and to hold the car or counterweight to the guides in the event of free fall, or, if governor operated, of over-speed in the descending direction. Any anticipated impact force shall be added in the general drawing or layout drawing.

5C.2.3.11Service Lift – A passenger cum goods lift meant to carry goods along with people.

Typically in an office building this may be required to carry food or stationeries, in a residential building to carry a bureau or accommodate a stretcher and in a hotel to be used for food trolleys or baggage. There is a need in such lifts, to take care of the dimensions of the car and the door clear opening in line with the type of goods that may have to be carried based on mutual discussion between supplier and customer. Also, such lifts shall have buffer railings in the car at suitable height to prevent damage to the car panels when the goods are transported. Typically such lifts, if provided with an automatic door, may use some means to detect trolleys and stretcher movement in advance to protect the door against damage. The car floor load calculations and car area of such a lift is as in the case of a passenger lift except that these are not meant to carry heavy concentrated loads.

5C.2.3.12Sheave – A rope wheel, the rim of which is grooved to receive the suspension ropes but to which the ropes are not rigidly attached and by means of which power is transmitted from the lift machine to the suspension ropes.

5C.2.3.13Slack Rope Switch – Switch provided to open the control circuit in case of slackening of rope(s).

5C.2.3.14Suspension Ropes – The ropes by which the car and counter weight are suspended.

5C.2.3.15Terminal Slow Down Switch – A switch when actuated shall compulsorily cut off the high speed and switch on the circuitry to run the lift in Levelling speed before reaching on terminal landings.

5C.2.3.16Terminal Stopping Switch Normal – Switch for cutting all the energizing current in case of car travelling beyond the top bottom landing or a switch cuts off the energizing current so as to bring the car to stop at the top and bottom level.

5C.2.3.17Terminal Stopping Device Final – A device which automatically cause the power to be removed from an electric lift driving machine motor and brake, independent of the functioning of the normal terminal stopping device, the operating device or any emergency terminal stopping device, after the car has passed a terminal landing.

5C.2.3.18Total Headroom – The vertical distance from the level of the top lift landing to the bottom of the machine room slab.

5C.2.3.19Travel – The vertical distance between the bottom and top lift handing served.

5C.2.3.20Geared Machine – A machine in which the power is transmitted to the sheave through worm or worm and spur reduction gearing.

5C.3 GENERAL

5C.3.1 The appropriate aspect of lift and escalator installation shall be discussed during the preliminary planning of the building with all the concerned parties, namely, client, architect, consulting engineer and/or lift/escalator manufacturer. This enables the lift/escalator manufacturer to furnish the architect and/or consulting engineer with the proposed layout on vice-versa.

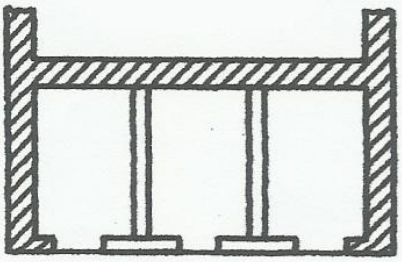
5C.3.2 Exchange of Information

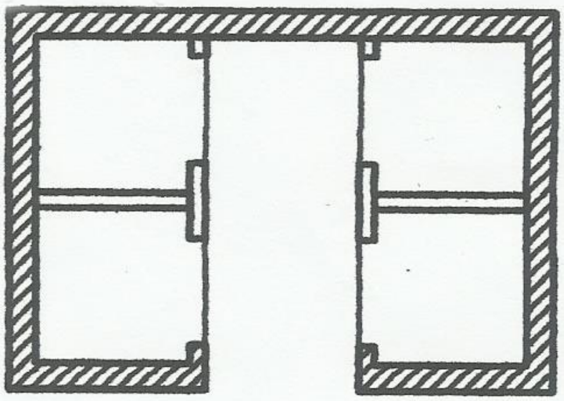
5C.3.2.1 If the proposed installation is within the scope of 6, the guidelines laid down together with Fig.1 will enable the preliminary scheme for the installation to be established.

Figure 1 shows only some of the typical arrangements and variations are possible with respect to number of lifts and the layout.

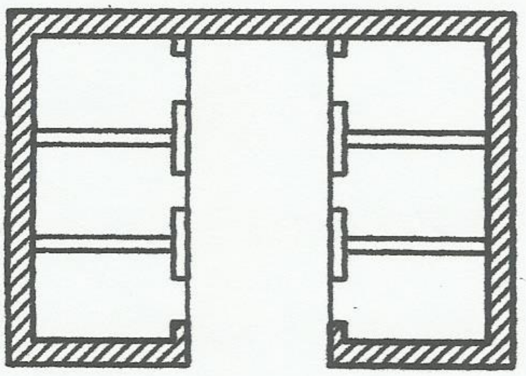
Although the recommended outline for the various classes of lifts given in 6 enables the general planning details to be determined by the architect, these should be finally settled at the earliest possible stage by detailed investigation with the purchaser's representative reaching agreement with the lift maker where necessary before an order is finally placed. This will enable a check to be made and information to be exchanged on such vital matters as:

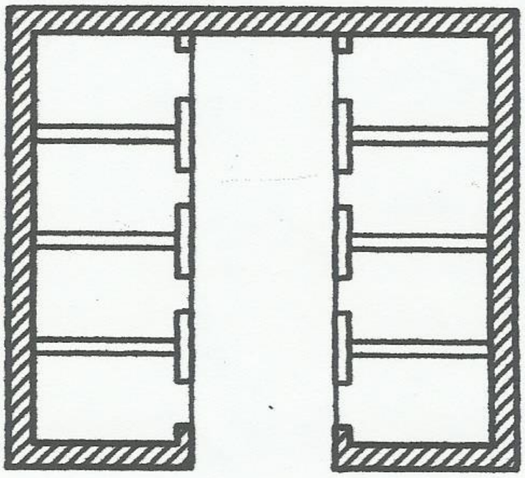
a) The number ,Capacity, speedand disposition of the lifts necessary to give adequate lift service in the proposed building.
b) The provision of adequate access to the machine room.
c) The loads which the lift will impose on the building structure, and the holes to be left in the machine room floor and cut-outs for wall boxes for push-buttons and signals.
d) The necessity for and type of insulation to minimize the transmission of vibration and noise to other parts of the building.





1A STRAIGHT LINE **1BALCOVE ARRANGEMENT**
FOR ARRANGEMENT FOR THREE LIFTS **FOUR**
LIFTS





1C**ARRANGEMENT FOR SIX LIFTS** **1D ARRANGEMENT**
FOR EIGHT LIFTS

Fig -1 ARRANGEMENT OF LIFTS

e) The special requirements of local authorities and other requirements set out in the 'planning permit'.
f) The need for the builder to maintain accuracy of building as to dimensions and in plumb.
g) The periods of time required for preparation and approval of relevant drawings for manufacturing and the installation of the lift equipment.
h) The requirements for fixing guide brackets to the building structure; and brackets spacing is not more than 2500 mm.
i) The time at which electric power will be required before completion to allow for testing.
j) Lift well shall be adequately ventilated at the top of the shaft to the external air by means of one or more permanent openings having a total unobstructed area of at least 1% of the horizontal section of the well and not less than 0.1 m^2 for each lift in the shaft.

k) Where the depth of a pit, measured from the lower terminal landing exceeds 1000 mm and where no other means of access exists, a ladder shall be fixed permanently within reach of the lower terminal landing door. The pit ladder or the handholds for the pit ladder shall extend up to 1500 mm above the bottom terminal floor to enable safe descent into the pit. Where more than one lift is operating in the same pit, pit ladder shall be installed for every lift.
l) Pits shall be waterproofed before installation of the lift equipment by the use of tanking, membranes or other positive means and where required, shall have a covered sump located therein. The sump cover shall be a non-slip type and shall be not easily displaced. The sump shall not be connected to any closed drainage system; but may be connected into an open-ended drain below the sump level so that it cannot be flooded.
m) Where pumps are required, they shall be installed outside the lift well. Pump shall be effectively partitioned from the lift well and separate access for maintenance. The level of any external sump shall be such that water cannot flow back into the lift well. Drains shall not run into pits.
n) The requirements for electrical supply feeders, etc.
o) The requirements for scaffolding in the lift well and protection of the lift well prior to and during installation of equipment and
p) Delivery and storage of equipment.

5C.3.2.2 Information to be Provided by Architect or Engineer

As a result of preliminary discussion the drawings of the building should give the following particulars and finished sizes;

a) Number, type and size of lifts and position of lift well
b) Particulars of lift well enclosure
c) Size, position, number and type of landing doors
d) Number of floors served by the lift
e) Height between floor levels
f) Number of entrances
g) Total headroom
h) Provision of access to machine room
i) Provision of ventilation and, if possible, natural lighting of machine room
j) Height of machine room; not less than 2100 mm
k) Depth of lift pit
l) Position of lift machine, above or below lift well
m) Size and position of any trimmer joists or stanchions adjacent to the lift well at each floor
n) Size and position or supporting steel work at roof levels
o) Size and position of any footings or grillage foundations, if these are adjacent to the lift pit and
p) In the case of passenger lifts whether the lift cage is required to carry household luggage, such as refrigerator, steel almirah, etc.

5C.3.2.2.1 The lift lobby should be designed appropriately since this has bearing on the traffic handling especially when more number of lifts are involved. In a dual line arrangement (lifts opposite to each other) the lobby can be between 1.5 times to 2.5 times the depth of one car.

Typically the more the number of lifts the bigger the multiple to be use. As an example a quadruplex may use 1.5 to 2 times where as an octoplex will need 2 to 2.5 times. For in line (single line) arrangements, the lobby can be typically half of the above recommendations.

It is preferable that the lift lobby is not used as a thoroughfare but in such cases the lift corridor shall take into account space for people who are moving.

5C.3.2.2.2 The architect/engineer should advise the lift manufacturer, if the Authority has any special requirements regarding lifts in buildings in the administrative area concerned.

5C.3.2.2.3 The architect/engineer should inform the lift/escalator manufacturer of the dates when the erection of the lift/escalator may be commenced and is to be completed so that sufficient time is allowed for the manufacture and erection of the lift/escalator.

5C.3.2.2.4 When submitting application for a building permit to the local Authority, the building plans shall include the details of lifts (number of lifts duly numbered, location, type, type of doors, passenger capacity and speed).

5C.3.2.3 Working Drawings to be Prepared by the lift/Escalator Manufacturer

The lift/escalator manufacturer requires sufficient information for the preparation of working drawings and is usually obtained from architect's drawings supplemented by any information obtained from the site and by collaboration with the other contractors.

5C.3.2.3.1 Working drawings showing the layout of lift/escalator duly numbered, details of builders works, for example, holes in walls for guide fixing, holes in machine room floor for ropes and conduits, recesses for landing sills, supports for lift/escalator machine and loads imposed on the building should be submitted by the lift/escalator manufacturer to the architect/engineer for written approval.

5C.3.3 Electrical Requirement

For information of the electrical engineer, the lift/escalator a manufacturer should advise the architect/engineer of his electrical requirements. This information should be available early in planning stage so that the electrical supply requirements of the lift(s)/escalator(s) may be included in the electrical provisions of the buildings and that suitable cables and switchgear may be provided.

5C.4 ESSENTIAL REQUIREMENTS

5C.4.1 Conformity with Lift/ Escalator Act and Rules

The installation shall be generally carried out in conformity with Myanmar Electricity **(**Lift/ Escalator) Act and Rules there under, wherever they are in force.

5C.4.1.1 It is the responsibility of the owner of the premises where the lift/escalator will be installed, to obtain necessary permission from the Authority before and after the erection of lift/ escalator and for subsequent operation of lift/ escalator.

5C.4.2 Conformity with Myanmar Electricity Act and Rules

All electrical work in connection with installation of electric lift/escalator shall be carried out in accordance with the provisions of Myanmar Electricity (lift/escalator) Rule – 1985 and the provisions framed there under as amended from time to time, and shall also comply with the other provisions of Part 5A and Part 5B, MNBC latest version.

5C.4.3 Conformity with Myanmar Standards

5C.4.3.1 The materials shall be approved by the competent authority. For detailed specification for lift/escalator, reference shall be made to accepted standard as according to cp 2 2009 &EN-81-1- 1998 or latest version and EN-115-1:2008 or latest version.

5C.4.4 Conformity with Fire Regulations

5C.4.4.1 The installation shall be carried out in conformity with Part 5F, 'Fire Protection Systems' and local fire regulations and rules there under wherever they are in force.

5C.4.5 Factor of Safety

The minimum factor of safety for any part of the lift shall not be less than five. Higher factor of safety for various parts shall be applicable in accordance with cp 2 2009, EN – 81 – 1 – 1998, Myanmar Electricity Rule & Regulation 1985.

5C.4.6 Additional Requirements for Passenger and Goods Lifts

5C.4.6.1 Bottom and Top Car Clearances

5C.4.6.1.1 Bottom car clearance

When the car rests on its fully compressed buffer there shall be vertical clearance of not less than 600mm between the pit floor and the buffer striker plate or the lowest structural or mechanical part equipment or device installed. The clearance shall be available beneath the whole area of the platform except for:

a) Guide shoe or rollers , safety jaw bocks platform aprons , guards of other equipment located within 300 mm measured horizontally from the sides of the car platform and
b) Compensating sheaves.
c) Provided that in all the cases, including small cars, a minimum clearance of 600 mm is available over a horizontal area of 800 mm x 500 mm.

Provided also that in all the cases, when the car rests on its fully compressed buffers, there shall be a vertical clearance of not less than 50 mm between any apart of the car and any obstruction of device mounted in the pit.

5C.4.6.1.2 Top car clearance

The vertical clearance between the car cross-head and the nearest overhead obstruction within 500mm measured horizontally to the nearest part of the crosshead when the car platform is level with the top landing, shall be not less than the sum of the following;

a) The bottom counterweight runby.
b) The stroke of the counterweight buffer used.
c) One-half of the gravity stopping distance based on:

1) 115 percent of the rated speed where oil buffers are used and no provision is made to prevent the jump of the car at counterweight buffer engagement and
2) Governor tripping speed where spring buffers are used.

NOTE - The gravity stopping distance based on the gravity retardation from any initial velocity may be calculated according to the following formula.

$$S = 51\ V^2$$

where

S = Free fall in mm (gravity stopping distance), and

V = Initial velocity in m/s

d) 600 mm

Where there is a projection below the ceiling of the well and the projection is more than 500 mm, measured horizontally from the centre line of the cross-head but over the roof of the car, a minimum vertical clearance not less than that calculated above shall also be available between the roof of the car and the projection.

Provided that the vertical clearance between any equipment mounted on top of the car and the nearest overhead obstruction shall be not less than the sum of the three items (a), (b) and (c) as calculated above plus 150 mm.

5C.4.6.2 Bottom Runby for Cars and Counterweights

5C.4.6.2.1 The bottom runby of cars and counterweights shall be not less than the following:

a) 150 mm where oil buffers are used;

b) Where spring-buffers are used;

(1) 150 mm for controls as in 5C.2.1.23 to 5C.2.1.27.

(2) Not less than the following for controls as in 5C.2.1.20 to5C.2.1.22.

Rated Speed	Runby
m/s	mm
Up to 0.125	75
0.125 to 0.25	150
0.25 to 0.50	225
0.50 to 1	300

5C.4.6.3 Maximum Bottom Runby

In no case shall the maximum bottom runby exceed the following:

a) 600 mm for cars and

b) 900 mm for counterweights.

5C.4.6.4 Top Counterweight Clearances

The top counterweight clearances shall be not less than the sum of the following four items:

a) The bottom car runby
b) The stroke of the car buffer used
c) 150 mm and
d) One-half the gravity stopping distance based on
   1) One hundred and fifteen percent of the rated speed where oil buffers are used and no provision is made to prevent jump of the counterweight at car buffer engagement and
   2) Governor tripping speed where spring buffers are used.

5C.4.7 Additional Requirements for Service Lifts

5C.4.7.1 Top and Bottom Clearances for Car and Counterweights

5C.4.7.1.1 Top car clearance

The top car clearance shall be sufficient to avoid any protruding part fixed on the top of the car coming in direct contact with the ceiling or diverting sheave.

The clearance shall be calculated taking into account the following and shall not be less than the sum of the following four items:

a) The bottom counterweightrunby
b) The stroke of the counterweight buffer used

c) The dimensions of the portion of the diverting sheave hanging underneath the ceiling in the lift well and

d) 150 mm for compensating for gravity stopping distance and future repairs to the rope connections at counterweight and at the car or at the suspension points

5C.4.7.1.2 Bottom car clearance

The bottom car clearance shall be maintained in such a way that the counterweight shall not come in contact with the ceiling or any part hanging underneath the ceiling, when the car completely rests on fully compressed buffers, provided the buffers are spring type mounted on solid concrete or steel bed.

In case of wooden buffers the bottom car clearance shall be maintained in such a way that the total downward travel of the car from the service level of the immediate travel of the car from the service level the immediate floor near the pit, shall not be more than the top counterweight clearance, when the wooden buffers are completely crushed.

5C.4.7.1.3 Top counterweight clearance

The top clearance for the counterweight can be calculated taking into account the following and shall not be less than the sum of the following three items:

a) Car runby
b) Compression of the buffer spring or height of the wooden block used as buffer and
c) 150 mm to compensate for gravity stopping distance for counterweight and any future repairs to rope connections at the counterweight at the car ends or at the suspension points.

5C.4.7.1.4 Runby for Cars and Counterweights

5C.4.7.1.5 The bottom runby for cars and counterweights shall not be less than 150 mm.

5C.4.7.1.6 Maximum bottom runby

In no case shall the maximum bottom runby exceed 300 mm.

5C.4.8 In order to maintain a safe work environment, and to avoid potential hazards, the following shall be provided:

a) Caution sign shall be installed in the areas listed below where potential hazard exists:
    1) Trip hazard in machine room and
    2) Caution notice against unauthorized use of rescue devices (for example, brake release device).
b) Use the hard hats for entry in pit and car top during construction period.
c) Warning sign shall be provided on the controller so also eliminate, the possibility of contact with any exposed or concealed power circuit.
d) Car top barricade system shall be provided as primary protection against fall, on car top.
e) Whenever work is carried out on the lift and lift is not required to be moved on power, notice shall be put on electrical main switch indicating requirement of de-energized condition.
f) During lift installation/maintenance, protection against fall shall be provided with suitable barricades for all open lending entrances.

5C.4.9 Planning for Dimensions

5C.4.9.1 General

The dimensions of lift well have been chosen to accommodate the door inside the well which is the normal practice. In special cases, the door may be accommodated in a recess in the front wall, for which prior consultation shall be made with the lift manufacturer.

5C.4.9.2 Plan Dimensions

5C.4.9.2.1 All plan dimensions of lift well are the minimum clear plumb sizes. The architect/engineer, in conjunction with the builder, shall ensure that adequate tolerances are included in the building design so that the specified minimum clear plumb dimensions are obtained in the finished work.

5C.4.9.2.2 Rough opening in concrete or brick walls to accommodate landing doors depend on design of architrave. It is advisable to provide sufficient allowances in rough opening width to allow for alignment errors of opening at various landings.

5C.4.9.2.3 When more than one lift is located in a common well, a minimum allowance of 150mm for separator beams shall be made in the widths shown in Table 1 to 5.

5C.4.9.2.4 For outline dimensions of lifts having more than one car entrance, lift manufacturers should be consulted.

5C.4.9.3 Outline Dimensions

5C.4.9.3.1 The outline dimensions of machine-room, pit depth, total headroom, overhead distance and sill for four classes of lifts to which the standard applies are specified in Tables 1 to 5 as indicated below.

1. Recommended Dimensions of Passenger Lifts and Service Lifts

(Machine Room System)

All dimensions in millimeters

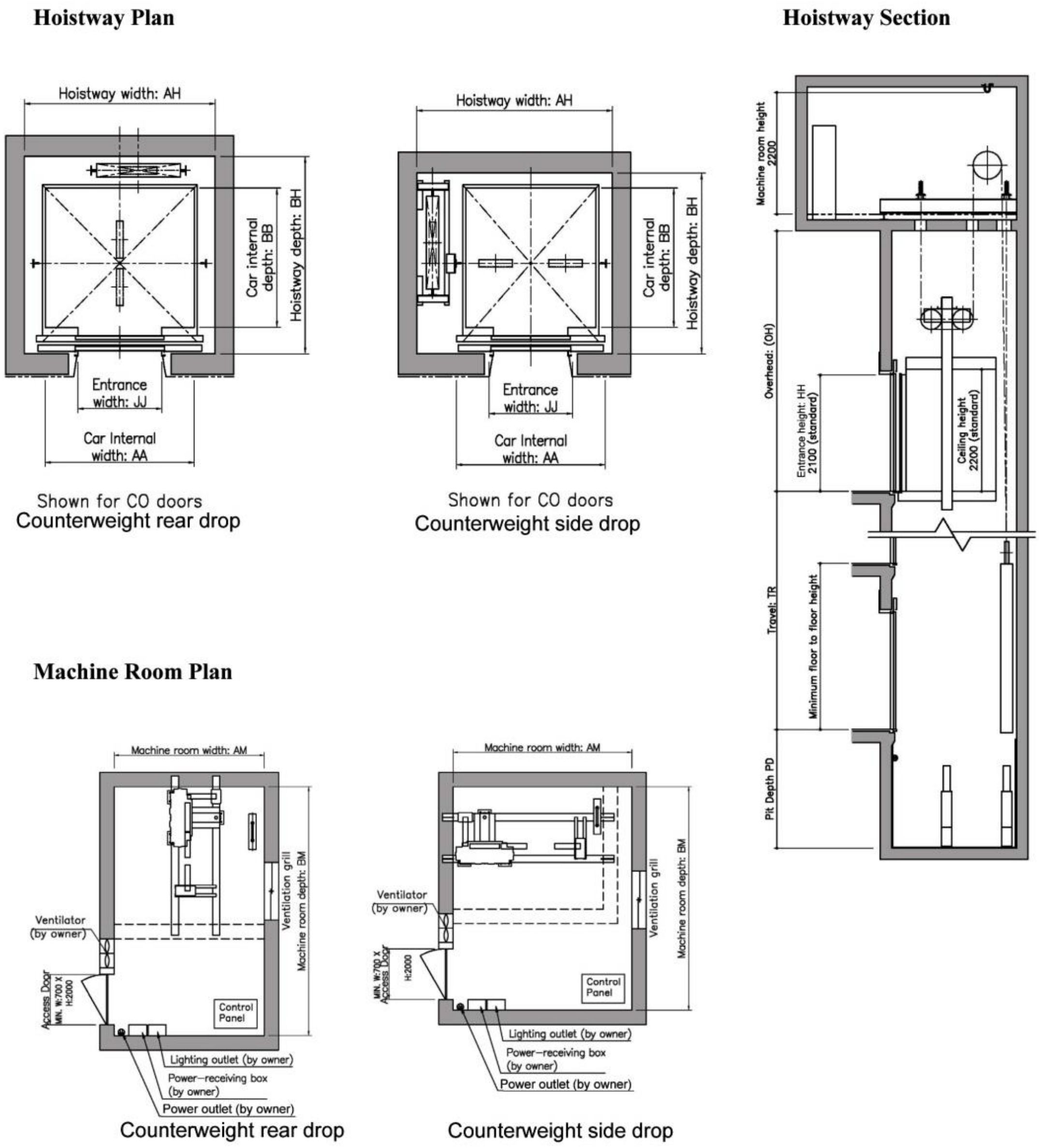


Table-1(a)

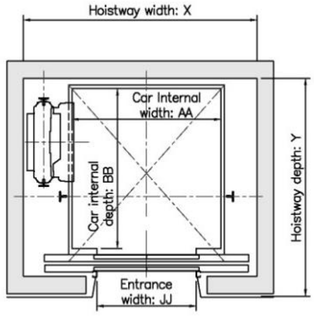
Number of persons	Rated Capacity (kg)	Rated Speed (m/sec)	Door Type	Entrance Width (mm) JJ	Car internal dimensions (mm) AA x BB	Counter-weight position	Minimum hoistway dimensions (mm) AH x BH /car	Minimum machine room dimensions (mm) AM x BM /car
6	450	1.0	CO	800	1400x850	Rear	1750x1400	2000x3250
						Side	2100x1200	2500x2900
8	550	1.0			1400x1030	Rear	1750x1590	2000x3350
		1.5						2000x3600
		1.0				Side	2100x1380	2500x3000
9	600	1.0			1400x1100	Rear	1750x1660	2000x3550
		1.0				Side	2100x1450	2500x3000
10	700	1.0			1400x1250	Rear	1750x1810	2000x3600
		1.5						2000x3650
		1.0 1.5 1.75				Side	2100x1600	2500x3100
11	750				1400x1350	Rear	1750x1910	2000x3700
						Side	2100x1700	2500x3100
13	900			900	1600x1350	Rear	2050x1910	2100x3700
						Side	2400x1730	2500x3100
15	1000				1600x1500	Rear	2050x2060	2100x3850
						Side	2400x1880	2500x3200
				1000	1800x1300	Rear	2250x1860	2300x3700
						Side	2600x1680	2600x3000
17	1150				1800x1500	Rear	2250x2110	2300x3900
						Side	2650x1880	2900x3100
				1100	2000x1350	Rear	2450x1960	2500x3450
						Side	2850x1730	3100x3000
20	1350			1000	1800x1700	Rear	2250x2310	2300x4100
						Side	2650x2080	3000x3200
				1100	2000x1550	Rear	2450x2160	2500x3650
						Side	2850x1930	3200x2800

Table 1(b)

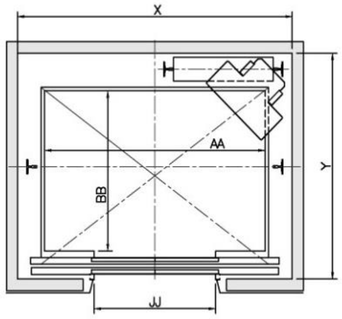
Rated Speed (m/sec)	Maximum travel (m) TR	Maximum number of Stops	Minimum overhead (mm) OH	Minimum pit depth (mm) PD	Minimum machine room clear height (mm)	Minimum floor to floor height (mm)
1	60	30	4400	1360	2200	2500
1.5	90		4560	1410		
1.75			4630	1410		

2. Recommended Dimensions of Passenger Lift and Service Lift
(Machine Room Less System)
All dimensions in millimeters

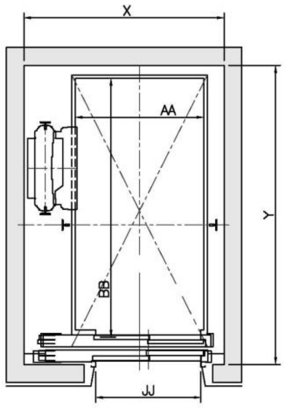
Hoistway Plan



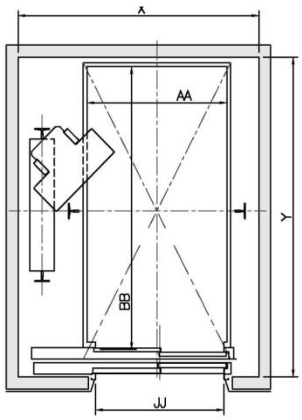
Shown for CO doors
Counterweight side drop
(Capacity 630kg ~ 1050kg)



Shown for CO doors
Counterweight rear drop
(Capacity 1275kg ~ 1600kg)

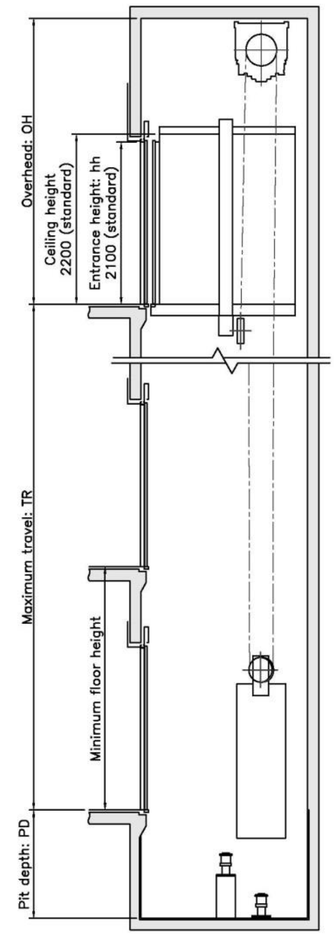


Shown for 2S doors
Counterweight side drop
(Capacity 450kg ~ 1050kg)



Shown for 2S doors
Counterweight side drop
(Capacity 1275kg ~ 1600kg)

Hoistway Section



Note: History Section for capacity of 1275 ~ 1600 kg is slightly different from this section

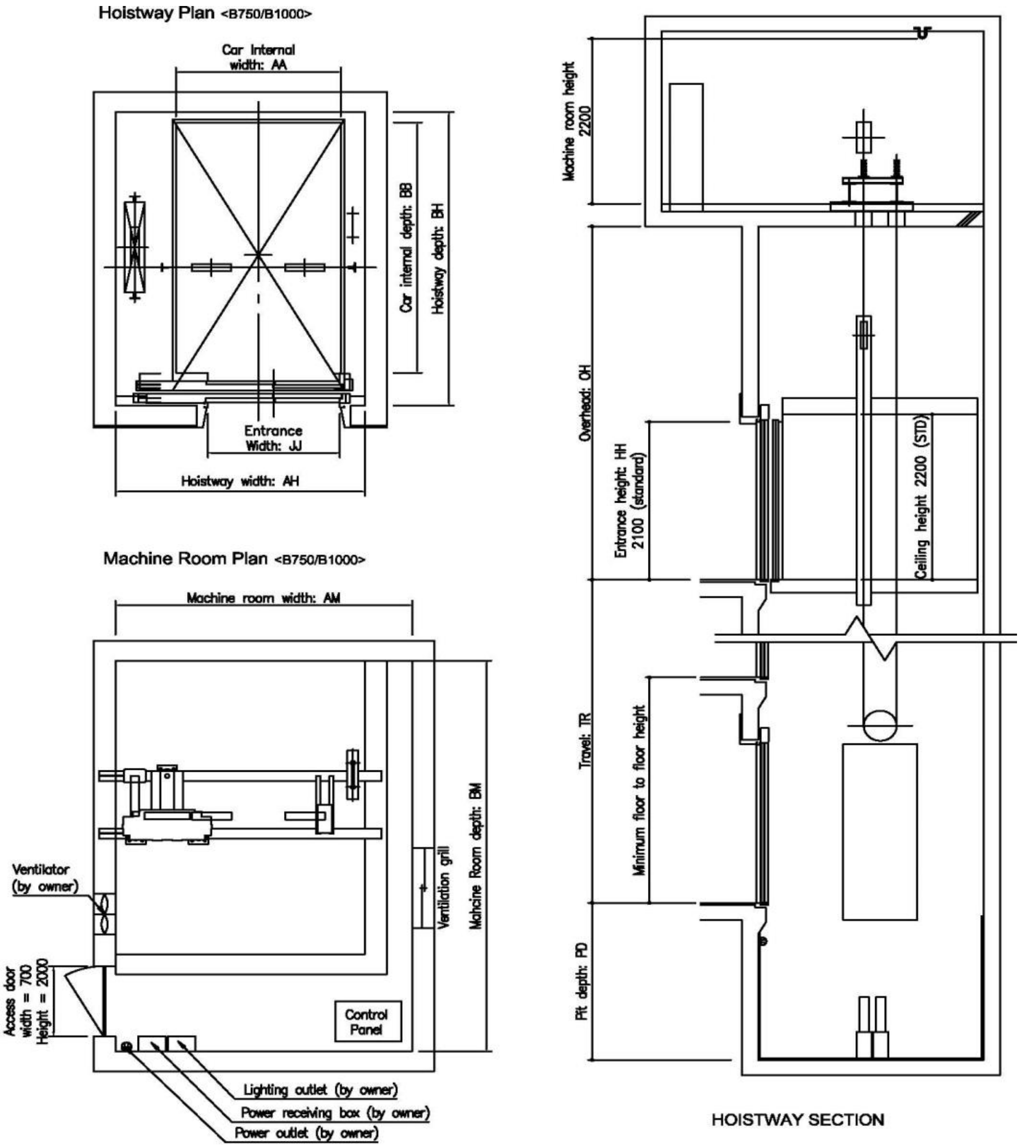
Table -2(a)

Code Number	Number of Persons	Rated Cap (Kg)	Door Type	Counter Weight Position	Car Internal Dimensions (mm) AA x BB	Entrance with(mm) JJ	Hoistway Dimensions (mm) X x Y
P 6	6	450	Co	Side	930 x 1300 1000 x 1200	800	1550 x 1700
P 8	8	550	Co	Side	1100 x 1300 1030 x 1400	800	1650 x 1700
P 9	9	600	Co	Side	1100 x 1400	800	1950 x 1720
P 10	10	700	Co	Side	1250 x 1400	800	2100 x 1720
P 11	11	750	Co	Side	1350 x 1400	900	2200 x 1720
P13	13	900	Co	Side	1350 x 1600	900	2350 x 1950
P 15	15	1000	Co	Side	1500 x 1600	900	2500 x 1950

Table -2(b)

Rated Speed (m/s)	Rated Capacity (Kg)	Maximum overhead (OH)	Maximum pit depth (mm) PD	Minimum Floor Height (mm)
1.0	450 - 750	3600	1300	2500
	900-1000	4100	1550	
1.5	450 - 750	3750	1400	
	900 – 1000	4250	1650	
1.75	450 - 750	3850	1450	
	900 – 1000	4350	1700	

3. Recommended Dimensions of Hospital Lifts
All dimensions in millimeters



<B750 / B 1000>

Table -3(a)

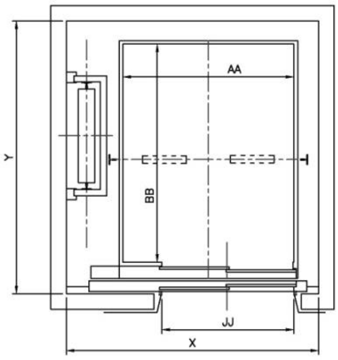
Number of persons	Rated Capacity (kg)	Rated Speed (m/sec)	Door Type	Counter-weight position	Car internal dimensions (mm) AA x BB	Entrance Width (mm) JJ	Minimum hoistway dimensions (mm) AH x BH /car	Minimum machine room dimensions (mm) AM x BM /car
11	750	1.0 1.5 1.75	2S	Side	1300x2300	1100	2135x2730	2600x3900
15	1000				1500x2500	1200	2335x2930	2700x3900

Table -3(b)

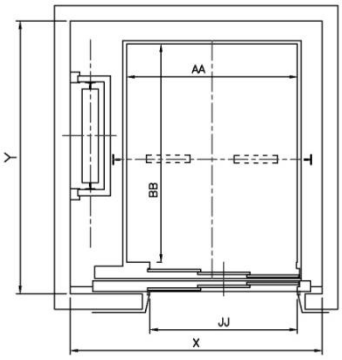
Rated Speed (m/sec)	Maximum travel (m) TR	Maximum number of Stops	Minimum overhead (mm) OH	Minimun pit depth (mm) PD	Minimum machine room clear height (mm)	Minimum floor to floor height (mm)
1	60	30	4400	1360	2200	2500
1.5	90		4560	1410		
1.75			4630	1410		

4. Recommended Dimensions of Good / Cargo / Freight Lift
All dimensions in millimeters
Hoistway Plan

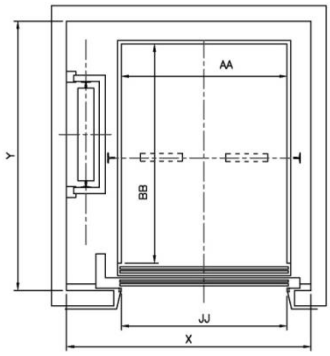
Hoistway Plan for 2-panel side opening door (2S)



Hoistway Plan for 3-panel side opening door (3S)



Hoistway Plan for 2-panel side opening door (2U)



Machine Room Plan

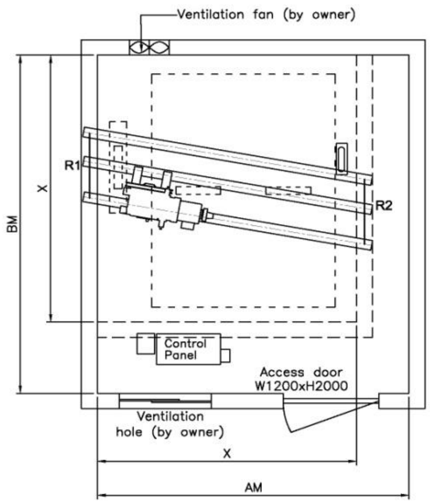


Table -4

Capacity (kg)	Speed (m/ sec)	Motor (kW)	Machine room (mm) AM x BM	Pit depth PD (mm)	Door type	Hoistway (mm) X x Y	Min. floor height (mm)	Overhead OH (mm)	Reaction loads (kN) Machine room R1	R2	Pit R3	R4
750	0.75	7.5	2600 x 3950	1250	2S	2200 x 2900	2800	4450	57.9	41.2	70.6	55.4
	1	9.5		1550				4650			71.6	55.4
1000	0.75	7.5	3150 x 3950	1250	2S	2600 x 2900	2800	4450	74.6	43.1	80.4	66.2
	1	9.5		1550				4650			84.8	73.1
1500	0.75	9.5	3600 x 4050	1250	2S	3150 x 3000	2800	4450	101	53.9	119.6	82.4
	1	13		1550				4650			129.4	88.3
2000	0.75	13	3600 x 4250	1250	2S	3150 x 3400	2800	4450	121.6	63.7	139.2	103
	1	18.5		1550				4650			150	109.8
2500	0.75	18.5	4000 x 4400	1250	3S	3600 x 3700	3300	4850	148.1	81.4	192.2	144.2
	1	22		1550				5050			206	154
	0.75	18.5	4000 x 4400	1250	2U	3600 x 3700	4500	4850	155.9	80.4	192.2	144.2
	1	22		1550				5050			206	154
	0.75	18.5	4000 x 4400	1250	3U	3600 x 3700	3950	4850	155.9	80.4	192.2	144.2
	1	22		1550				5050			206	154
3000	0.75	18.5	4100 x 4800	1250	3S	3750 x 4100	3300	4850	166.7	92.2	208	154
	1	26		1800				5050			223	165
	0.75	18.5	4100 x 4800	1250	2U	3750 x 4100	4500	4850	174.5	92.2	208	154
	1	26		1800				5050			223	165
	0.75	18.5	4100 x 4800	1250	3U	3750 x 4100	3950	4850	174.5	92.2	208	154
	1	26		1800				5050			223	165

5. Recommended Dimensions of Dumb Waiter

5.(a) Table Type

Hoistway Plan and Allied Installation MNBC 2016 or Last version **Hoistway Section**

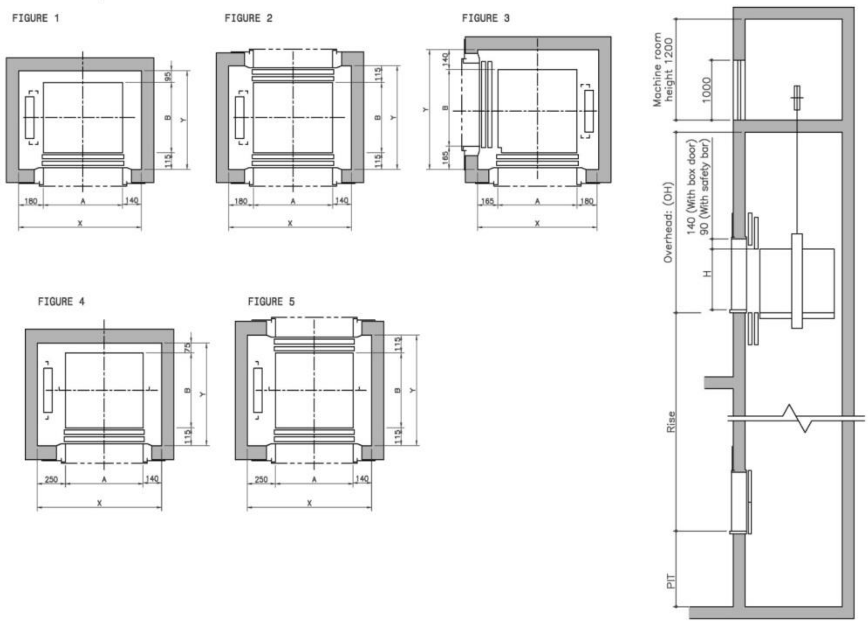
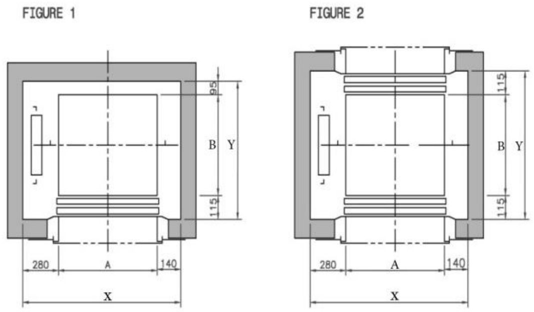


Table 5(a) Table Type

Load capacity (Kgs)	Speed m/sec	Kind of Equipment	Figure	Dimension (mm)							Motor Rating (KW)
				A (mm)	B (mm)	H (mm)	X (mm)	Y (mm)	OH (mm)	PIT (mm)	
50	0.2		1	550	550	750	870	780	1375	750	0.75
			2								
			3				895	850			
75		Table Type	1	600	600	800	960	1070	1450	750	0.75
			2								
	to		3				1200	970			
100			1	700	700	900	1020	930	1600	750	1
			2								
			3				1045	1005			
150	0.3		4	800	800	1000	1190	990	1750	750	1
			5					1030			

5.(b) Floor Type

Hoistway Plan



Hoistway Section

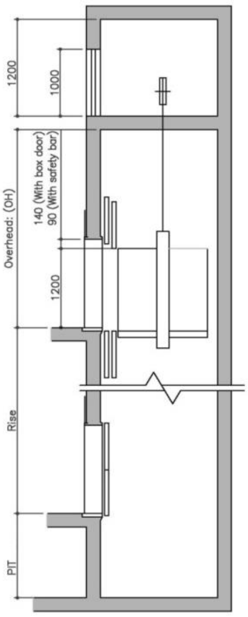


Table 5.(b) **Floor Tpe**

Load capacity (Kgs)	Speed m/sec	Kind of Equipment	Figure	Dimension (mm) A (mm)	B (mm)	H (mm)	X (mm)	Y (mm)	OH (mm)	PIT (mm)	Motor Rating (KW)
200	0.2 to 0.3	Floor Type	1	800	100	120	120	150	150	400 (min)	1.5
			2				140	140			
300			1	850	115	120	125	165	165	400 (min)	2.5
			2				145	155			

5C.4.9.3.2 Travel

The tables have been established for a maximum travel of 30m. For travels above 30m, the lift manufacturer should be consulted.

5C.4.9.3.3 Pit

The pit depth of the lifts will normally accommodate compensating chains. If compensating ropes are required, pit depth shall be increased for all loads and speeds and lift manufacturer should be consulted.

5C.4.9.3.4 Minimum floor to floor height

Minimum floor to floor height for landings on same side for horizontally sliding door is f + 750 mm and for vertically biparting doors is 1.5 f + 250 mm, where 'f' is clear entrance heights in mm.

5C.4.10 Lift Wells and Lift Well Enclosures

5C.4.10.1 Lift wells

5C.4.10.1.1 No equipment except that forming a part of the lift or necessary for its operation and maintenance shall be installed in the lift well. For this purpose, the main supply lines shall be deemed to be a part of the lift and the underground cable, if laid along the lift well shaft, shall be properly clamped to the wall.

5C.4.10.1.2 Sufficient space shall be provided between the guides for the cars and the side walls of the lift well enclosure to allow safe and easy access to the parts of the safety gears for their maintenance and repairs; safety gears provided shall be in accordance with Part 5A & Part 5B, MNBC latest version.

5C.4.10.1.3 Lift wells, together with the whole of the contained equipment and apparatus, shall be rendered fire resistant to the greatest possible extent.

5C.4.10.1.4 Every counterweight shall travel in juxtaposition to its car in the same lift well.

5C.4.10.1.5 It is undesirable that any room, passage or thoroughfare be permitted under any lift well. If unavoidable spaces for other uses may be permitted under the lift well, with the prior approval of the lift Inspectorate Authority and the following provisions shall be made:

a) Spring or Oil buffers shall be provided for lift car and counterweight.
b) The pit shall be sufficiently strong to withstand successfully the impact of the lift car with rated load or the impact of the counterweight when either is descending at rated speed or at governor tripping speed.
c) The car and the counterweight shall be provided with a governor-operated safety gear and
d) The forces required on the structure in the event of car buffering directly without safety gear application to be indicated in the general arrangement drawing.

5C.4.10.2 Lift Well Enclosures

5C.4.10.2.1 Lift well enclosures shall be provided and shall extend on all sides from floor-to-floor or stair-to-stair, and shall have requisite strength and in proper plumb. Liftwall enclosures are made concrete wall or Brick wall in up to 9 stop but more than 9 stop, must be do concrete wall only.

5C.4.10.2.2 The inner sides of the lift well enclosures facing any car entrances shall, as far as practicable form a smooth, continuous flush surface devoid of projections or recesses.

NOTE – This requirement may be met in existing lift wells by filling any recesses or spaces between projections or alternatively by covering them with suitable sheet material. If it is not possible to render flush any objection or tops of recesses, they should be beveled on the under side to an angle of 60°, from the horizontal by means of metal plates, cement rendering or other fire-resisting materials. Where a car-Levelling device is operative with car door opening, such interior surfaces shall always form a smooth flush surface below each landing level for a depth to at least the depth of the car-Levelling zone plus the distance through which the lift car may travel of its own momentum when the power is cut-off.

5C.4.10.2.3 Where an open lift well would increase the fire risk in a building, the lift well enclosure shall be fire-resisting construction (see Part 5F 'Fire Protection Systems').

5C.4.10.2.4 Where wire grill or similar constructions is used, the mesh or opening shall be such that the opening between the bars shall reject the ball of 30 mm in diameter and the lift well enclosure shall be of sufficient strength to resist accidental impact by users of the staircase or adjoining floor or by materials or trucks being moved in the vicinity.

5C.4.10.2.5 Where the clearance between the inside of an open-type lift well enclosure and any moving or movable part of the lift equipment of apparatus is less than 50 mm, the openings in the enclosure shall be further protected by netting of square mesh of aperture not greater than one centimeter and of wire not smaller than one mm.

5C.4.10.2.6 There shall be no opening in the lift well enclosure permitting access to the lift car by passing under the counterweight.

5C.4.10.2.7 In case of a completely enclosed lift well, a notice with the word 'Lift' may be placed outside of each landing door.

5C.4.10.2.8 Indicator

Where lifts are installed in totally enclosed wells, position indicators are recommended to be provided at each floor; however, where position indicators are not provided, at least direction indicators or 'In Use' indicators shall be provided at each landing.

5C.4.10.2.9 Landing doors

Every lift well shall, on each side from which there is access to a car, be fitted with a door. Such a door shall be fitted with efficient electromechanical locking so as to ensure that it cannot be opened except when the lift car is at landing and that the lift car cannot be moved away from the landing until the door is closed and locked. If the door is mechanically locked, means should be provided for opening the same by means of special key during emergency or inspection.

5C.4.10.2.10 Automatic devices for cutting off power

An efficient automatic device shall be provided and maintained in each lift whereby all power shall be cut off from the motor before the car or counterweight lands on buffer.

5C.4.10.3 Lift Pits

5C.4.10.3.1 A lift pit shall be provided at the bottom of every lift.

5C.4.10.3.2 Pits shall be of sound construction and maintained in a dry and clean condition. Where necessary, provision shall be made for permanent drainage and where the pit depth exceeds 1.5m suitable descending arrangement shall be provided to reach the lift pit. And a suitable fixed ladder or other descending facility in the form of permanent brackets grouted in the wall extending to a height of 0.75m above the lowest floor level shall be provided. A light point with a switch shall also be provided for facility of maintenance and repair work.

5C.4.11 Machine Rooms and Overhead Structures

5C.4.11.1 The lift machine, controller and all other apparatus and equipment of a lift installation, excepting such apparatus and equipments as function in the lift well or other positions, shall be placed in the machine room which shall be adequately lighted and rendered fire-proof and weather-proof.

5C.4.11.2 The motor generators controlling the speed of multi-voltage or variable voltage machines, secondary sheaves, pulleys, governors, floor selecting equipment may be placed in a place other than the machine room, but such position shall be adequately lighted, ventilated and rendered fire-proof and weather – proof.

5C.4.11.3 The machine room shall have sufficient floor area as well as permit free access to all parts of the machines and equipment located therein for purposes of inspection, maintenance or repair.

5C.4.11.4 The room shall be kept closed, except to those who are concerned with the operation and maintenance of the equipment. When the electrical voltage exceeds 220/230 V ac, a danger notice plate shall be displayed permanently on the outside of the door and on or near the machinery. Where standby generator is provided, it is necessary to connect fireman lift to the standby generator. Depending upon the capacity of the standby generator one or more other lifts may also be connected to the supply.

Rescue instruction with required tools and tackles if any shall be made available in the machine room.

All lift which do not have any automatic transfer facility to an alternate supply, such as generator, shall be equipped with Battery Operated Automatic Rescue Device to bring the lift to the nearest floor and open the door in the event of power failure.

5C.4.11.5 The machine room shall be equipped with an insulated portable hand lamp provided with flexible cord for examining the machinery.

5C.4.11.6 If any machine room floor or platform does not extend to the enclosing walls, the open sides shall be provided with hand rails or otherwise suitably guarded.

5C.4.11.7 The machine room shall not be used as a store room or for any purpose other than housing the lift machinery and its associated apparatus and equipment.

5C.4.11.8 Machine room floor shall be provided with a trap door, if necessary. The size of the trap door shall be as per manufacturer's recommendation.

5C.4.11.9 The height of the machine room shall be sufficient to allow any portion of equipment to be accessible and removable for repair and replacement and shall be not less than 2m clear from the floor or the platform of machine whichever is higher.

5C.4.11.10 It will be noted that generally lifts have machine rooms immediately over the lift well, and this should be arranged whenever possible without restricting the overhead distance required for normal safety precautions. In case where machine room provision on top is a limitation, either machine room less lift or basement drive or side drive lift can be considered.

5C.4.11.11 For detailed information regarding nomenclature of floors and storeys, reference may be made to Building Authories.

5C.4.11.12 There should be a proper access planned for approach to the machine room taking into account need for maintenance personnel to access the machine room at all times of day and night and also the need to take heavy equipment. Any fixture such as a ladder provided should be secured permanently to the structure and should have railings to reduce the risk of falling.

5C.4.11.13 It is desirable that emergency exit may be provided in case of large machine rooms having four or more lifts.

5C.4.11.14 Where the machine room occupies a prominent position on roof of a building, provision should be made for lightning protection in accordance with Part 5A & Part 5B, MNBC latest version and Myanmar electricity Rule and Regulation.

5C.4.11.15 Wherever the machine room is placed, it should be property ventilated. The ambient temperature of machine room shall be maintained between +5°C and +40°C.

5C.4.11.16 If located in the basement, it should be separated from the lift well by a separation wall.

5C.4.12 Essential Features Required

5C.4.12.1 Power operated car doors on automatically operated lifts shall be so designed that their closing and opening is not likely to injure a person. The power operated car door shall be provided with a sensitive device which shall automatically initiate reopening of the door in the event of a passenger being struck or is about to be struck by the door, while crossing the entrance during closing movement. The effect of the device may be neutralized:

a) During the last 58 mm of travel of door panel in case of side opening doors
b) When panels are within 58 mm of each other in case of center opening doors.

The force needed to prevent the door from closing shall not exceed 150 N and this measurement shall not be made in the first third of the travel of the door.

In order to achieve this it is desirable that all power operated doors have a full length (covering at least 80 percent of the car door height from the bottom) infrared light curtain safety to retract the door in the event of coming across any obstacle during closing of the door.

5C.4.12.2 Single speed and two speed drives which are poor in Levelling accuracy and energy consumption shall not be used for new lifts in view of availability of latest technology energy efficient Variable Voltage Variable Frequency drive systems with improved Levelling accuracy.

5C.4.12.3 For passenger lifts with car call button control in car and with capacities of 16 passenger and above, it is recommended to have an additional car operating panel with call buttons on the opposite side to main panel for ease of access to buttons.

5C.4.12.4 Passenger lifts shall be provided with power operated doors which are imperforate.

5C.5 DIMENSIONAL TOLERANCES

5C.5.1 Lift Well Dimensions

Plan dimensions of lift wells given by the lift maker represent the minimum clear plumb sizes. The purchaser's representative, in conjunction with the builder, should ensure that adequate tolerances are included in the building design so that the specified minimum plumb dimensions are obtained in the finished work.

Dimensions in excess of these minimum plumb dimensions for lift well and openings (but not less) can be accommodated by the lift maker up to certain maximum values beyond which changes in design may be necessary involving additional expense or work by the builder. The purchaser's representative should take these factors into account when specifying the lift well structural dimensions on the basis of the constructional tolerance appropriate to the building technique.

5C.5.2 Landing Door Openings

It is very important that finished landing openings should be accurate to design size and plumb one above the other for the full travel of the lift. In constructing the structural openings in concrete walls to lift wells it is not possible to achieve a degree of accuracy vertically which will allow doors and frames to be inserted in the opening without some form of masking or packing to overcome inaccuracies. Provisions should therefore be made in design by increasing the nominal height form design finished floor level and width of openings to each jamb and head.

In addition, the alignment of the outer face of the front wall of the lift well is of importance when architrave of fixed dimensions are called for, and in this case the alignment of the outer face from floor to floor should not vary to a greater extent than can be accommodate by the subsequent front wall finish, the architrave being set accurately plumb.

To facilitate accurate alignment of landing sills it is common practice to provide at each landing an independent threshold, the position of which can be adjusted.

5C.5.3 Structural Limits for Lift Wells at any Level

If the net plumb well (dimensions A and B of Fig-2) and the nominal structural entrance openings (dimensions C and D of Fig.2) are defined by plumb lines, the actual wall should not encroach on these dimensions.

Dimension K (inside face of wall of Fig .2) should fall within the following limits:

For wells up to 30 meter	-	0 - 25 mm
For wells up to 60 mete r	-	0-35 mm
For wells up to 90 meter	-	0-50 mm

When architrave are to be supplied by the lift maker dimension L (side of structural opening of Fig.2) should fall within the limits of 0 and 25 mm and dimension M (outer face of the front wall of Fig.2) should not vary to a greater extent than can be accommodated by the subsequent front wall finish, the architrave being set accurately plumb.

When the entrance linings are supplied by the builder, corresponding provision should be made for the finished openings to be accurately plumb one above the other for the full travel of the lift end to design size.

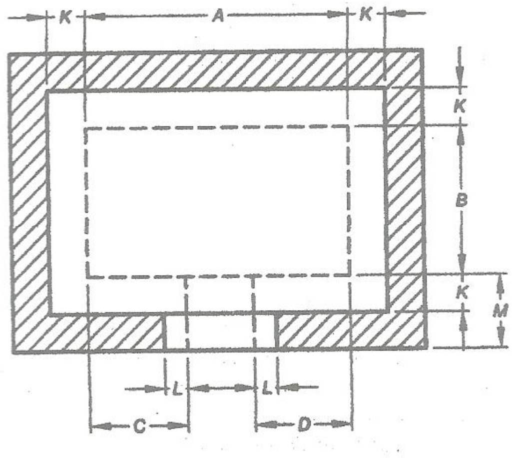


FIG. 2 LIFE WELL TOLERANCE

5C.6 PRELIMINARY DESIGN

5C.6.1 Number of Lifts and Capacity

5C.6.1.1 Two basic considerations, namely, the quantity of service required and the quality of service desired, determine the type of lifts to be provided in a particular building. Quantity of service gives the passenger handling capacity of the lifts during the peak periods and the quality of service is measured in terms of waiting time of passengers at various floors. Both these basic factors require proper study into the character of the building, extent and duration of peak periods, frequency of service required, type and method of control, type of landing doors etc. In busy cities patience, coefficient being low satisfaction cannot be obtained if lifts with adequate capacities and speed are not provided. In view of many variables, no simple formula is possible for determining the most suitable lifts.

NOTE – It is recommended to do Traffic Analysis Study to ensure optimum provision of lifts for the building in consultation with lift manufactures. In view of the dynamic situation it is recommended that a computerized software is used for Traffic Analysis Study.

5C.6.1.2 The number of passenger lifts and their capacities, that is load and speed, required for a given building depend on the characteristics of the building. The most important of these are:

a) Number of floors to be served by the lifts
b) Floor to floor distance
c) Population of each floor to be served and
d) Maximum peak demand; this demand may be unidirectional, as in up and down peak periods, or a two-way traffic movement.

It should be appreciated that all calculations on the traffic handling capabilities of lifts are dependent on a number of factors which vary according to the design of lift and the assumptions made on passenger actions. It follows, therefore, that the result of such calculations can only be put to limited use of a comparative nature. For instance, they can with advantage be used to compare the capabilities of lifts in a bank with different loads and speeds provided the same set of factors are used for all cases. On the other hand, they cannot be used to compare the capabilities of different makes of lift used for a given bank of lifts.

Different authorities and manufacturers differ widely in their methods of calculation, due to the variations in lift performance, especially with regard to rates of acceleration and deceleration and door operation times which form the components of performance time. Therefore, the calculations made by different organizations will not necessarily agree.

5C.6.2 Preliminary Lift Planning

5C.6.2.1 General

Methods of calculating the traffic handling capabilities of lifts were first devised for office buildings. In due course detailed modifications were devised to suit other applications without altering the basic principles. The application to office buildings is still the most frequently used.

Therefore, the following method may be used as general guidance on preliminary lift planning for offices, bearing in mind the differences set out in 5C.6.1.2.

A lift installation for office building is normally designed to populate the building at a given rate and the three main factors to be considered are:

a) Population or the number of people who require lift service.

b) Handling capacity of the maximum flow rate required by these people.

c) Interval or the quality of service required.

5C.6.2.2 Population

The first point to be ascertained from the eventual occupier is the total building population and whether this is likely to increase in the future.

If a definite population figure is unobtainable an assessment should be made from the net area and probable population density. Average population density can vary from about one person per 4 m^2 to one person per 20 m^2. It is essential, therefore, that some indication of the probable population density should be obtained from the building owner. If no indications is possible (a speculative development for example) population in the region of 5m^2 per person for general office buildings is usually assumed.

5C.6.2.3 Quantity of Service

The quantity of service is a measure of the passenger handling capacity of a vertical transportation system. It is measured in terms of the total number of passenger handled during each five-minute peak period of the day. A five-minute base period is used as this is the most practical time over which the traffic can be averaged.

The recommended passenger handling capacity for various buildings is as follows:

Type of Building	Handling Capacity
Office – Diversified tenants	10 to 15 percent
Office – Single tenant	15 to 25 percent
Residential	7.5 percent

5C.6.2.4 Quality of Service

The quality of service on the other hand is generally measured by the passenger waiting time at the various floors. The following shall be the guiding factor for determining this aspect.

Quality of Service or Acceptable Interval

20 to 25 seconds	Excellent
26 to 35 seconds	Good
36 to 40 seconds	Fair
41 to 45 seconds	Poor
Over 45 seconds	Unsatisfactory

NOTE – For residential buildings longer intervals should be permissible.

5C.6.2.5 Traffic Peaks

The maximum traffic flow during the up peak period is usually used as a measure of the vertical transportation requirement in an office building. The employees of all offices are subject to discipline and are required to be at their place in time. Consequently, the incoming traffic flow is extremely high and the arrival time is over a short period.

Sometimes it becomes necessary to reduce the maximum traffic flow by staggering the arrival of the employees so that different groups arrive at different times. This reduces the peak and also the requirement of lifts. However, many organizations may object to staggering and prefer to have all employees arrive at the same time since it is claimed that staggering will affect the proper co-ordination of business.

5C.6.2.6 Capacity

The minimum size of car recommended for a single purpose buildings is one suitable for a duty load of 900 kg. Generally, for large office buildings cars with capacities up to 2000 kg are recommended according to the requirements.

5C.6.2.7 Speed

It is dependent upon the quantity of service required and the quality of service desired (see 5C.6.2.3 and 5C.6.2.4). Therefore, no set formulae for indicating the speed can be given. However, the following general recommendations are made:

No. of Floors	Speed
2 to 5	0.5 m/s to 1 m/s
6 to 12	1 m/s to 1.5 m/s
13 to 20	1.5 m/s to 2.5 m/s
Above 20	2.5 m/s and above

5C.6.2.8 Layout

The shape and size of the passenger lift car bears a distinct relation to its efficiency as a medium of traffic handling. A study of the most suitable proportions for these lifts reveal that the width of the lift well entrance is in reality, the basic element in the determination of the best proportions. In other words, the width of the car is determined by the width of the entrance and the depth of the car is regulated by the loading per square metre permissible under this Code. Centre opening doors are more praticable and efficient entrane units for passenger lifts.

5C.6.2.9 Determination of Transportation or Handling Capacity During the Up Peak

5C.6.2.9.1 The handling capacity is calculated by the following formula:

$$H = \frac{300 \text{ x } Q \text{ x } 100}{T \text{ x } P}$$

Where

H = Handling capacity as the percentage of the peak population handled during 5 min period,

Q = Average number of passengers carried in a car,

T = Waiting interval in seconds, and

P = Total population to be handled during peak morning period. (It is related to the area served by a particular bank of lifts.)

The value of Q depends on the dimensions of the car. It may be noted that the car is not loaded always to its maximum capacity during each trip and, therefore, for calculating H the value of Q is taken as 80 percent of the maximum carrying capacity of the car.

The waiting interval is calculated by the following formula:

$$T = \frac{RTT}{N}$$

where

T = Waiting interval in seconds,

N = Number of lifts, and

RTT = Round trip time, that is, the average time required by each lift in taking one full load of passengers from ground floor, discharging them in various upper floors and coming back to ground floor for taking fresh passengers for the next trip.

RTT is the sum of the time required in the following process:

a) Entry of the passengers on the ground floor,
b) Exit of the passengers on each floor of discharge,
c) Door closing time before each starting operation,
d) Door opening time on each discharging operation,

e) Acceleration periods,
f) Stopping and Levelling periods,
g) Periods of full rated speeds between stops going up, and
h) Periods of full rated speeds between stops going down.

It is observed that the handling capacity is inversely proportional to waiting interval which in turn is proportional to RTT. Reducing the RTT of a lift from 120 to 100 increases its handling capacity by 20 persent.

The round trip time can be decreased not only by increasing the speed of the lift but also by improving the design of the equipment related to opening and closing of the landing and car doors, acceleration, deceleration, Levelling and passenger movement. These factors are discussed below:

a) The most important factor in shortening the time consumed between the entry and the exit of the passengers to the lift car is the correct design of the doors and the proper car width. For comfortable entry and exist for passengers it has been found that most suitable door width is 1000 mm and that of car width is 2000 mm.
b) The utilization of centre opening doors has been a definite factor in improving passenger transfer time, since when using this type of door the passengers, as a general rule, begin to move before the doors have been completely opened. On the other hand, with a side opening door the passengers tend to wait until the door has completely opened before moving.

The utilization of centre opening doors also favours the door opening and closing time periods. Given the same door speed, the centre opening door is much faster than the side opeing type. It is beyond doubt that the centre opening door represents an increase in transportational capacity in the operation of a lift.

5C.6.2.9.2 An example illustrating the use of the above consideration is given below:

Gross area per floor 1100 m^2

Net usable area per floor 950 m^2

No. of landings including ground 15

Assuming population density 9.5 m^2 per person

Probable population in

$$P = \frac{14 \text{ x } 950}{9.5}$$

Upper floors 1400 persons

Taking 20 passengers lift with 2.5 m/s the calculated RTT = 165 s

$$Q = 20 \text{ x } 0.8 = 16$$

a) Taking No. of lifts, N = 4

$$T = \frac{RTT}{N} = \frac{165}{4} = 41s$$

$$H = \frac{300 \text{ x } Q \text{ x } 100}{T \text{ x } P} = \frac{300 \text{ x } 16 \text{ x } 100}{41 \text{ x } 1400} = 8.3 \text{ percent}$$

b)Taking No. of lifts, N = 6

$$T = \frac{165}{6} = 27.6s$$

$$H = \frac{300 \text{ x } Q \text{ x } 100}{T \text{ x } P} = \frac{300 \text{ x } 16 \text{ x } 100}{27.6 \text{ x } 1400} = 12 \text{ percent}$$

5C.6.3 Quiet Operation of Lifts

Every precaution should be taken with passenger lifts to ensure quiet operation of the lift doors and machinery. The insulating of the lift machine and any motor generator from the floor by rubber cushions or by a precast concrete slab with rubber cushions, prevents transmission of most of the noise.

5C.6.4 Positioning of Lifts

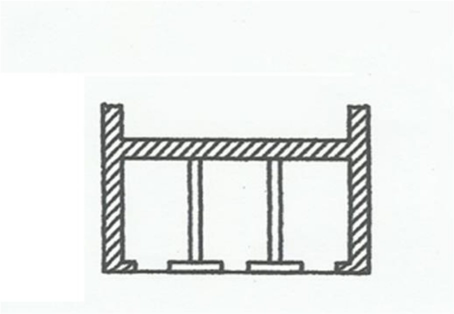
A thorough investigation should be made for assessing the most suitable position for lift(s) while planning the building. It should take into account future expansions, if any. Though each building has to be considered individually for purposes of location of lifts, factors influencing the locations of passenger and goods lifts are given in 5C. 6.4.2 to 5C. 6.4.4.

The location of lifts may also conform to the travel distance requirements specified in Part 5F ‘Fire Protection Systems’.

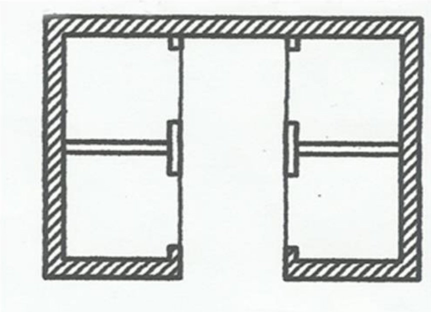
5C.6.4.1 Arrangement of Lifts

The lifts should be easily accessible from all entrances to the building. For maximum efficiency, they should be grouped near the centre of the building. It is preferably not to have all the lifts out in straight line and, if possible, not more than three lifts should be arranged in this manner. It has to be kept in mind that the corridor should be wide enough to allow sufficient space for waiting passengers as well as through passengers.

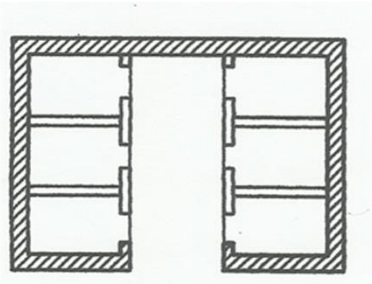
5C.6.4.1.1 In some cases when there are more than three lifts, the alcove arrangement is recommended. With this arrangement, the lift alcove lead off the main corridor so that there is no interference by traffic to other groups or to other parts of the ground floor. This arrangement permits the narrowest possible corridors and saves space on the upper floors. Walking distance to the individual lift is reduced and passenger standing in the center of the group can readily see all the lift doors and landing indicators. The ideal arrangement of the lifts depends upon the particular layout of the respective building and should be determined in every individual case. Some typical recommended arrangements are given in Fig. 1.



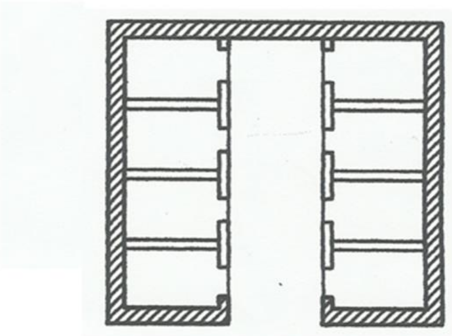
1A STRAIGHT LINE ARRANGEMENT FOR THREE LIFTS



1BALCOVE ARRANGEMENT FOR FOUR LIFTS



1CARRANGEMENT FOR SIX LIFTS



1D ARRANGEMENT FOR EIGHT LIFTS

5C.6.4.2 Passenger Lifts

5C.6.4.2.1 Low and medium class flats

Where a lift is arranged to serve two, three or four flats per floor, the lift may be placed adjointing a staircase, with the lift entrances serving direct on to the landlings. Where the lift is to serve a considerable number of flats having access to balcomies or corridors, it may be conveniently placed in a well ventilated tower adjointing the building.

5C.6.4.2.2 Office buildings, hotels and high calss flats

In general the arrangement as recommended in 5C 6.4.1 is to be followed. However, in case this is not possible, it is desirable to have at least a battery of two lifts at two or more convenient points of a building. If this is not possible, it is advisable to have at least two lifts side by side at the main entrance and one lift each at different sections of the building for intercommunication. When two lifts are installed side by side, the machine room shall be suitably planned with sufficient space for housing the machine equipment. The positioning of lifts side by side gives the following advantages:

a) All machine and switch gear may be housed in one machine room
b) The lifts can be inter-connected more conveniently from an installation point of view and
c) Greater convenience in service owing to the landing openings and each floor being adjacent.

5C.6.4.2.3 Shops and departmental stores

Lifts in shops and stores should be situated so as to secure convenient and easy access at each floor.

5C.6.4.2.4 For buildings with more than 12 floors, it is recommended to have provision of one service lift in addition to the passenger lifts.

5C.6.4.2.5 For buildings with more than 12 floors, where passenger and service lifts are provided in one lobby it is recommended to have group control for all the lifts.

5C.6.4.3 Goods Lifts

The location of lifts in factories, warehouses and similar buildings should be planned to suit the progressive movement of goods throughout the buildings, having regard to the nature of position of the loading platforms, railway sidings, etc. The placing of a lift in a fume or dust laden atmosphere or where it may be exposed to extreme temperatures, should be avoided wherever possible. Where it is impossible to avoid installing a lift in an adverse atmosphere, the electrical equipment should be of suitable design and construction to meet the conditions involved.

5C.6.4.3.1 Normally goods lifts have lower speeds than passenger lifts for the same travel because traffic conditions are less demanding, and more time is required for loading and unloading.

5C.6.4.3.2 As loads for goods lifts increase in size and weight, so the operation of loading and unloading becomes more difficult. Therefore, it is usual to require greater accuracy of levelling as the capacity of the goods lift increases.

5C.6.4.3.3 A large capacity goods lift at high speed is often a very uneconomical preposition. The inherent high cost is enhanced due to the very small demand for such equipment, much of which is custom made. The high capital cost of the lift, building work and electrical supply equipment usually shows a much smaller return as an investment than more normal sizes of lifts.

5C.6.4.4 Hospital Bed Lifts

Hospital bed lifts should be situated conveniently near the ward and operating theatre entrances. There shall be sufficient space near the landing door for easy movement of stretcher.

It is convenient to place the passenger lifts in a hospital, near the staircases.

5C.6.4.5 MRL lifts (Lift Without Conventional Machine Rooms)

MRL Lifts are a special type of lifts where hoisting machine in placed inside the lift shaft and control system may be inside and/or adjacent are at close proximity to top landing door, eliminating the need for conventional machine room.

MRL Lifts shall be in conformance with Electrical Inspectorate apart from other relevant provisions of this Section.

MRL Lifts may be provided with emergency door on the top portion of the hoist-way which is equipped with electromechanical lock wired in series with lift safety chain and of size (700mm x

700mm) minimum so as to access the machinery space in case of emergency or safety device being activated on or above the top landing.

5C.6.4.6 Hydraulic Lift

The hydraulic lift is a special type of lift where the lift car is directly or indirectly driven by action of one or more hydraulic jacks.

The hydraulic lifts shall conform Electrical Inspectorate apart from other relevant provisions of this Section.

These lifts should preferably be hole-less type of lifts.

5C.6.4.7 Automobile Lift

Where required, lifts suitable for moving passenger vehicles such as light motor vehicles (LMV),small utility vehicles(SUV), etc may be provided. The minimum requirements to be considered while providing such lifts are as given in Electrical Inspectorate**.**

The minimum and maximum car area requirements for passenger lifts as defined in part 5C.6.1 may not be applicable for automobile lifts. For this class of loading, the rated load shall be based on not less than 1.45kN/m^2 of inside net platform area.

Strengthening stiffeners may be added to car panels to have sufficient strength to avoid permanent or temporary deflection of cars panel beyond limits in case the vehicle touches the lift car panels while moving in or out. Under no circumstance, it should result into unsafe condition.

The hall button for calling the lift may be provided in the approach way at such a location that the button is accessible to the vehicle driver in the driving position without having to get off the vehicle. Optional light ray detection system or card reader system may be provided for automatic detection of vehicles and calling the lift to the floor.

Minimum entrance width of such lifts may be 2400mm and entrance of height 2300mm.The minimum car inside dimensions may be 2500mm wide and 5300mm deep and typically with entrance doors on both sides of the lift. This will enable the car to be driven inside and can be taken out in the same direction without any need to reverse the same. Minimum load carrying capacity shall not be less than 2500kg.

Barricades may be provided outside the lift entrance doors(s) so as to limit the size of the vehicle and preventing oversized vehicles from entering the lifts and possibly damaging the equipment.

There shall be sufficient place on both sides of the vehicle is inside the lift. The lift car width should be selected such that in case of emergency while the automobile is in the lift car the driver should be able to open the automobile door and come out of the automobile.

The car operating panel, where the car call can be given, may be provided at such a location that is accessible by the vehicle driver in the driver position without having to get of the vehicle. The time duration for which the doors remains open upon arrival at landing floor or upon stopping at landing floors shall be sufficient enough so as to enable smooth movement of the vehicles in and out of the lift car. Lift car entrance door(s), shall be equipped with light curtain device in accordance with 19.1.4 of Electrical Inspection Department.

Overload warning device shall be installed in accordance with 6.2 of Electrical Inspectorate.

5C.6.4.8 Lift accessible for persons with Disabilities

All lifts open to public shall adhere to the accessibility provisions in terms of size of the car, door width, control panel, flooring, finish, handrails, communication systems and information, given in ‘ Development Control Rules and General Building Requirements’.

Lifts for persons with disabilities shall conform to Myanmar National Building Code 2025, part-2 apart from other provisions of this Section.

5C.6.4.9 Home Lift

a) The home lift is designed especially for private home having up to 4 stops (maximum travel 12m), where the usage of the lift is restricted primarily to the residents of the private home. Unlike conventional lift which all of virtually unlimited access to members of the general public, in case of home lift non-residents shall have limited access.

b) The rated capacity of the home lift shall be minimum 250kg (3 persons), 320kg (4 persons) and maximum 400kg (5 persons) and lift car speed shall not exceed 0.5m/s.

c) The home lift shall conform to electrical installation Myanmar National Building Code 2025, 5B apart from other relevant provision.

5C.6.4.9.1 Home Lift machine

a) A simple drum type machine using a single phase or three phase motor installed directly in the hoist way or in a suitable protected place.

b) A traction machine place in the hoist way or in a suitable protected place.

c) A hydraulic jack driven by a pump transmitting hydraulic liquid.

5C.6.4.9.2 Controller

a) Microprocessor controller with a variable voltage variable frequency inverter shall be provided.

b) The overload dimension shall not be less than 2900mmprovided the top from the highest point of the car shall not be less than 225mm when the car is at the top terminal landing.

c) The pit depth shall be such that the car or counter weight when applicable is resting on a fully compressed buffer, the free distance between the pit floor and the lowest point of the car shall not be less than 50mm. At the minimum clear space of 50mm is not available under the platform when at its lowest position, a manually positioned mechanical blocky device shall be provided to enable the platform to be held in raised position and to create a free distance of at least 500mm between the floor of the pit and lowest parts of the elevator car at a counter weight is provided such device shall also be made available for the counter weight.

5C.6.4.9.3 Home Lift car cage

a) The car enclosure shall be constructed in such a way that there is on possibility of any things outside coming in direct contact with people or things inside the car. For optimum of space, the car may have curved car side wall panels

b) The car need not have a car frame .The load can be home by the car enclosure and car platform.

5C.6.4.9.4 Landing door, car door & Loading device

The requirement specified in Myanmar National Building Code 2025,5C-2 Terminology.

5C.6.4.9.5 Operating and Safety Device

a) Overload Prevention Device

   As with the provision of overload prevention devices in conventional elevator, the elevator car shall not start when the elevator car is overloaded. The elevator operation shall resume only upon removal of the overload.

b) The elevator car shall stop at each landing with car sill level with the landing sill. The difference in level shall not exceed ± 5mm max.

c) There levelly facility automatically adjusts the elevator car position to be level with the landing when the elevator car moves up and down slightly with people boring and leaving the elevator car.

d) In the event of the power failure during the normal operation a battery operated ARD shall automatically moves the stalled elevator the flow, open the doors, there by facilitating reduce of the standard passenger in the elevator.

e) For intercommunication with passenger in the elevator car, a suitable intercom facility shall be provided.

f) (An option shall be available to the purchases of ordering the hall buttons and car operating panel lower than normal so as to make the elevator wheel chair user friendly.

5C.6.4.9.6 Other

a) Electric MRL type home lift, shall in addition conform to the technical requirements specified lift installation Electrical Inspectorate.

b) Hydraulic type home lift shall in addition conform to the technical requirements specified in lift installation Electrical Inspectorate.

5C.6.4.10 Air Conditioning System for lift Cabin (Car cage)

Where the lift car is equipped with air conditioning system, following additional requirements are recommended:

a) The whole equipment, its container, condenser, etc.., should be typically made of corrosion resistant material, with average designed life span of 10 years.

b) The air conditioning system should work on single phase electric power supply of maximum 230V AC and should be well within the current carrying capacity of trailing cable cores provided for the air conditioning system. The power supply for the air conditioning system shall be provided from RCCB of suitable rating. This RCCB shall be located in the lift machine room with proper identification and lock out tag out facility.

c) The air conditioning system should be provided with suitable air filters which should ensure clean air inside lift car. The filters should be easily accessible and serviceable from top of the lift car in a safe and easy manner.

d) The lift air conditioning should typically include functions such as:

    1) Cooling, with adjustable temperature setting provided on the unit itself or through remote control unit, which may be maintained in the lift car.

    2) Ventilation, with adjustable air flow having less than 52dBA noise level in the car.

5C.6.5 Structural Considerations

5C.6.5.1 Lift well enclosures, lift pits, machine rooms and machine supports besides conforming to the essential requirements given in 5C-4, should form part of the building construction and comply with the lift manufacturer's drawings.

5C.6.5.2 Machine Room

Floors shall be designed to carry a load of not less than 350 kg/m^2 over the whole area and also any load which may be imposed there on by the equipment used in the machine room or by any reaction from any such equipment both during periods of normal operation and repair.

5C.6.5.3 The side wall of the lift well may be made of reinforced cement concrete at least 150 mm thick so as to provide satisfactory anchoring arrangement for fixing. Reference shall also be made to Part 3 'Structural Design, Section 5, Plain, Reinforced and Prestressed Concrete, Plain and Reinforced Concrete'.

5C.6.5.4 The total load on overhead beams shall be assumed as equal to all equipment resting on the beams plus twice the maximum load suspended from the beams.

5C.6.5.5 The factor of safety for all overhead beams and supports based on ultimate strength of the material and load in accordance with 5C 6.5.4 shall be not less than the following:

For Steel 5

For Reinforced Concrete 7

5C.6.6 Access to Machine Room and Lift Pits

5C.6.6.1 Access to machine room above a lift well may be either from the roof or by an internal staircase with a proper arrangement for fixing.

5C.6.6.2 Access between a secondary floor and a machine room may be by ladder. Where a machine room entrance is less than 1.5 m above or below the adjacent floor or roof surfaces, a substantial permanently attached ladder may be used. Ladders shall be fixed at least 150 mm clear of any wall, beam or obstruction and shall extend at least to the landing level. Above the landing level and for a height of at least 1.15m, either the ladder stringers shall be extended or suitable hand grips shall be provided.

5C.6.6.3 Where the machine room entrance is 1.5 m or more above or below the adjacent floor or roof surface, access shall be provided by means of stairs in accordance with the requirements given in 5C 6.6.3.1 to 5C 6.6.3.6.

5C.6.6.3.1 The angle of inclination of the stair shall not exceed 50° from the horizontal and the clear width of the stair shall be not less than 600 mm.

5C.6.6.3.2 The tread shall have a non-slip surface which shall be not less than 150 mm wide for open stair construction and not less than 20cm wide for closed stair construction.

5C.6.6.3.3 The rise of the stair shall not exceed 250 mm.

5C.6.6.3.4A hand rail shall be provided on the outer stringer of all stairways fixed at a convenient height, but not less than 500 mm high measured vertically from the noisings, and not less than 1m high on landings and platforms. Such hand rail shall have atleast 50 mm clearance between nearest permanent object at the corresponding side of the stair.

5C.6.6.3.5 Headroom clearance of not less than 2 m measured from the nosings of the stairway, shall be provided on every stairway.

5C.6.6.3.6 Heights of stairs over 5 m in length shall be provided with intermediate landings.

NOTE – Where compliance with any of the requirements specified in 5C.6.6.1 to 5C.6.6.3 is impracticable, applications for variation shall be made to the Authority, who may, very such requirements.

5C.6.6.4 Access to a machine room in a basement may be provided from a corridor.

5C.6.6.5 Access to a machine room via the lift well shall be prohibited.

5C.6.6.6 The lift pit should be capable of being examined by a separate access. In the case of a battery of two lifts, it is possible to examine the lift pit through the adjoining one.

5C.6.7 Fire Protection

To prevent fire from spreading by means of the lift well, lift well enclosurers shall conform to the requirements given in Part 5F 'Fire Protection Systems'. The machine room should be constructed of a suitable grade of fire-resisting material and precautions should be taken to minimize spread of fire from the machine room into the lift well see also Myanmar National Building Code 2025, 5C.4.11.

5C.6.8 Requirements for Fireman's Lift

Fire Protection Requirements for Lift

Fire Protection Requirements of Lifts in High Rise Buildings

5C.6.8.1 Buildings of Height 15m and above

Following requirements over and above those specified fire of the Code are applicable to all lifts provided in buildings having height more than 15m:

a) All materials of constructions in load bearing elements, stairways and corridors and facades shall be non-combustible.

b) The interior finishing materials shall be of very low flame spread type

c) Walls of the lift bank well enclosure for a lift or group of lifts shall have a fire rating of 120 min. The lift well shall have a vent at the top, of area not less than $0.2m^2$ per lift.

d) Landings doors - Lift landing doors shall be imperforate. Collapsible doors shall not be permitted. Lift landing doors provided in the lift enclosure shall have a minimum fire resistance rating of 60 min.

e) Lift car door – Lift car doors shall be imperforate. Collapsible car doors shall not be permitted.

f) Telephone or other communication facilities shall be provided in the lift car and the lift main lobby. Communication system for lifts shall also be connected to the fire control room of the building if provided. For lifts for use by persons with disabilities , the facilities shall be provided in accordance with 'Myanmar National Building Code 2024, Part-2'

g) Photo luminescent safety signs shall be posted and maintained on every floor at or near the lift indicating that in case of fire, occupants shall use the stairs unless instructed otherwise.The sign shall have the plan of the respective floor showing location of the stairways. The plan shall also indicate the direction to and the level of refuge area. All signs posted and maintained on every floor of Buildings open to and used by the public shall comply with the requirements of accessible signage given in ''Myanmar National Building Code 2024, Part-2'

h) All Lifts (fireman's lifts/non fireman's lifts) shall be provided with phase I operations as 5C.6.8.1 (j)(x)(grounding operation).

i) The grounding operation may be initiated by individual switches for lifts or a common switch for a group of lifts or by a signal from fire alarm system of the building if available.

j) Fireman's lift – The fireman's lift is provided in a building for the purpose of aiding firefighter in evacuating trapped persons in the building and to take the requirement for fighting fire to upper levels with minimum delay. Some lifts out of all the lifts shall be identified as fireman's lifts.

The number of required fireman's lifts and their location in a building will vary depending on the size, design, complexity of the building. Some considerations are as follows:

1) There shall be at least one fireman's lift per building.

2) If there are multiple wings in the building, there shall at least one fireman's lift per wing.

3) If there are multiple banks of lifts in the building there shall be at least one fireman's lift per bank of lifts.

4) If the building height is up to 600m and it is zoned height –wise and it does not have single fireman's lift serving every floor of the building, then there shall be at least one fireman's lift per zone which shall serve the main level /fire access level and shall serve all the landing in the respective zone.

5) If the building height is more than 600m and it does not have any single fireman's lift serving all the floors , that is , it has all lift serving only respective zone, the fireman's lift shall be provided in each zone separated, serving all landings in respective zone, with a transfer landing for transferring from one zone to another.

Considering all the above, fireman's lift(s) shall be identified on the building plan and duty displayed in Fire Command Centre.

To be effective in firefighting operation, the fireman's lift shall have following requirements:

i). The Fireman's lift may be used by the occupants in the normal times.

ii). The Fireman's lift shall be provided with a fireman's switch. The switch shall be a two position (ON/OFF) switch fixed at the evacuation floor (normally main entrance floor) for enabling the lift to be put into fireman's model. The switch shall be situated in a glass-fronted box with suitable label and fixed adjacent to the lift at the entrance level When the switch is on, landing call-points shall become inoperative and the lift shall be on the car control only or on a priority control device .When the Switch is off , the lift will return to normal working.

iii). The fireman's lift shall be provided with an audio and visual signal in the car.

iv). The fireman's lift shall have a floor area of minimum 1.44 m^2. It shall have loading capacity of not less than 550kg (8persons lift).

v). The fireman's lift shall be provided with power operated (automatic) doors of minimum 0.8m width.

vi). The speed of the fireman's lift shall be 1.0m/s or more such that it can reach the top floor from main floor/firefighter access level within 1min. In case the building is zoned, the fireman's lift shall operate from the lowest served landing to the topmost served landing in 1 min.

vii). Reliable alternative source of power supply should be provided for all fireman lifts through a manually /automatically operated change over switch .The route of wiring shall be safe from fire.

viii). Suitable arrangements such as providing slope in the floor of lift lobby shall be made at all the landing to prevent water used during firefighting from entering the lift shafts.

ix). The words ‘Fireman Lift’ shall be conspicuously displayed in fluorescents paint on the lift landing.

x). Operational requirements of fireman’s lift -

The lift shall be provided with the following operational controls, phase I and phase II.

a) Phase I – Return to evacuation floor-

Shall start when the fireman’s switch at the evacuation floor is turned to the ‘ON’ position or the signal from smoke detector (if provided by the Building Management System) is on. All lifts controlled by this switch shall cancel all existing car calls and separate from landing calls and no landing or car calls shall be turned on. All heat and smoke sensitive door reopening devices shall be rendered inoperative.

If the lift is travelling towards the evacuation floor, it shall continue driving to the floor.

If the lift is travelling away from the evacuation floor, it shall reverse its direction at the nearest possible floor without opening its doors and return non-stop to the evacuation floor.

If the lift is standing at a floor other than the evacuation floor, it shall close the doors and start travelling non-stop to the evacuation floor.

When at the evacuation floor, the lift shall park with doors open. The continuous audio signal is turned off after this return drive.

NOTE –If the building is designed for alternative evacuation floor. In case of fire at main floor the lifts shall park at the alternative evacuation floor with doors open.

b) Phase II – Operation of the Lifts shall be as defined below – The phase II is started after phase I , if the fireman’s switch is ‘ON’

If the lift are grounded by the smoke detector signal, for phase II to begin it shall be necessary to turn the fireman’s switch is ‘ON’

The lift does not respond to landing calls but registers car calls. All heat and smoke sensitive door reopening devices are rendered inoperative.

When the car call button is pressed, the doors start closing .If the button is released before the doors are fully closed, they re-open. The car call is registered only when the doors are fully closed.

After registering a car call the lift starts driving to the call.

If more than one car call is registered, only the nearest call is answered and the remaining calls will be cancelled at the first stop.

At the floor the doors are opened by pushing the door open button. If the button is released before the doors are fully open, they reclose.

The lift returns to normal services when it stands at the evacuation floor with doors open and the switch is turned 'OFF' thereafter.

The operation of fireman's lift shall be by means of a full set of push buttons in the car. Other Operating systems shall be rendered inoperative.

5C.6.8.2 Buildings of Height 60m and above

The following requirements over and above those specified in 5C.6.8.1 are applicable to the lifts and lift enclosures provided in buildings having height more than 60m.

a) Fireman's Lifts – Following additional requirements apply to all fireman's lifts in the building.

   1) The fireman's lift shall have loading capacity of not less than 1000kg and floor area not less than $2.35m^2$.

   2) Electrical equipment within the fireman's lift well and on the car. Located within 1.0m of any wall containing a landing door, shall be protected from dripping and splashing water or provided with enclosures classified to at least IPX3 (according to Electrical Inspection Department).

   3) The electrical switchgear placed less than1m above lift pit floor shall be protected to IP 67. The socket outlet and lowest lamp shall also be located at least 0.5m above the highest permissible water level in the pit.

   4) Suitable means shall be provided in the lift pit to ensure that water will not rise above the level of the fully compressed car buffer.

   5) Means shall be provided to prevent the water level in the pit from reaching equipment which could create a malfuncation of the fireman's lift.

   6) Alternative source of power supply shall be provided for all fireman's lift through automatically operated changeover switch. In case of failure of normal electric supply, it shall automatically trip over to alternative supply. The route of wiring shall be safe from fire.

b) There shall be Fire Command Center (FCC) and/or Building Management System (BMS) room in the building CCTV camera shall be fixed in the lift lobbies and the display screen(s) shall be placed in the FCC or BMS room.

5C.6.8.3 Fireman's lifts in a building having more than 22 m or more height, shall work at or above the speed of 1.0 m/s so as to reach the top floor from ground level within one minute.

5C.6.8.4 Operation Requirements of Fireman's Lift

The lift shall be provided with the following as a minimum:

a) A two position switch at evacuation floor (normally main entrance floor) (ON/OFF), and
b) Buzzer and 'Fireman's lift' – light in car

5C.6.8.4.1 Sequence of operation:

a) Return to evacuation floor (Phase 1):
   1) Shall start when the switch at the evacuation floor is turned to the "ON" position or the signal from smoke detector (if provided by the Building Management System) is on. All lift(s) controlled by this switch shall cancel all existing car calls and separate from landing calls and no landing or car calls shall be registered. The buzzer and "fireman's lift" light shall be turned on. All heat and smoke sensitive door reopening devices shall be rendered inoperative.
   2) If the lift is travelling towards the evacuation floor, it shall continue driving to that floor.
   3) If the lift is travelling away from the evacuation floor, it shall reverse its direction at the nearest possible floor without opening its doors and return non-stop to the evacuation floor.
   4) If the lift is standing at a floor other than the evacuation floor, it shall close the door and start travelling non-stop to the evacuation floor.
   5) When at the evacuation floor the lift shall park with doors open.
   6) The buzzer is turned off after this return drive.
b) Fireman's service (Phase 2):

The phase 2 operation of the lift shall be as defined below.

1) The phase 2 is started after phase 1, if the switch is "ON".
2) The lift does not respond to landing calls but registers car calls. All heat and smoke sensitive door reopening devices are rendered inoperative.
3) When the car call button is pressed the doors start closing. If the button is released before the doors are fully closed, they re-open. The car calls is registered only when the doors are fully closed.
4) After registering a car call the lift starts driving to the call. If more than one car call is registered, only the nearest call is answered and the remaining calls will be cancelled at the first stop.
5) At the floor the doors are opened by pushing the door open button. If the button is released before the doors are fully open, they re-close.
6) The lift returns to normal service when it stands at the evacuation floor with doors open and the switch is "OFF".

5C.6.9 Supply Cables and Switches

Each lift should be provided with a main switch or circuit breaker of a capacity determined by the lift manufacturer and the incoming supply cable should terminate in this switch. For a single lift, this switch should be fixed adjacent to the machine room entrance inside the machine room. In a machine room common to more than one lift, each main switch should be conveniently situated with respect to the lift it controls. Switches and fuses should be provided for isolating the supply cables to the machine room.

5C.6.10 The detailed design considerations for different types and selection of the lifts shall be done in accordance with Part 5A & Part 5B, MNBC latest version.

5C.7 POWER AND CONTROL SYSTEMS

5C.7.1 Features Associated with Power Systems

5C.7.1.1 Industrial Switchgear

Switchgear for controlling lift power systems is characterized by its high duty cycle and its high rupturing capacity. Switchgear must be robust enough and shall be so designed as to withstand the high duty cycle and high rupturing capacity introduced during the operation of the lifts.

5C.7.1.2 Levelling Accuracy

The Levelling tolerances in not more than ±5mm, are those which can be reasonably expected between no load and full load in either direction.

Where greater Levelling accuracy is required, careful examination should be made to see whether such increased precision is justified or practical. Advice should also be obtained, as additional apparatus and cost may be involved, and in some cases the requirement may not be practicable.

5C.7.1.3 Overload Tests

A lift is designed to operate and transport the contract load at the required duty cycle, and should not by intention or habitually be used to carry overloads. During test as a safeguard to cover variable supply and temperature conditions a lift is checked for the car to complete one round trip with contract load plus 10 percent at nominal supply voltage and nominal ambient temperature. There is also static test with contract load plus 25 percent to check that the brake will sustain the car.

It is unnecessary to specify and additional overload test or capacity and in fact it is detrimental to the normal running efficiency and safety of the lift to do so.

5C.7.1.4 Occasional Extra Load

It is not good practice to request that a lift should be designed to carry an occasional extra load. It is tantamount to specifying an excessive overload test which is detrimental to the normal running efficiency and safety of the lift.

5C.7.2 Description of Operation Systems

5C.7.2.1 Methods of Control Systems

The methods of control systems are as follows:

a) Attendant and dual control (see 5C.7.2.2) and
b) Automatic push button operation (see 5C.7.2.2).

5C.7.2.1.1 Types of control systems

a) Collective control (see 5C.7.2.3)

b) Single push button collective control (see 5C.7.2.4)
c) Down collective control (see 5C.7.2.5)
d) Directional collective control for one car (see 5C.7.2.6)
e) Directional collective control for two or three cars (see 5C.7.2.7)
f) Group supervisory control (see 5C.7.2.8)

Features of control systems are described in 5C. 7.3.

5C.7.2.2 Automatic Push Button Operation

Automatic control is a method of operation by which a momentary pressure on a push button sets the car in motion and causes it to stop automatically at any required lift landing. This is ths simplest control system and it is sometimes referred to as push button control.

A car answers a landing or car call whichever is actuated first by momentary pressure provided the lift is not in use. Momentary pressure of a car push button will send the car to the designated floor. The car always responds to a car push button in preference to a landing push button.

With this type of control, a RED landing signal light or direction arrow indicates that the car is in use that is the lift is travelling.

This type of control is recommended for the following applications.

a) A single passenger lift serving up to 4 floors.
b) Goods lifts serving any number of floors where it is usually the most suitable form of control.

For special purposes, the following two systems may be considered:

a) Despatch from landings as an additional feature for a goods lift with manually operated doors. The call is registered by pressing the car push button and when the doors are closed the car will travel to the designed floor.
b) Automatic with attendant control as an additional feature on goods lifts with a key operated switch in the car to transfer the control from normal automatic to attendant operation. There is also a visual call indicator with buzzer in the car to indicate to the attendant the landing floors at which push buttons have been pressed when the car is under attendant control.

5C.7.2.3 Collective Control

Collective control is a generic term for those methods of automatic operation by which calls made by pressing push buttons in the car and at lift landings are registered and answered by the car stopping in floor sequence at each lift landing for which calls have been registered irrespective of the order in which the calls have been made, and until all calls have had attention.

Collective control of any form is usually not suitable for goods lifts except where loading is not expected to fill the car and additional loads can be taken at other stops.

5C.7.2.4 Single Push Button Collective Control

Single push button collective control has a single push button at each landing. It is not recommended, as the direction in which it is desired to travel cannot be registered by the intending passenger.

5C.7.2.5 Down Collective Control

Down collective is a control system where landing calls are registered from a single push button, irrespective of the car being in motion or the landing door being open and calls are stored until answered. Any number of car calls can be registered and the car will stop in sequence in the down direction at each of the designated floors. The car will travel in the up direction to the highest call registered stopping only in response to car calls. It will then travel downwards answering calls in floor sequence. If only one call has been registered the car travels to the floor of call.

This system is suitable where there is traffic between the ground and upper floors only and no interfloor traffic. Two or three car banks have interconnected control.

With this type of control the following signals are included:

a) A landing signal light indicates that the call has been registered and will be answered.
b) Illuminated car position indicator abovethe entrance in the car.
c) Arrow shaped signal lights in the back of the car or on the landing to indicate to the entering person in which direction the car is going to depart.

5C.7.2.6 Directional Collective Control for One Car

Directional collective control for one car is a control system having UP and DOWN push buttons at intermediate landings whereby the call is registered for the intended direction of travel. Calls from the car or landing push buttons are registered and stored until answered. The car will answer calls in floor sequence in one direction of travel. Calls for the opposite direction of travel are answered when the direction of travel is reversed.

This system is suitable for single lifts serving 4 or more floors with interfloor traffic, such as small office blocks, hotels and blocks of flats.

With this type of control the following signals are included:

a) A landing signal light for each landing push button indicated that the call has been registered and will be answered.
b) Illuminated car position indicator above the entrance in the car.
c) Arrow shaped signal lights in the back of the car or on the landing to indicate to the entering person in which direction the car is going to depart.

5C.7.2.7 Directional Collective Control for Two or Three Cars

Directional collective control for two or three cars is a system covering a control in which the two or three cars in a bank are interconnected. One push button unit with UP and DOWN push buttons or floor buttons (in case of car control from floor) are required at each landing and the call system is common to all lifts. If for architectural balance, in the case of a three car bank, extra push button units are required, these should be specified. Each landing call is automatically allocated to the best placed car. The control is designed so that cars are effectively spaced and thus give even service. When a car reaches the highest floor to which there is a call its direction of travel is automatically reversed when it next starts. One or more cars will return to the parking floor.

Automatically bypassing of landing calls when a car is fully loaded is an essential feature for three-car banks. It is also necessary for two-car banks in offices. Other cars will continue to provide service to all floors.

When three-car banks serve 7 or 8 floors and over, some form of automatic supervisory control (see 5C.7.2.8) is generally necessary in the interest of efficiency.

With this type of control the following signals are included:

a) A landing signal light for each landing push button to indicate that the call has been registered and will be answered.
b) Illuminated car position indicator above the entrance in the car.
c) Arrow shaped signal lights in conjunction with an audible single stroke gong or an indication on the landing call push button station above each landing entrance to indicate to the waiting person(s) which car is going to stop and in which direction it will continue its course.

5C.7.2.8 Group Supervisory Control

A bank or group of intensive traffic passengers lifts requires a supervisory system to co-oridante the operation of individual lifts which are all on collective control and are interconnected.

The very nature of intensive service calls for a sophisticated automatic supervisory control system so as to match the speed capacity of these lifts.

The supervisory system regulates the despatching of individual cars and provides service to all floors as different traffic conditions arise minimizing such unproductive factors as idle cars, uneven service and excessive waiting time. The system will respond automatically to traffic conditions such as UP and DOWN peaks, balanced or light traffic and provides for other specialized features.

If desired, a master station can be provided in the lift lobby which gives by indicators, visual information regarding the pattern under which the system is operating. Where the system is based on a definite programme, control means are provided for altering the type of traffic programme. There are other facilities, such as the removal of any lift from service.

5C.7.3 Features of Operation Systems

5C.7.3.1 Car Preference

Sometimes it is necessary to give a special personal service or a house service. When this service is required and for whatever purpose, it should be specified as 'car preference' is by a key operated switch in the car. The operation is then from the car only and the doors remain open until a car call is registered for a floor destination. All landing calls are bypassed and car position indicators on the landing for this lift are not illuminated. The removal of the key when the special operation is completed restores the control to normal service.

5C.7.3.2 Landing Call Automatic Bypass

For collective operation, automatic bypassing of landing calls can be provided. This device will bypass landing calls when a car is fully loaded but the calls are not cancelled.

5C.7.3.3 Motor Generator Shut Down

Lifts controlled by variable voltage system automatically shutdown when subject to an over-riding control which puts them out of service under certain conditions, for example, no demand for lift service. They are automatically put back into service as required.

5C.7.3.4 Basement Service

For lifts with collective control when service is required below the main parking floor, which is usually the ground floor, to a basement and/or a sub-basement, the lift maker should be informed of the type of service required, as special technical considerations are then usually necessary.

5C.7.3.5 Hospital Service

Lifts for carrying beds and stretchers require a car preference switch so than an attendant can have complete control of the car when required. This requirement should be specified as 'car preference' and it will function as described in 5C.7.3.1. Otherwise such lifts can have the same control system as for normal passenger lift, the choice depending on the number of floors and served, the service required and the number of lifts.

5C.7.3.6 Manually Operated Doors (Without Closers)

A 'door open' alarm should be provided to draw attention to a car or landing door which has been left open.

5C.7.3.7 Automatically Power Closed Doors

For passenger operation when the cars arrives at a landing the door will automatically open and then close after lapse of a time interval. This time interval can be overruled by the pressure of a push button in the car to give instant door closing.

An 'open door' push button is provided in the car to reverse closing motion of the doors or hold them open.

5C.7.3.8 Controlled Power Closed Doors

When there are conditions that particularly affect the safety of passengers or damage to vehicles or turcks, the closing of the door should only be made by the continuous pressure of push buttons in the car or on landings.

A 'door open' alarm should be provided to draw attentions to a car or landing door which has been left open. This means of operation is required for some forms of good lifts.

5C.7.3.9 Safe Operation of Doors

The safety of passengers passing through lift entrances is fully covered by provision. No modification of these provisions should be specified.

5C.7.3.10 Director Service

There are many forms of giving special service for individuals, but they should always be avoided. They range from key operated switches at preferred landings to the complete segregation of one out of a bank of lifts. It is obvious that any preferential treatment of this nature can seriously jeopardize the efficiency of the service as a whole. When a bank of say three lifts is installed to meet the anticipated traffic requirements and then, when the buildings is occupies, one lift is detached permanently for directors' service, the traffic handling can be reduced by a half rather than a third.

When preferential service is imperative, then the car preference feature should be available (see 5C.7.3.1)

5C.7.3.11 Indication of Car Arrival

As all lift cars are illuminated when available (in service). It is recommended that this illumination be used to signal the arrival of a car at a landing.

The following is the practice adopted for vision panels in doors:

a) For lifts with manually operated car and landing doors, vision panels are provided in all doors
b) For lifts with power operated car doors and manually operated landing doors, vision panels are provided in the landing doors only
c) For lift with automatically opened car and landing doors, no vision panels are required and

5C.7.3.12 Service Switches

When switches are provided to take cars out of service, that is because the remaining cars in the groups can cater for the required passenger traffic, it is essential that such switches should not stop the fireman's control from being operative in the event of the lift being designated as a fireman's lift. Service switches should not be confused with maintenance switches which are only used when it is dangerous to attempt to operate the lift because maintenance work is actually in progress. A control station fitted on top of the car is regarded as a maintenance switch.

5C.7.3.13 Fire Switch

When required by the fire authority a fire switch has to be provided, the function of which is to enable the fire authority to take over the complete control of one or more lifts in an installation.

5C.7.3.14 Push Buttons and Signals

It is most important that the purpose of every push button and signal should be clearly understood by all passengers.

5C.7.3.15 In public places where blind persons are expected to use the lifts it is recommended to provide Brailey buttons.

5C.7.4 Electrical Installation Requirements

5C.7.4.1 General

The lift are requirements for main switches and wiring with reference to relevant regulations. The lift maker should specify, on a schedule, particulars of full load current, starting current, maximum permissible voltage drop, size of switches and other details to suit requirements. For multiple lifts a diversity factor may be used to determine the cable size and should be stated by the lift manufacturer.

a) Power supply mains – The lift sub-circuit from the intake room should be separate from other building service.

   Each lift should be capable of being isolated from the mains supply. This means of isolation should be lockable.

b) For banks of interconnected lifts, a separate sub-circuit is required for the common supervisory system, in order that any car may be shut down without isolating the supervisory control of the remainder.
c) Lighting – Machine rooms ,liftshaft and all other rooms containing lift equipment should be provided with adequate illumination and with a switch fixed adjacent to the entrance. At least one socket outlet, suitable for lamps or tools, should be provided in each room.

The supply to the car light should be from a separate circuit, and controlled by a switch in the machine room. For multiple lifts with a common machine room a separate supply should be provided for each car. The car lighting supply should be independent of the power supply mains. Plug should be provided with a light, the switch for which should be in the lift well, and accessible from the lower terminal floor entrance.

When the alarm system is connected to a transformer or trickle charger, the supply should be taken from the machine room lighting.

5C.7.4.2 Electric Wiring and Apparatus

5C.7.4.2.1 All electrical supply lines and apparatus in connection with the lift installation shall be so constructed and shall be so installed, protected, worked and maintained that there may be no danger to persons therefrom.

5C.7.4.2.2 All metal casings or metallic coverings containing or protecting any electric supply lines of apparatus shall be efficiently earthed.

5C.7.4.2.3 No bare conductor shall be used in any lift car as may cause danger to persons.

5C.7.4.2.4 All cables and other wiring in connection with the lift installation shall be of suitable grade for the voltage at which these are intended to be worked and if metallic covering is used it shall be efficiently earthed.

5C.7.4.2.5 Suitable caution notice shall be affixed near every motor or other apparatus in which energy is used at a pressure exceeding 250 V.

5C.7.4.2.6 Circuits which supply current to the motor shall not be included in any twin or multicore trailing cable used in connection with the control and safety devices.

5C.7.4.2.7 A single trailing cable for lighting control and signal circuit shall be permitted, if all the conductors of this trailing cable are insulated for maximum voltage running through any one conductor of this cable.

5C.7.4.3 Emergency Signal or Telephone

It is recommendatory that lift car be provided either with an emergency signal that is operative from the lift car audible outside the lift well or with a telephone.

When an alarm bell is to be provided each car is fitted with an alarm push which is wired to a terminal box in the lift well at the ground floor by the lift maker. This alarm bell, to be supplied by the lift maker (with indicator for more than one lift) should be fixed in an agreed position and wired to the lift well. The supply may be from a battery (or transformer) fixed in the machine room or, when available, from the building fire alarm supply.

When a telephone is to be provided in the lift car the lift maker should fit the cabinet in the car and provided wiring from the car to a terminal box adjacent to the lift well.

The type of telephone should be stated in the enquiry.

5C.7.4.4 Earthing

5C.7.4.4.1 The terminal for the earthing of the frame of the motor, the winding machine, the frame of the control panel, the cases and covers of the tappet switch and similar electric appliances which normally carry the main current shall be at least equivalent to a 5 mm diameter bolt, stud or screw. The cross-sectional area of copper earthing conductor shall be not smaller than half that of the largest current – carrying conductor subject to an upper limit of 65 mm^2(Part 5A & Part 5B, MNBC latest version) CP 2- 2009 & Myanmar Electricity Rule & Regulation.

5C.7.4.4.2 The terminal for the earthing of the metallic cases and covers of door interlocks, door contacts, call and control buttons, stop buttons, car switches, limit switches, junction boxes and similar electrical fittings which normally carry only the control current (such terminal being one specially provided for this purpose), and the earth conductor should be appropriately sized in accordance with Part 5A & Part 5B, MNBC latest version, Myanmar Electricity Rule & Regulation 1985.

The size of earthing conductor shall be in accordance with Part 5A & Part 5B, MNBC latest version.

5C.7.4.4.3 The earthing conductor shall be secured to earthing terminal in accordance with the recommendations made in Part 5A & Part 5B, MNBC latest version, Myanmar Electricity Rule & Regulation 1985 and also in conformity with the latest provisions of Myanmar Electricity Rule & Regulation and Rules framed thereunder from time to time.

5C.7.4.4.4 The exposed metal parts of electrical apparatus installed on a lift car shall be sufficiently bonded and earthed.

5C.7.4.4.5 Where screwed conduit screws into electric fittings carrying control current making the case and cover electrically continuous with the conduit, the earthing of the conduit may be considered to earth the fitting. Where flexible conduit is used for leading into a fitting, the fitting and such length of flexible conduit shall be effectively earthed.

5C.7.4.4.6 One side of the secondary winding of bell transformers and their cases shall be earthed.

5C.7.4.4.7 Where there are more than one lift in a building, there should be a separate earth pit for the lifts.

5C.7.4.5 Residual Current Device

Residual current device (RCD), if provided, right type and sensitivity shall be selected. The RCD shall,

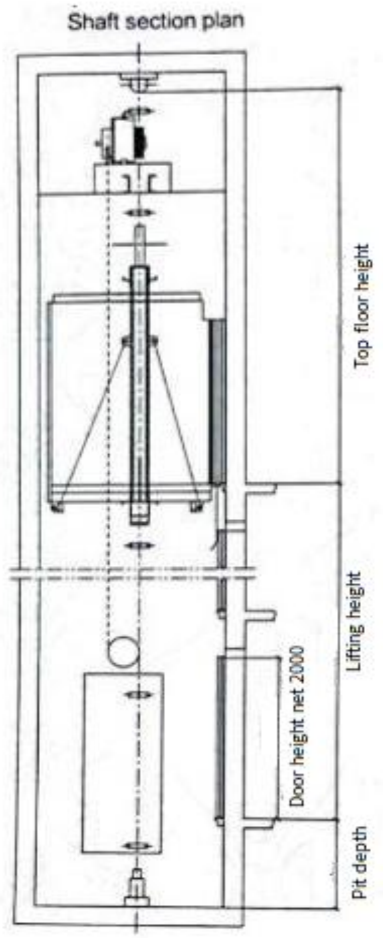
a) Have 10 times the maximum leakage current (300 mA maximum) as tripping current and be suitable for frequency converters with a 3-phase supply.

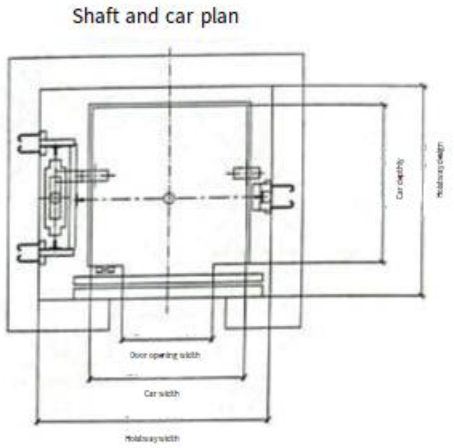
b) Be sensitive for sinusoidal currents up to 1000Hz, insensitive for currents more than 1000Hz.

NOTE – This kind of RCDs are generally classified as 'Type B'.

Three-phase power supply for the lift should never be protected with a 30mA residual current devices (RCD).The 30mA RCD trips easily when the lift starts to drive and prevents the lift to run. If the construction-time power supply is for some reason protected with a 30mA residual current device (RCD), suitably sized isolation transformer needs to be provided by the electrical contractor.

TECHANICAL DATA FOR HOME ELEVATOR





LOAD		SPEED (m/s)	Car Size		DOOR WIDTH	HOISTWAY		PIT	Max: TRAVEL HEIGHT (meter)
Kg	Person		CW(mm)	CD(mm)	OP(mm)	HW(mm)	HD(mm)	P(mm)	
250	3	0.5	1000	1000	700	1600	1400	300	18
350	4	0.5	1000	1200	800	1600	1600	300	18
400	5	0.5	1200	1200	800	1800	1600	300	18

5C.7.5 Building Management Systems – Interface for Lifts

5C.7.5.1 Where more than three lifts are provided in a building and especially when these are provided at different locations in the building a form of central monitoring may be provided. Such central monitoring may be through a Building Management Systems, if provided in the building or through a display panel.

5C.7.5.2 The following signals should be given to the building management interface from each lift.

a) Alarm button in car,

b) Door Zone or floor level information,
c) Lift moving information,
d) Power on information and
e) Lift position information.

5C.7.5.3 Each of these signals shall be provided through a potential free contact located in the lift machine room. The contacts shall be rated for 230 V ac/1A or 24 V dc/1A. A pair of wires should be used for each potential contact.

5C.7.5.4 The wiring between lift machine room to Building Management Systems shall be planned and carried out by the builder along with other wiring in the building.

5C.7.5.5 The building management system should ensure that any position information is read only when the lift is moving (lift moving information) or is capable of reading several times to detect a stable state.

In addition to the signals above the following signals may be added if required for the benefit of monitoring the lift performance.

a) A summary fault output to indicate a lift in fault condition, which prevents the lift from providing service. This summary fault condition shall include the most common faults such as safety circuit open.
b) Service or inspection mode.
c) Attendant mode.
d) Fire mode.
e) Doors opening.
f) Doors closing.
g) Lift moving up.

(In combination with lift moving and lift moving up information, lift moving down information can be sensed by the Building Management Systems).

h) Door Reopen Request (Summary of Door Open, Light Curtain, Photocell, Safety Edge Signals).

5C.7.5.6 Where it is desired that it should be possible to control the lift from Building Management Systems, the following control signals can be provided.

a) Normal to service/inspection mode change over.
b) Fault Accept/Rest Input

(Using this input, the lift controller may be allowed to clear an existing fault if this is other wise safe. It will be decided by the Lift manufacturer as to what faults can be cleared)

c) Car call to top most floor and bottom most floor of each lift.

Where such control inputs are provided, it should be with a pass word and login feature that allows one to determine who has used these inputs and at what time. Always such inputs should be through authorized person only. The Building Management Systems should make all changeovers effective only when lift is not moving.

5C.7.5.7 Control inputs from Building Management Systems should be through a potential free contact capable of carrying 24 V dc/1A or 230 V ac/1A. The wiring should be terminated in each lift machine room.

5C.8 CONDITIONS FOR OPTIMUM PRACTICE

5C.8.1 Lift Entrance Operation

5C.8.1.1 General

Every lift journey involves two horizontal movements, in and out of the car, to one vertical movement. The type of door, and the operation of the doors, play a main part in the service given, and should receive careful consideration.

5C.8.1.2 Goods Traffic

Most types of goods traffic require relatively longer loading and unloading times and manual doors are frequently used for economy and simplicity.

Power operation can be applied, especially for large entrances, to give automatic opening: the doors then always open fully, reducing the risk of damage. For many types of goods traffic, it is preferable for closing though powered, to be controlled by continuous pressure button, rather than being automatically initiated EN 81-1 1998 or latest version.

For heavy duty lifts, a power operated vertically sliding door preferred, this can be made extremely robust, and is capable of extension to very large entrances.

5C.8.2 Painting at Works and on Site

Lift equipment with normally receive a protective coat of paint at works before dispatch to site. Further painting of lift equipment may be necessary and is normally in the form of a finishing coat and can take place on site. Alternatively, the further painting of the equipment may be carried out at works as a finishing coat with normal touching up after site erection as may be necessary.

Any additional painting, due to site conditions during erection and/or final operating conditions in the premises, is subject to negotiation between the lift maker and the purchaser.

Decorative finishes are a subject for separate negotiation.

5C.8.3 Special Environments

Standard equipment is suitable for use inside normal residential, commercial and industrial buildings but when unusual environments are likely to be encountered, the advice of the lift maker should be sought at the earliest possible stage to enable the most economic satisfactory solution to be found. Special mechanical protection and or electrical enclosures may be necessary as well as compliance with statutory or other regulations and with the purchaser's particular requirements, which should be fully considered at the time of enquiry.

Examples of situations which necessitate special consideration are:

a) Exposure to weather, for example, car parks.
b) Low temperatures, for example, cold stores.
c) High temperature, for example, boiler plant.
d) Hosing – down for example, for hygiene or decontamination.

e) Corrosive atmosphere, for example, chemical works.
f) Dusty atmospheres, for example, gas plant.
g) Explosive and inflammable atmosphere, for example gas plants and petroleum and polyester industries.

5C.8.4 Ventilation of Machine Rooms

Machine rooms shall be ventilated. They shall be such that the motors and equipment as well as electric cables etc, are protected as far as possible from dust, harmful dusts and humidity. The ambient temperature in the machine room shall be maintained between 5°C and 40°C.

5C.8.5 Lighting and Treatment of Walls, Floors, Etc

5C.8.5.1 All machine rooms should be considered as plant space, and conditions provided to permit reliable operation of electrical switchgear and rotating machinery, and be conductive to good maintenance.

Lighting should be provided to give at least 200 lux around the controller and machine. The machine room walls, ceiling and floor should be faced in dust-resisting materials, tiles, etc, or painted as minimum to stop dust circulation which otherwise could damage rotating machinery and cause failure of switchgear. Machine rooms should also be weatherproof and if ventilation louvers are provided they should be designed and sited to prevent snow being driven through or to the apparatus.

5C.8.5.2 Lift wells should be constructed to be weatherproof and of a dust free surface material or should be painted to minimize dust circulation on to moving apparatus and from being pumped by the car movement into machine rooms or on to landings.

Sufficient number of light points should be provided in the lift shaft for proper illumination.

5C.8.5.3 Should a lift entrance open out into an area expected to the weather the entrance should be protected by a suitable canopy and the ground level slope up to the entrance to prevent during rain or surface drainage from entering the lift well through the clearances around the landing doors. Any push buttons so enclosed should be of weatherproof type.

5C.8.6 Stairwell Enclosure

The location of lifts in stairwells is not recommended.

The use of stair stringers for fixing of guides normally involves extensive site measurement in order to fabricate purpose-made brackets. The resulting attachments are often unreliable and lacking in robustness. For stairwells of normal width, the span required for the lift machine support beams is excessive and unless uneconomic sections are used the deflections under varying load adversely affect the motor of the lift.

The necessary provision of suitable continuous enclosures can be very expensive.

5C.8.7 Handwinding Release Procedure and Indication

The release procedure by handwinding should only be carried out in an emergency and by authorized persons who have received the necessary instruction because it is dangerous for any other persons to attempt to do so.

Before attempting to move the car, it is imperative that any person in the car be warned of the intention to move the car and that they do not attempt to leave the car until they are advised that it is safe to do so. Any failure to carry out this precaution may render the person concerned guilty of negligence should an accident occur.

Before attempting to handwind the lift machine, it is vital that the supply is switched off at the main switch.

It is usually necessary to have two persons in the machine room: one to operate the brake release and the other to carry out the handwinding. The exceptions are small lift machines where the handwinding and be easily controlled by one man and larger machines which need two men to operate the handwinding alone with an additional man to control the brake release.

If the car is stuck in the lift well and cannot be moved when an attempt is made to move it in a downward direction, then no attempt at handwinding should be made because the car safety gear may have set. Any further procedure should be carried out under the instruction of a qualified lift mechanic.

Provided the car is free to be moved in the downward direction, then it should be hand wound to the nearest floor. There is a preference to move the car in a downward direction. However, this may not always be practical owing to the distance involved and the time taken to complete the movement. In addition the amount of out of balance load on the counterweight side, due to the size of car and the small number of persons inside it, may make it necessary to wind the car upwards. In the case of higher speed lifts the direction of handwinding will usually be governed by effort required to move the car because of the absence of a large gear reduction ratio.

It is essential that all detail operations be carried out according to the manufacturer's instructions for the lift concerned and these should be clearly stated and permanently displayed in the form of a notice in the machine room.

5C.9 RUNNING AND MAINTENANCE

5C.9.1 The lift installation should receive regular cleaning, lubrication, adjustment and adequate servicing by authorized competent persons at such intervals as the type of equipment and frequency of service demand. In order that the lift installation is maintained at all times in a safe condition, a proper maintenance schedule shall be drawn up in consultation with the lift manufacturer and rigidly followed. The provision of a log book to record all items relating to general servicing and inspection is recommended for all lifts. It is essential that the electrical circuit diagram of the lift with the sequence of operation of different components and parts should be kept readily available for the persons responsible for the maintenance and replacement where necessary.

5C.9.2 Particular attention may be directed for through periodical examination of wire ropes when in service. Attention should also be directed to the thorough examination of the groove of drums, sheaves and pulleys when installing a new rope. A groove deepened by rope wear is liable to lead to early failure of a new rope unless the groove is returned.

5C.9.3 Any accident arising out of operation of maintenance of the lifts should be duly reported to the Authority in accordance with the rules laid down. A notice may be put in the machine room to this effect.

5C.10 PROCEDURE FOLLOWING TEST, INCLUDING INSPECTION AND MAINTENANCE

5C.10.1 Acceptance

The purchaser should make timely arrangement for accepting the lift on completion of test, and for insurance cover. Special arrangements (see 5C.10.4) are necessary if there is no be at interval before the lift goes into normal service.

5C.10.2 Guarantee and Servicing

Any guarantee provided by the lift maker should be conditional upon the lift receiving regular and adequate servicing, and should cover the free replacement of parts which prove defective through reasons of fault, materials or workmanship in the guarantee period, which is generally twelve months.

To ensure the continuance of satisfactory and safe operation, the purchaser (or building occupier) should arrange for the completed lift to receive regular servicing by competent persons at such intervals as the type of equipment and intensity of operation demand. Such service can be secured under a service contract. It is desirable and normal for the lift maker to be entrusted with the servicing during the guarantee period of a new lift.

The scope of a service contract may be extended to cover not only regular servicing, but also intermediate service calls, repairs and replacement of worn parts.

The building owner should co-operate with the service engineer, and should ensure that the equipment is properly used, and that unauthorized persons are not permitted to enter the lift well or machine rooms.

Particular attention should be paid to methods of ensuring that lifts are not overloaded when they are used in connection with furniture and equipment removals, and internals redecoration and other similar activities, which may be undertaken within the building.

5C.10.3 Statutory Examinations

Lifts in certain premises are required by statutory regulations to be examined at intervals, as specified by the Lift Act, by a competent person, who is required to report on a prescribed form. Such reports should normally be kept in a register.

Statutory examinations are not a substitute for servicing, the provision of statutory reports may be specially included in a service contract or may be arranged separately.

5C.10.4 Lift not in Immediate Use (Shut Down Maintenance)

When conditions do not permit a lift to be taken to normal service immediately following completion and acceptance, it should be immobilized. The main contractor should take effective precautions against damage especially to finishes, or damage to equipment from dampness and builder's debris, until such time as the lift is required.

A separate service contract should be made with the lift maker to make regular visits during this period, to inspect, lubricate and report on the condition of the lift.

A date should also be agreed with the lift maker from which his guarantee period will commence.

5C.10.5 Temporary Use of Lifts

If the purchaser intends to permit temporary use of a lift by some other party, such as the building contractor, before taking it into normal service, so that it is not immobilized, then the responsibilities of those concerned should be clearly defined and agreed. In addition to the precautions noted in 5C.10.4, temporary insurance cover should be arranged.

If temporary use of lifts is envisaged, it should preferably be given consideration at an early stage, having regard to the conditions under which it is likely to take place.

5C.10.6 Cleaning Down

Acceptance following test should include checking the condition of decorative finishes, before the lift maker leaves the site.

After a shut down (or temporary service) period, the lift may require a further general cleaning down immediately before taking into normal service. The lift maker should be instructed accordingly to undertake this work and if any accidental damage has occurred to repair this at the same time. Both these items should be the subject of extra costs.

5C.11 ESCALATORS

5C.11.1 Escalators are deemed essential where the movement of people , in large numbers at a controlled rate in the maximum of space, is involved , for example, railway stations, air-ports, etc. In exhibitions big departmental stores and the like, escalators encourage people to circulate freely and conveniently.

5C.11.1.1 As the escalators operate at a constant speed, serve only two levels and have a known maximum capacity, the traffic study is rather easy. Provided the population to be handled in a given time is known, it is easy to predict the rate at which the population can be handled.

5C.11.1.2 For normal peak periods, the recommended handling capacities for design purposes should be taken as 3200 to 6400 persons per hour depending upon the width of the escalator.

The number of persons that may be theoretically carried by the escalator in 1 hr. can be calculated as follows:

For determination of theoretical capacity it is assumed that one step with an average depth of 0.4 m can carry 1 person for a step width of 0.6 m,1.5 persons for a step width of 0.8 m and 2 persons for a step width of 1.0 m.

The theoretical capacity then is:

3600 x (rated speed in m/s x k)/0.4

Where

K=1.15, or 2 for 0.6, 0.8 and 1.0 m step widths.

Some values calculated as per the above are:

Step width	Theoretical Capacity in Persons/hour		
	0.5 m/s speed	0.65 m/s speed	0.75 m/s speed
0.6 m	4 500	5 850	6 750
0.8 m	6 750	8 775	10 125
1.0 m	9 000	11 700	13 500

5C.11.2 Terms and definitions

For the purposes of this document, the terms and definitions given the following apply.

5C.11.2.1 Angle of inclination

Maximum angle to the horizontal in which the steps, the pallets or the belt move

5C.11.2.2 Balustrade

Part of the escalator/ moving walk which ensures the user's safety by providing stability, protecting from moving parts and supporting the handrail

5C.11.2.3 Balustrade decking

Transverse member of the balustrade which meets the handrail guidance profile and which forms the top cover of the balustrade

5C.11.2.4 Brakeload

Load on the step/pallet/belt which the brake system is designed to stop the escalator/moving walk

5C.11.2.5 Comb

Pronged section at each landing that meshes with the grooves.

5C.11.2.6 Comb plate

Platform at each landing to which the combsare attached.

5C.11.2.7 Electrical safety system

Safety related part of the electrical control system as anarrangement of safety circuits and monitoring devices.

5C.11.2.8 Electrical safety devices

Part of a safety circuit consisting of safety switches and/or fail safe circuits.

5C.11.2.9 Escalator

Power-driven, inclined, continuous moving stairway used for raising or lowering persons in which the user carrying surface (e.g.steps) remains horizontal.

NOTE Escalators are machines- even when they are out of operation- and cannot be considered as fixed staircases.

5C.11.2.10 Exterior panel

Part of the exterior side of the enclosure of an escalator or moving walk.

5C.11.2.11 Fail safe circuit

Safety related electrical and/or electronic system with defined failure mode behaviour.

5C.11.2.12 Hand rail

Power-driven moving rail for persons to grip while using the escalator or moving walk.

5C.11.2.13 Interior panel

Panel located between the skirting or lower inner decking and the handrail guidance profile or balustrade decking.

5C.11.2.14 Lower inner decking

Profile that connects the skirting with the interior panel when they do not meet at acommon point.

5C.11.2.15 Lower outer decking

Profile that connects the exterior panels with the interior panel.

5C.11.2.16 Machinery

Escalator or moving walk machine(s) mechanisms and associated equipment.

5C.11.2.17 Machinery spaces

Space(s) inside or outside of the truss where the machinery as a whole orin parts is placed.

5C.11.2.18 Maximum capacity

Maximum flow of persons that can be achieved under operational conditions.

5C.11.2.19 Moving walk

Power-driven installation for the conveyance of persons in which the user carrying surface remains parallel to its direction of motion and is uninterrupted (e.g.pallets, belt)

NOTE Moving walks are machines- even when they are out of operation –and should not be used as a fixed access.

5C.11.2.20 Newel

End of the balustrade

5C.11.2.21 Nominal speed

Speed in the direction of the moving steps, pallets or the belt, when operating the equipment under no load condition (i.e.without persons), stated by the manufacturer as that for which the escalator or moving walk has been designed.

NOTE Rated speed is the speed the escalator/ moving walk moves under rated load conditions.

5C.11.2.22 Rated load

Load which the equipment is designed to move.

5C.11.2.23 Rise

Vertical distance between the upper and lower finished floor levels.

5C.11.2.24 Safety circuit

Part of the electric safety system consisting of electrical safety devices.

5C.11.2.25 Skirting

Vertical part of the balustrade interfacing with the steps, pallets or belt.

5C.11.2.26 Skirtde flector

Device to minimize the risk of trapping between the step and the skirting.

5C.11.2.27 Stand-by operation

Mode in which an escalator/ moving walk can be stopped or operated under no load condition with any speed below the nominal speed.

5C.11.3Symbols and abbreviations

The following symbols and corresponding units of measurement of the followingTable1are used in this standard.

Table1—Symbols and corresponding units of measurement used in this standard

Symbol	Designation	Unit	Figure
b1	Distance between the hand rail centre lines	m	3
b2	Width of the hand rail	mm	3
b3	Horizontal distance between skirting and interior panel	mm	3
b4	Width of the horizontal part of the lower inner decking that directly joins the interior panel	mm	3
b5	Horizontal distance between the inner edge of the hand rail and the top edge of the interior panel	mm	3
b6', b6"	Horizontal distance between the handrail profile and guide or cover profiles	mm	3
b7	Width of the grooves	mm	2
b8	Web width	mm	2
b9	Horizontal distance between the outer edge of the hand rail and a non- continuous obstruction, e.g. roof intersection, column	mm	A.1
b10	Horizontal distance between the outer edge of the hand rail and a continuous obstruction,e.g.wall	mm	A.1
b11	Horizontal distance between the hand rails of adjacent escalators/ moving walks	mm	A.1
b12	Vertical distance between the lower edge of the hand rail and the balustrade decking	mm	3
b13	Width of the lower outer decking	mm	4
b14	Horizontal distance between the outer edges of interior panels on adjacent escalators or moving walks	mm	4
b15	Horizontal distance between the building structure (wall) and the centre line of the hand rail	mm	4
b16	Horizontal distance between the centre lines of the hand rails of adjacent escalators/moving walks	mm	4
b17	Horizontal distance of the anti-slide device to the outer edge of the handrail	mm	4
h1	Vertical distance between the top of the hand rail and step nose or pallet surface or belt surface	m	2, 3
h2	Vertical distance between top edge of skirting or bottom edge of cover joints and the line of the step nose or the tread surface of the pallets or belt	mm	3
h3	Distance between the entry of hand rail into the new land the floor	m	2,3

Table -1 Continued

Symbol	Designation	Unit	Figure
h4	Free height above any point of step surfaces, pallets or belt over the area between both outer edges of the hand rails	m	2, A.1
h5	Height of the deflector	m	2,4
h6	Clearance between the upper edge of the tread surface and the root of the comb teeth	mm	2
h7	Depth of the grooves	mm	2
h8	Mesh depth of the comb into the grooves of the tread	mm	2
h9	Vertical distance between floor and lower end of the anti-climbing device	mm	4
h10	Vertical distance between lower edge of the hand rail and upper end of the access restriction device	mm	4
h11	Height of the anti-slide device	mm	4
h12	Height of the upper edge of the free space outside the hand	mm	A.1
h13	Vertical distance between the upper and lower finished floor levels	m	2
L1	Root of the comb teeth	-	2
l1	Horizontal distance between supports	m	2
L2	Comb intersection line	-	2
l2	Distance between the furthest poin treached by the hand rail and the comb intersection line measured parallel to the tread surface	m	2
l3	Length of the straight portion of the hand rail in the direction of landing measured from the comb intersection line	m	2
l4	Distance between the furthest point reached by the hand rail and the point of entry into the newel measured parallel to the tread surface	m	2
l5	Length of anti-climbing device on the lower outer decking	mm	4
v	Nominal speed	m/s	-
x1	Step height	m	5
y1	Step depth	m	5
z1	Nominal width for the load carrying area (step, pallet or belt)	m	3, 5
z2	Horizontal distance between skirting	m	3
z3	Transverse distance between the supporting rollers	mm	8
α	Angle of inclination of the escalator or moving walk	°(degree)	2
ß	Design angle of the teeth of the comb	°(degree)	2
γ	Cross-sectional angle of inclination of the lower inner decking	°(degree)	3
μ	Friction coefficient	-	-

5C.11.4 List of significant hazards

5C.11.4.1 General

This clause contain sall the significant hazards, hazardous situations and events, as far as they are dealt within this standard, identified by risk assessment as significant for escalators and moving walks and which require action to eliminate or reduce the risk.

5C.11.4.2 Mechanical hazards

Mechanical hazards on escalators and moving walks and in their immediate vicinity can occur because of the design of the machine or access to it.

These include:

- Contact with moving machinery parts (e.g. driving unit, handrail drive) normally not accessible to the public (see 5C.11.5.2(b), 5C.11.5.2(d), 5C.11.5.2(e), 5C.11.5.2(f), 5C.11.5.6.1, A.3.2, A.3.3);

- Impact on bodies caused by collision with building structures (wall, roof, criss-cross arrangement or with persons on adjacent escalators/moving walks (see A.2.1, A.2.2, A.2.3, A.2.4);

- Trapping between step and step or pallet and pallet (see 5C.11.5.4).

5C.11.4.3 Electric hazards

Electric hazardous situations can occur due to:

- Contact of persons with live parts

- Indirect contact

- Inadequate emergency stops [see5C.11.5.12.2(c)]

- Wrong assembly of electric components

- Electrostatic phenomena

- External influences on electric equipment [see5C.11.5.12.1(d),5C.11.5.12.1(e), 5C.11.5. 12.2(d)]

5C.11.4.4 Fire hazard

Fire hazards can be generated by accumulation of combustible material inside the truss, by the isolation material for cables and over loading of drives [see5C.11.5.2.1(d), 5C.11.5.10].

5C.11.4.5 Hazards generated by neglecting ergonomic principles in machinery design

Hazardous situation can occur because of:

- Inadequate lighting in the working places and access to them (see 5C.11.5.9.3(a),5C.11.5.9.3(b),A.3.4,A.3.5).

- Insufficient space in working places (see5C.11.5.11.2(b),5C.11.5.11.2(c), 5C.11.5.11.2(d), A.3.6,A.3.7,A.3.8).

- Missing lifting equipment for heavy loads (see 5C.11.5.9.2.2).

5C.11.4.6 Hazards generated by break-up during operation

Even if the design of an escalator or moving walks follows the requirements of EN 115-1, there are specific hazards which can occur due to

- Greater than specified user and structural loads on the truss (see 5C.11.5.2.3).

- Loads greater than specified on the steps/pallets by unforeseeable misuse (see 5C.11.5.5).

5C.11.4.7 Slipping, tripping and falling hazards

Most of the dangerous situations on escalators and moving walks are caused by the slipping and falling of persons.

This is:

- Falling caused by inadequate lighting at the landings (see A.2.8,A.2.9).

5C.11.5 Safety requirements and/or protective measures

5C.11.5.1 General

Escalators and moving walks shall comply with the safety requirements and/or protective measures of this clause.

5C.11.5.2 Supporting structure (truss) and enclosure

5C.11.5.2.1 General

(a) All mechanically moving parts of the escalator or moving walk shall be completely enclosed within imperforate panels or walls. Except from this are the accessible steps, the accessible pallets, the accessible belt and that part of the handrail available for the user. Apertures for ventilation are permitted [see also5C.11.5.2.1(e)].

(b) The exterior panels shall withstand a force of 250 N at any point at right angles on an area of 25 cm² without breakage or deflection resulting in any gap. The fixing shall be designed in that way to carry at least twice the dead load of the enclosure.

(c) It is permissible to omit an enclosure of the mechanically moved parts if other measures (such as rooms with locked doors accessible to authorized personnel only) make a hazard to the public impossible.

(d) Accumulation of materials (e.g. grease, oil, dust, paper) represents a fire risk. Therefore it shall be possible to clean the inner part of the escalator/moving walk.

(e) Ventilation apertures shall be built or arranged. However it shall not be possible to pass a straight rigid rod 10 mm in diameter through the enclosure and to touch any moving part through a ventilation aperture.

(f) Any exterior panels which are designed to be opened (e.g. for cleaning purposes) shall be provided with an electric safety device).

5C.11.5.2.2 Angle of inclination

The angle of inclination α of the escalator shall not exceed 30°, but for rises h13 not exceeding 6 m and a nominal speed not exceeding 0,50 m/s the angle of inclination is permitted to be increased up to 35° (see α in Figure 2).

The angle of inclination of moving walks shall not exceed 12°.

5C.11.5.2.3 Structural design

The supporting structure shall be designed in a way that it can support the dead weight of the escalator or moving walk plus a rated load of 5 000 N/m^2.

Based on the rated load, the maximum calculated or measured deflection shall not exceed 1/750 of the distance l1 between the supports.

5C.11.5.3 Steps, pallets, belt

5C.11.5.3.1 General

In the user carrying area of the escalator, the step treads shall be horizontal with a tolerance of ± 1° in the direction of travel.

Tread surfaces for escalators and moving walks shall provide a secure foothold.

5C.11.5.4 Dimensions

5C.11.5.4.1 General

For escalators and moving walks the nominal width z1 shall be not less than 0,58 m and not exceed 1,10 m. For moving walks with an angle of inclination up to 6° widths up to 1,65 m are permitted.

- Step treads and pallets (see Figure 2, detail X and Figure 5).
- The step height x1 shall not exceed 0,24 m.
- The step depth y1 shall be not less than 0,38 m.
- The surface of the step treads and pallets shall have grooves in the direction of movement with which the teeth of the combs mesh.
- The step risers shall be cleated and the surface of the cleat shall be smooth. The ends of the step tread shall mesh with the cleating of the next step riser.
- The width b7 of the grooves shall be at least 5 mm and not exceed 7 mm.
- The depth h7 of the grooves shall be not less than 10 mm.
- The web width b8 shall be at least 2,5 mm and not exceed 5 mm.
- The step treads and step risers or pallets shall not finish with a groove at their side edges.

- The edge between the surface of the step tread and the riser shall have any sharpness relieved.
- Belts (see Figure 2, detail X).
- The belts shall have grooves in the direction of travel with which the teeth of the comb mesh.
- The width b7 of the grooves shall be at least 4,5 mm and not exceed 7 mm, and shall be measured at the tread surface of the belt.
- The depth h7 of the grooves shall be not less than 5 mm.
- The web width b8 shall be at least 4,5 mm and not exceed 8 mm and shall be measured at the tread surface of the belt.
- The belt shall not finish with a groove at the side edge of the belt.

Splicing of the treadway belt shall be such as to provide a continuous unbroken treadway surface.

5C.11.5.5 Structural design

5C.11.5.5.1 General

The materials shall retain their strength characteristics during their specified life cycle taking into account the environmental conditions, e.g. temperature, ultra violet radiation, humidity, corrosion.

The steps, pallets and the belt shall be designed to withstand all possible loading and distortion effects, which may be imposed by the tracking, guiding and driving system during normal operation and shall be designed to support an equally distributed load corresponding to 6 000 N/m^2.

NOTE 6000 N/m^2 is derived from a static load of 5000 N/m^2 plus an impact factor of 1.2.

Assembled steps and pallets shall be designed such that all component parts e.g. inserts or fixings are securely attached and do not become loose during their life cycle. The inserts and fixings shall withstand the reaction force of operating the comb/comb plate electric safety device.

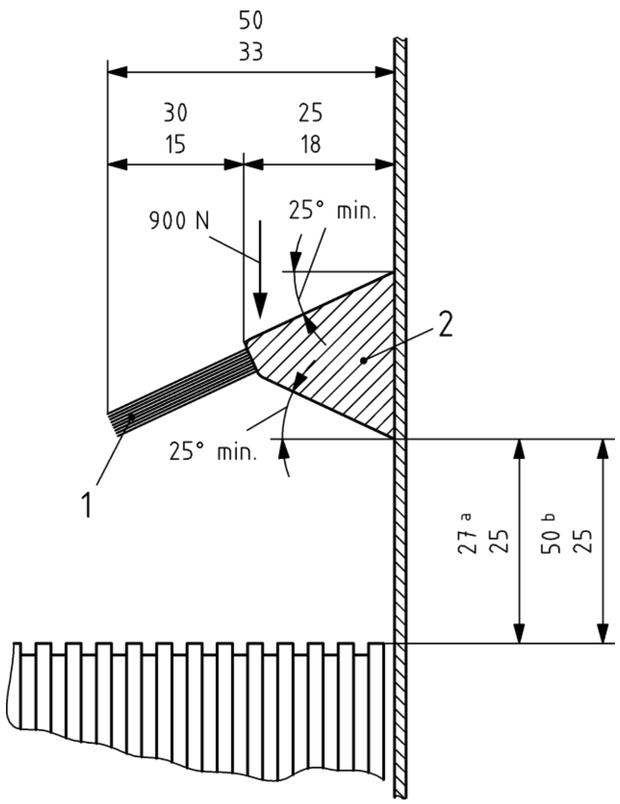
Key

1 flexiblepart

2 rigidpart

a intheinclinedarea

b inthetransitionandhorizontalareas



Dimensionsinmillimetres

NOTE This figure has not been drawn to scale. It only serves to illustrate the requirements.

Figure1 —Requirements on skirt deflectors

5C.11.5.6 Newel

5C.11.5.6.1 The newel including the hand rails shall project horizontally beyond the comb intersection line by at least 0, 60 min longitudinal direction (see L_2 and l_2 in Figure 2 and detail X).

5C.11.5.6.2 The horizontal portion of the hand rail shall continue longitudinal lyat the landings for a distance l_3 (see Figure 2) of at least 0, 30 mpast the comb intersection line (see L_2 in Figure 2 and detail X).

In the case of inclined moving walks without a horizontal section at the landings, the continuation of the hand rail parallel to the angle of inclination is permitted.

5C.11.5.7 Landings

5C.11.5.7.1 Surface properties

The landing area of escalators and moving walks (i.e.comb plate and floor plate) shall have a surface that provides as ecure foot hold for a minimum distance of 0, 85 m measured from the root of the comb teeth (see L_1 in Figure 2 and detail X).

5C.11.5.7.2 Configuration of steps, pallets and belts

(a) At the landings, the steps of the escalator shall be guided in such away that the front edges of the steps leaving the comb and the rear edges of the steps entering the comb are moving horizontally for a length of at least 0, 80 m measured from point L_1(see Figure 2 and detail X).

At nominal speeds above 0, 50 m/s and not more than 0, 65m/s or rises h_{13} above 6m this length shall be at least 1, 20m, measured from point L_1(see Figure 2 and detail X).

At nominal speeds above 0, 65 m/s this length shall be at least 1, 60m measured from point L_1(see Figure 2 and detail X).

A vertical difference in level between two consecutive steps of 4 mm is permitted.

(b) For escalators, the radius of curvature in the upper transition from incline to horizontal shall be:

- At least 1,00m for nominal speeds $v \leq$ 0, 5m/s (inclination of max35°).

- At least 1, 50m for nominal speeds 0, 5m/s $< v \leq$ 0, 65m/s (inclination of max30°).

- At least 2, 60m for nominal speeds $v >$ 0, 65m/s (inclination of max30°).

The radius of curvature in the lower transition from incline to horizontal of the escalator shall be at least 1,00 m up to 0,65 m/s the nominal speed and at least 2,00 m above 0,65 m/s.

(c) For belt moving walks, the radius of curvature in the transition from incline to horizontal shall be at least 0,40 m.

For pallet moving walks, it is not necessary to determine the radius of curvature because, on account of the maximum permissible distance between two consecutive pallets, it will always be sufficiently large.

(d) At the upper landings of moving walks with an inclination of more than 6°, the pallets or belt shall move for a length of at least 0,40 m at a maximum angle of 6° before entering or after leaving the comb.

Analogous to 5C.11.5.7.2 (a), for pallet moving walks the movement is specified as follows:

The front edge of the pallet leaving the comb and the rear edge of the pallet entering the comb shall move without changing the degree of angle over at least 0,40 m.

(e) Provisions shall be made in the area of the combs to ensure the correct meshing [see 5C.11.5.7.2(e)] of the comb teeth with the grooves of the tread surface.

Belts shall be supported in this area in a suitable manner, e.g.by drums, rollers, sliding plates.

5C.11.5.8 Combs

5C.11.5.8.1 General

Combs shall be fitted at both landings to facilitate the transition of users. The combs shall be easily replaceable.

5C.11.5.8.2 Design

(a) The teeth of the combs shall mesh with the grooves of the steps, pallets or belt [see 5C.11.5.8.2.(g)] The width of the comb teeth shall be not less than 2, 5mm, measured at the tread surface (see Figure 2, detail X).

(b) The ends of the combs shall be rounded off and so shaped as to minimize the risk of trapping between combs and steps, pallets or belt.

(c) The radius of the teeth end shall be not greater than 2 mm.

(d) The teeth of the combs hall have a formand inclinations that the feet of users, leaving the escalator or moving walk, should not stub against them. The design angle ß shown in Figure 2, detail X shall note xceed 35°.

(e) The combs or their supporting structure shall be adjustable, to ensure correct meshing (see Figure 2, detail X).

(f) The combs shall have such a design that upon trapping of foreign bodies either their teeth deflect and remain in mesh with the grooves of the steps, pallets or belt, or they break.

(g) In the case of objects being trapped which are not dealt with by the means described in [5C.11.5.8.2(e)] and in the case of comb/ step/ pallet impact the escalator or moving walk shall be stopped automatically.

(h) Mesh depth of the combs into the grooves

(i) The mesh depth h8 of the combs into the grooves of the tread (see Figure 2, detail X) shall be at least 4mm.

(j) The clearance h6 (see Figure 2, detail X) shall not exceed 4 mm.

5C.11.5.9 Machinery spaces, driving station and return stations

5C.11.5.9.1 General

These rooms/ spaces shall be used only for accommodating the equipment necessary for the operation and maintenance and inspection of the escalator or moving walk. Fire alarm systems, equipment for direct fire abatement and sprinkler heads, provided they are sufficiently protected against incidental damage, are permitted in these rooms provided they do not generate additional risks for maintenance operation.

5C.11.5.9.2 Dimensions and equipment

(a) In machinery spaces, especially in driving and return stations inside the truss, space with a sufficiently large standing are a shall be kept free from permanently installed parts of any kind. The size of the standing area shall be at least 0, 30m^{2}and the smaller side shall be at least 0, 50m long.

(b) If the controller cabinethas to be moved or lifted for maintenance purposes, then suitable attachments for lifting shall be provided, e.g. eye bolts, handle.

(c) Where the main drive or brake is arranged between the user side of the step, pallet or belt and the return line, a level standing are a in the working zone of not less than 0, 12 m^2 shall be provided. The minimum dimension shall be not less than 0, 30m. This standing area is permitted to be fixed or removable.

NOTE For machinery spaces, see also A.3.

5C.11.5.9.3 Lightingandsocketoutlets

(a) The electric lighting and the socket outlets shall be independent of the power supply to the machine being fed either by a separate cable or a branchcable which is connected before the main switch of the escalator or moving walk. It shall be possible to break the supply of all phases by means of a separate.

(b) Electric lighting installations in driving and return stations and machinery spaces inside the truss shall be by means of a portable lamp permanently available in one of these places. One or more socket outlets shall be provided in each of these places.

The light intensity shall be at least 200lx in working areas.

5C.11.5.9.4Socketoutletsshallbe

Either of type 2 P+PE (2 poles + earth conductor), 250 V, directly supplied by the mains, or of a type that is supplied at a safety extra low voltage in accordance with Local Rule. 5C.11.5.11.3 Maintenance and repair stop switch. There shall be a stop switch in the driving and return station. Escalators and moving walks with the driving unit arranged between the user side of the step, pallet or belt and the return line, or outside the return stations, shall have additional stop switches in the area of the driving unit. The operation of these stop switches shall cause the disconnection of the power supply from the driving machine and allow the operational brake to become effective to stop the escalator or moving walk.

The stop switches shall be achieve a category 0 stop. When activated it shall prevent the escalator or moving walk from starting. The switching positions shall be marked clearly and permanently.

SPECIFICCASE A stop switch need not be provided in a machinery space if a main switch according to 5C.11.5.10 is located therein.

5C.11.5.10 Fire protection

Fire protection and building requirements differ from country to country and so far neither have been harmonized. Therefore, this standard cannot include specific requirements for fire protection and building requirements. However, it is recommended that as faras possible, escalators and moving walks are made of materials that do not create an additional hazard in case of fire.

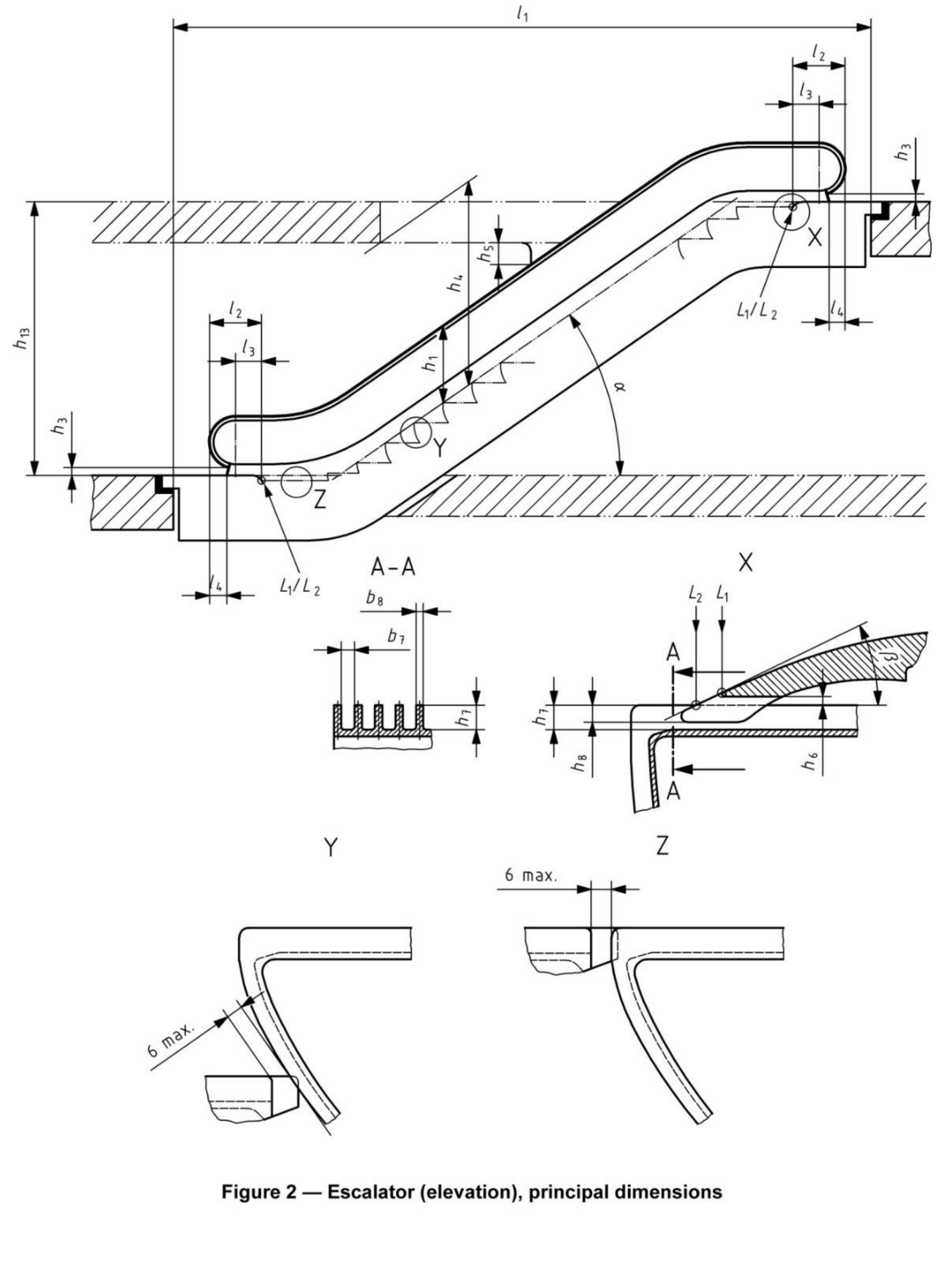
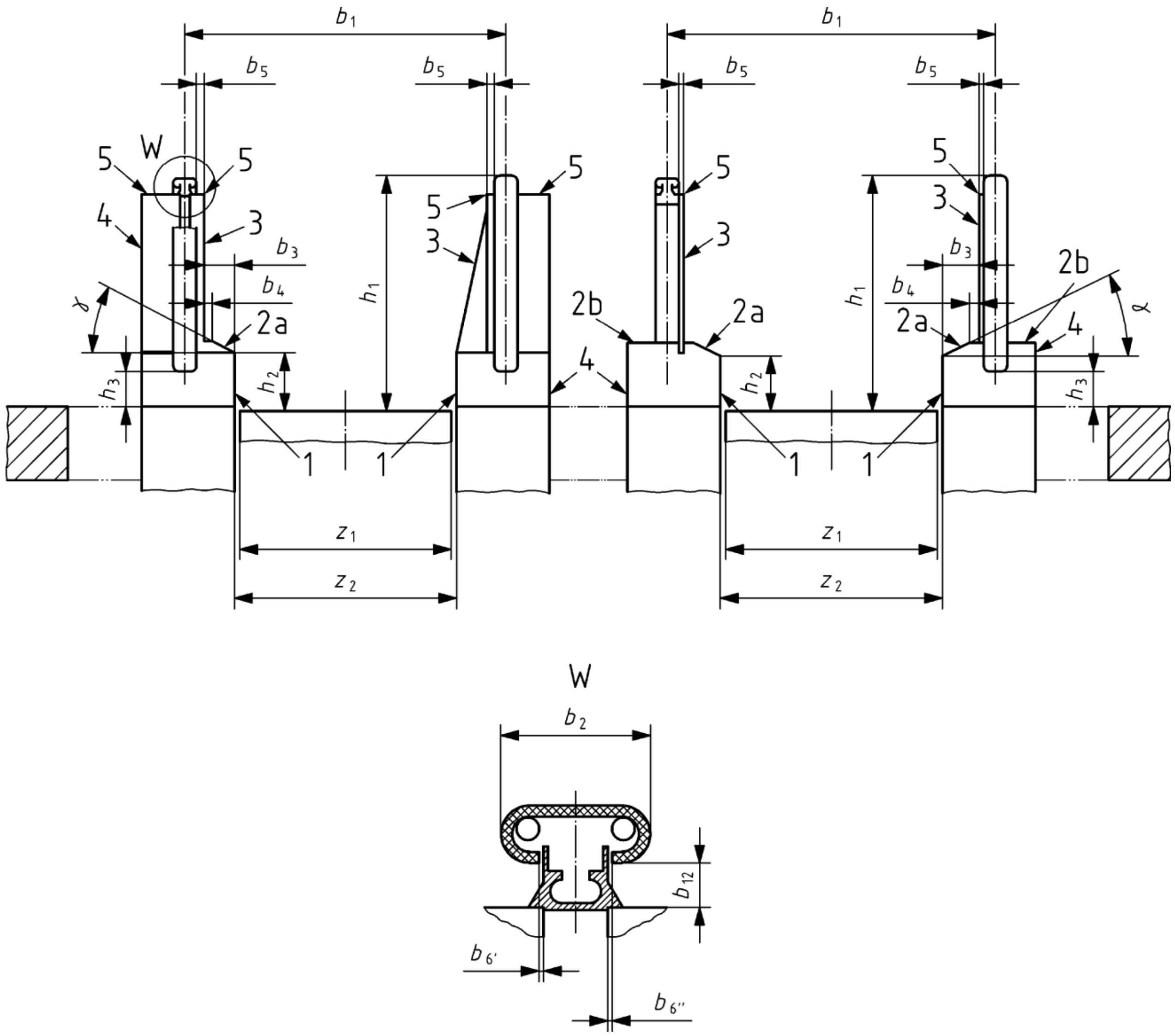


Figure 2 — Escalator (elevation), principal dimensions

Principaldimensions	Clause	Principaldimensions	Clause
b7 5 mm to 7mm (step treads and pallets)	11.5.4.1(f)	h8≥ 4mm	11.5.8.2(h)
b7 4, 5mm to 7mm (belts)	11.5.4.1(m)	h13 Rise	
b8 2,5 mm to 5 mm (step treads and pallets)	11.5.4.1(b)	L1 Root of thecomb teeth	
b8 4,5mmto 8mm (belts)	11.5.4.1(o)	L2 Comb intersection line	
h1 0,90m to1,10m	11.5.8.2(a)	l1 Distance between supports	
h3 0,10m to0,25m		l2≥ 0,60m	
h4≥ 2,30m		l3≥ 0,30m	
h5≥ 0,30m		l4≥ 0,30m	
h6 ≤ 4mm	11.5.8.2(i)	α Angle of inclination	
h7 ≥ 10 mm (step treads and pallets)	11.5.8.2(g)	β≤ 35°	11.5.8.2(c)
h7≥ 5mm(belts)	11.5.8.2(b)		

NOTE This figure has not been drawn to scale. It only serves to illustrate the requirements.

Figure2 — Escalator (elevation), principal dimensions



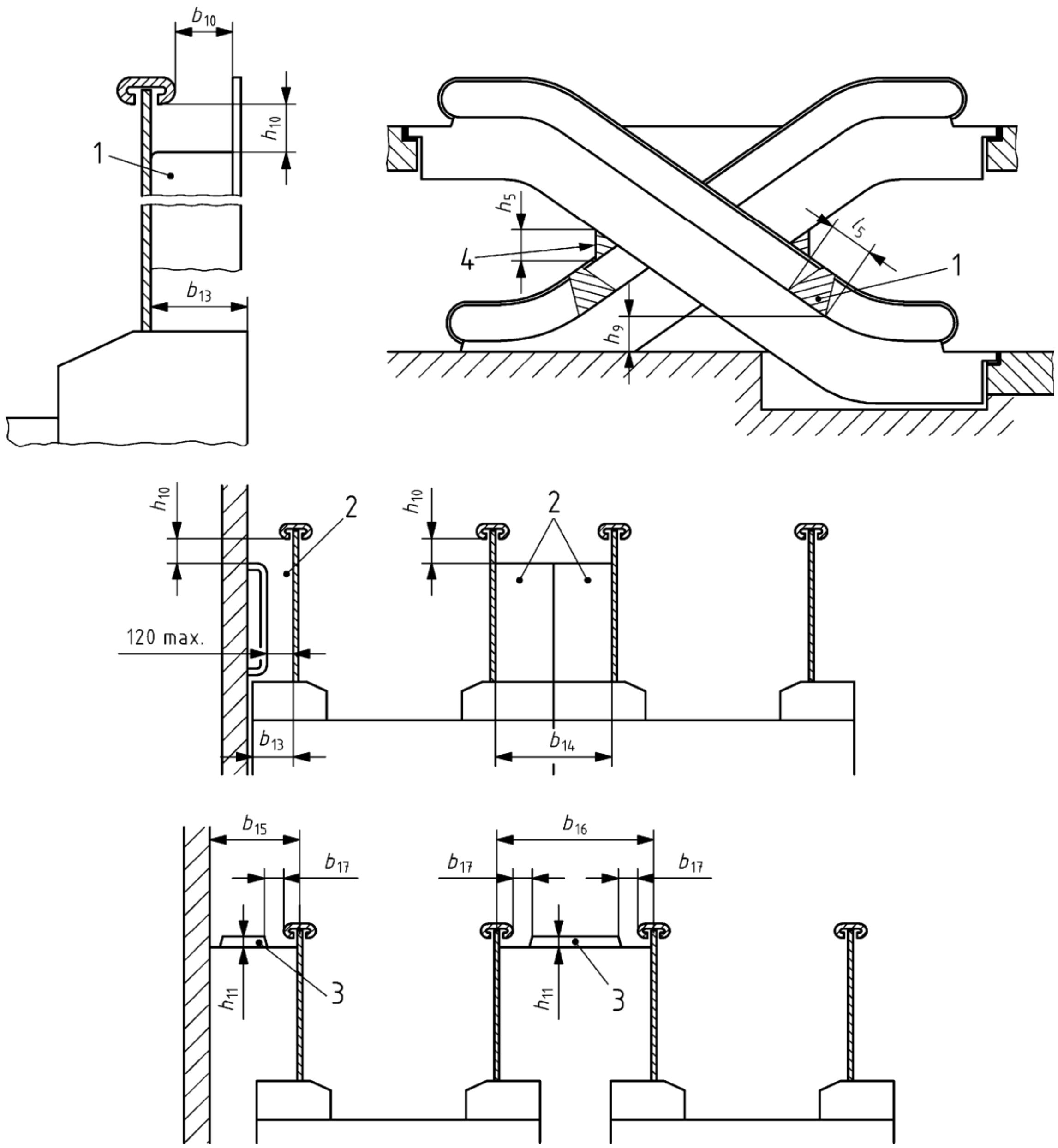
Key

1	skirting	3	interior panel
2a	lower inner decking	4	exterior panel
2b	lower outer decking	5	balustra dedecking

Principal dimensions	Clause	Principal dimensions	Clause	Principal dimensions	Clause
b1 ≤z2+0,45m		b6'+b6''≤8mm		z2=z1+7mm; distance between skirting	
b2		b12≥25mm	A. 2.2		
b3<0,12m(if		h1			
b4 <30mm		h2≥25mm		γ≥ 25°	
b5 ≤50mm		h3			

NOTE This figure has not been drawn to scale. It only serves to illustrate the requirements.

Figure3—Escalator/moving walk (sectional view), principal dimensions



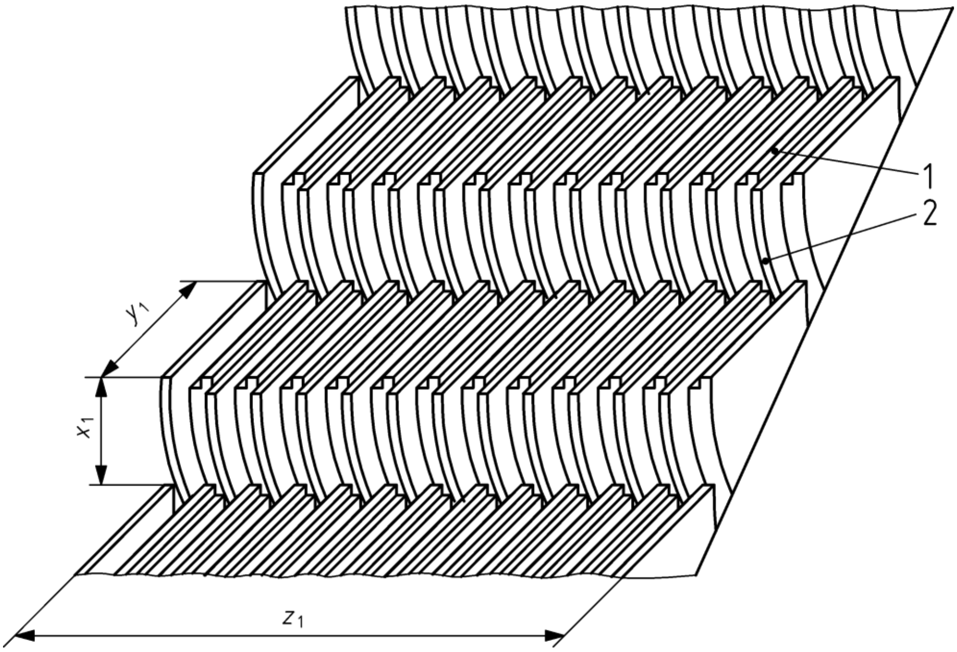
Key

1	anti-climbing device	3	anti-slide device
2	access restriction device	4	vertical deflector

Principal dimensions	Clause	Principal dimensions	Clause
b13,b14,b15, b16		h10=25mmto150mm	
b17≥100mm		h11≥20mm	
h5≥0.30m	A.2.4	l5≥1000mm	
h9=(1000 ± 50)mm			

NOTE This figure has not been drawn to scale. It only serves to illustrate the requirements.

Figure4—Anti-misuse devices



Key

1 steptreads

2 steprisers

Principaldimensions	Clause
x1≤ 0,24m	11.5.4.1(b)
y1 ≥ 0,38m	11.5.4.1(c)
z1 0,58mto 1,10m	11.5.4

NOTE This figure has not been drawn to scale. It only serves to illustrate the requirements.

Figure5—Steps, principal dimensions

Dimensions in millimetres

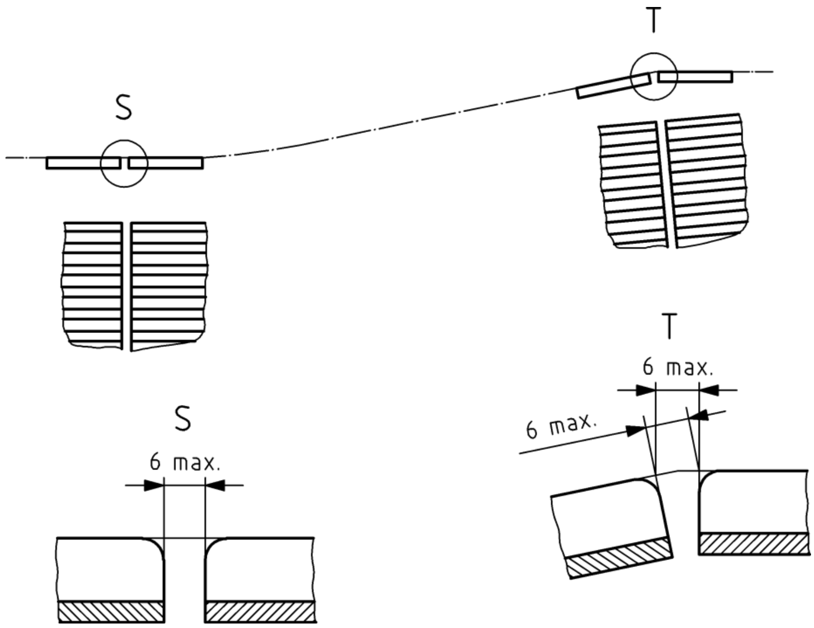


Figure6—Pallets, clearance and mesh depth (pallet type moving walk without meshed front and rear edges) in lower and upper landing and transition curves

Dimensions in millimetres

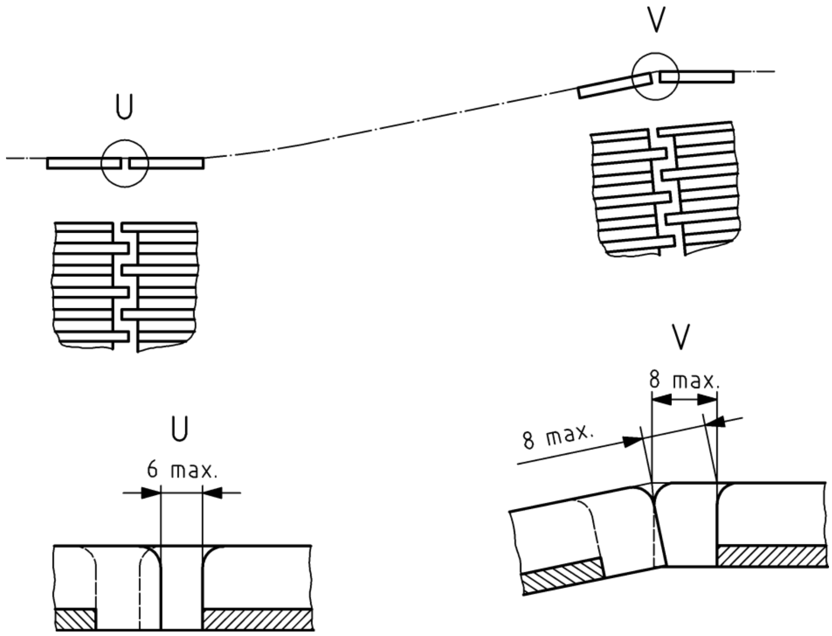
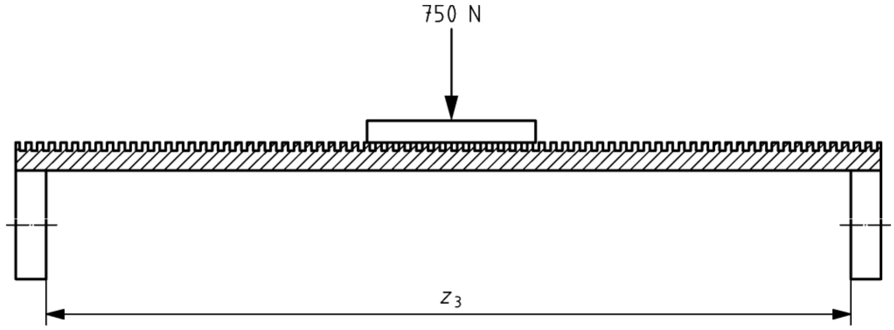


Figure7—Pallets, clearance and mesh depth (pallet type moving walk with meshed front and rear edges) in lower and upper landing and transition curves



Symbol for quantity/Designation		Clause
z3	Transverse distance between the supporting	

NOTE This figure has not been drawn to scale. It only serves to illustrate the requirements.

Figure8—Belt (sectional view), single force

5C.11.5.11 Electric installations and appliances

5C.11.5.11.1General

Introduction

The electric installation of escalators or moving walks shall be so designed and manufactured as to ensure protection against hazards a rising from the electric equipment or which may be caused by external influence sonit, provided the equipment isused in applications for which it was made and is adequately maintained.

Therefore, the electric equipments hall:

(i) Comply with the requirements stated in Myanmar Electrical Regulations;

(ii) Where no harmonized standards as referred toin a) exist, comply with the equirements of the International Electrotechnical Commission (IEC)

Limits ofapplication

The requirements of this standard relating to the installation and to the constituent components of the electric equipment apply:

(i) To the main switch of each independent power circuit (e.g.machine, heating system) of the escalator or moving walk and dependent circuits;

(ii) To the switch for the lighting circuit of the escalator or moving walk and dependent circuits.

The escalator or moving walk shall be considered as a whole, in the same way as a machine with its incorporated apparatus.

The electricity supply to the input terminals of the switches refers to in (b) and the electricity supply to the lighting of the machinery spaces, driving and return stations are not laid down by this standard.

5C.11.5.11.2 Voltage limit for control and safety circuits

For control and safety circuits, the value in direct current orther. m.s.value in alternating current between conductors or between conductors and earth shall not exceed 250V.

(a) Conductor for neutral and earth-continuity

(b) Contactors, relay contactors, components of fail safe circuits

(c) Contactors and relay contactors

(d) To stop the driving machine the main contactors shall be long to the following categories .

(i) AC-3 for contactors of alternating current motors;

(ii) DC-3 for contactors of direct current machines.

(e) Relay contactors shall belong to the following categories ,

(i) AC-15 for contactors in alternating current control circuits;

(ii) DC-13 for contactors in direct current control circuits.

(f) Components of fail safe circuits

(g) When devices according to 5C.11.5.11.2 (e) are used as relays in a fail safe circuit, the assumptions of also apply.

(h) If the relays used are such that the break and make contacts are never closed simultaneously for any position of the armature, the possibility of partial attraction of the armature is permitted to be disre garded

(i) Devices connected after electric safety devices shall meet the requirements of 5C.11.5.12.2
(j) With regard to the creep distances and air gaps (not with regard to these parathion distances).

This requirement does not apply to the devices mentioned in 5C.11.5.11.2(c).

5C.11.5.11.3 Main switches

(a) In the vicinity of the machine or in the return stations, or in the vicinity of the control devices, there shall be a main switch capable of breaking the supply to the motor, to the brake releasing device and to the control circuit in the live conductors.

This switch shall not cut the supply to the socket outlets or to the lighting circuits necessary for inspection and maintenance (see 5C. 11.5.9).

When separate supplies are provided for auxiliary equipment such as heating, balustrade elighting and comb lighting, it shall be possible to switch the muffin dependently. The corresponding switches shall be located close to the main switch and be marked unambiguously.

(b) The main switches as defined in 5C. 11.5.11.3 (a) shall be capable of being locked or otherwise secured in the "isolated" position, with the use of a pad lock or equivalent, to ensure noinadvertent operation by others. The control mechanism of the main switch shall be easily and rapidly accessible after opening of the doors or trap doors.

(c) Main switches shall be capable of interrupting the highest current involved in normal operating conditions of the escalator or moving walk.

(d) Where the main switches of several escalators or moving walks are positioned together it shall be possible to easily identify to which escalator or moving walk they refer.

5C.11.5.12 Electric safetydevices

5C.11.5.12.1 General requirements

(a)The electric safety devices for the (events escalator or moving walk listed in Table 6) shall prevent the driving machine from starting or cause the immediate stopping of the driving machine and consist of:

(i) Either one or more safety switches satisfying 5C. 11.5.12.2 directly disconnecting the supply to the contactors or their relay contactors, or

(ii) Fail safe circuits satisfying consisting of:

1) Either one or more safety switches satisfying 5C. 11.5.12.2 not directly disconnecting the supply to the contactors or their relay contactors, or

2) Contacts not satisfying the requirements of 5C. 11.5.12.2 or

3) Other components in accordance with the requirements of Annex B.

(b)No electric equipment shall be connected in parallel with an electric safety device with the exception of:

(i) Electric safety devices in case of inspection mode;

(ii) Connections to different points of the safety circuit for information about the status of electric safetydevices; the devices used for that purpose shall fulfil the requirements of Annex B.

(c)The effects of internal or external inductance or capacitance shall not cause failures of fail safe circuits.

(d) An output signal emanating from a fail safe circuit shall not be altered by an extraneous signal emanating from an other electric device placed further down the same circuit, which would cause a dangerous condition to result.

(e)The construction and arrangement of the internal power supply units shall be such as to prevent the appearance of false signals at the outputs of electric safety devices due to the effects of switching. In particular, voltage peaks arising from the operation of the escalator or moving walk or other equipment on the network shall not create in admissible disturbances in electronic components .

5C.11.5.12.2 Safety switches

(a)The operation of a safety switch shall be by positive mechanical separation of the contacts. This positive mechanical separation shall even occur if the contacts are welded together.

Positive mechanical separation is achieved when all contacts are brought to their open position in such away that for a significant part of the travel there are no resilient elements (e.g.springs) between the moving contacts and the part of the actuator to which the actuating force is applied.

The design shall be such as to minimize the risk of ashort-circuit resulting from a faulty component.

(b)The safety switch shall be provided for a rated in sulation voltage of 250 V if the enclosure provides a degree of protection of at least IP, or 500V if the degree of protection of the enclosure is less than IP4X.

(i) AC-15 for safety switches in alternating current circuits;

(ii) DC-13 for safety switches in direct current circuits.

(c) If the protective enclosure is not at leas to ftype IP4X the air gaps shall be at least 3mm and creep distances at least 4mm.

After separation the distance for contacts shall beat least 4mm.

(d) In the case of multiple breaks, the individual distances for breaking contacts shall be at least 2 mm after separation.

(e) Debris from the conductive material shall not lead to short-circuiting of contacts.

The starting switch(es) shall be located within reach of a stop switch according to 5C.11.5.12.2(b). For remote starting devices the requirements above shall apply.

NOTE For the obligation of the maintainer to observe a complete revolution of the step/pallet band before making the escalator/moving walk available to the public after maintenance.

NOTE An average speed against for a walking person of 1m/s should be taken into account.

The requirements protection of electric faults shall be met. Constructional measures may be necessary to prevent circumvention of the control elements.

(f) Stop switch for emergency situations, manually operated

(g) Stop switch for emergency situations shall be provided to stop the escalator or moving walks in the event of an emergency. They shall be placed in conspicuous and easily reachable positions at least at or near each landing of the escalator or moving.

The distances between stop switches for emergency situations shall not exceed:

- 30 m on escalators;

- 40 m on moving walks.

If necessary, additional stop switches shall be provided to maintain the distance.

For moving walks intended to transport shopping trolleys and baggage carts (C-2).

(h) Stop switch for emergency situations shall be electric safety devices according to electric safety devices.

(i) Stopping initiated by monitoring or electric safety devices [see5C.11.5.12.1(a)]

AnnexA(normative)

Building interfaces

A.1 General

The requirements in A.2 and A.3 are important for the safety of users and maintenance personal.

If it is not possible for the manufacturers of the escalator or moving walk to fulfill these requirements (or some of them) due to the fact that e.g. they are not installing the escalator or moving walk, those requirements that are not fulfilled have to be part of the instruction handbook as an obligation for the owner. Recommendations do not use escalators as regular staircases or emergency exits. Provide the staircases from user in case of emergency each floor.

A.2 Free space for users

A.2.1 The clear height above the steps of the escalator or pallets or belt of the moving walk at all points shall be not less than 2, 30 m (see h_4 in Figures 2 and A.1).

The clear height shall extend to the end of the newel.

NOTE -The clear height of 2, 30m should also be applied to the unrestricted area.

A.2.2 Top revent collision, a minimum free area around the escalator or moving walk is defined as per Figure A.1. The height h_{12}, measured from the steps of the escalator or the pallets or the belt of the moving walk shall be at least 2, 10m. The distance between the outer edge of the handrail and walls or other obstacles (see b_{10} in Figure A.1) shall under no circumstances be less than 80 mm horizontally and 25 mm vertically below the lower edge of the handrail (see b12 in Figure 3). The area is permitted to be smaller, if by appropriate measures, the risk of injury is minimized.

A.2.3 For escalators arranged adjacent to one another either parallel or criss-cross, the distance between the handrails shall be not less than 160 mm (see b_{11} in FigureA.1).

A.2.4 Where building obstacles can cause injuries, appropriate preventive measures shall be taken.

In particular, at floor intersections and on criss-cross escalators or moving walks, a vertical deflector of not less than 0, 30 m in height, not presenting any sharp cutting edges, shall be placed above the hand rail level and extend at least 25 mm below the lower edge of the handrail, e.g. a sanimper for ate triangle (see h_5 in Figures 2 and 4).

It is not necessary to comply with these requirements when the distance b_9 between the outer edge of the handrail and any obstacle is equal to or greater than 400 mm (see Figure A.1). 14.A.2.5 At the exit(s) of each individual escalator or moving walk a sufficient unrestricted area shall be available to accommodate persons. The width of the unrestricted area shall at least correspond to the distance between the outer edges of the handrails plus 80 mm on each side. The depth shall be at least 2, 50 m measured from the end of the balustrade. It shall be permissible to reduce it to 2,00 m if the width of the unrestricted area is increased to at least double the distance between the outer edges of the handrails plus 80mm on each side.

For succeeding escalators and moving walks the depth of an unrestricted area shall be determined in each individual case depending on e.g. type of use (persons only or persons with transport devices, number of intermediate exits, relative orientation and the oretical capacity).

A.2.6 In the case of successive escalators and moving walks without intermediate exits, they shall have the same capacity.

A.2.7 Where it is possible for people to come into contact with the outer edge of a handrail at a landing and can be drawn into a hazardous situation, such a stoppling over a balustrade, appropriate prevent ative measures shall be taken (for an example, see Figure A.2).

Some examples are:

- Prevention of entry into the space by the placement of permanent barriers;
- Increasing the height of the building structure of the fixed balustrade in the hazard area by at least 100 mm above the handrail level and positioned between 80 mm and 120 mm from the outer edge of the handrail.

A.2.8 The surrounds of the escalator or moving walk shall be illuminated, especially in the vicinity of the combs.

NOTE - Information should be exchanged between the manufacturer and the customer.

A.2.9 It is permissible to arrange the lighting in the surrounding space and/ or at the installation itself. The intensity of illumination at the landings including the combs shall be related to the intensity of illumination of the general lighting in the area. The intensity of illumination shall be not less than 50 lx at the comb intersection line measured at floor level.

A.3 Machinery spaces outside the truss

A.3.1 A safe access for persons to machinery spaces shall be provided.

A.3.2 Machinery spaces shall be lockable and only accessible to authorised

A.3.3 Machinery spaces shall be provided with permanently installed electric lighting on the following basis:

a) A minimum of 200lx at floor level in working areas;

b) A minimum of 50lx at floor level in access routes leading to these working areas.

A.3.4 Emergency lighting shall be installed to allow the safe evacuation of all personnel working in any machinery space.

NOTE -Emergency lighting is not intended for continuation of maintenance or other activities.

A.3.5 The dimensions of machinery spaces shall be sufficient to permit easy and safe working on equipment, especially the electricale quipment.

In particular there shall be provided at least a clear height of 2,00 m at working areas, and:

a) A clear horizontal area in front of the control panels and the cabinets. This area is defined as follows:

> **1)** Depth, measured from the external surface of the enclosures: at least 0, 70m.
>
> **2)** Width, the greater of the following values: 0, 50 m or the full width of the cabinet or panel.

b) A clear horizontal area of at least 0,50 m x 0,60 m for maintenance and inspection of moving parts at points where this is necessary.

A.3.6 The clear height for movement shall not be less than 1,80 m.

The access ways to the clear spaces mentioned in A.3.6 shall have a width of at least 0,50 m. This value may be reduced to 0,40 m where there are no moving parts.

This full height form ovementis taken to the underside of the structural roof beams and measured from both:

a) The floor of the access area.

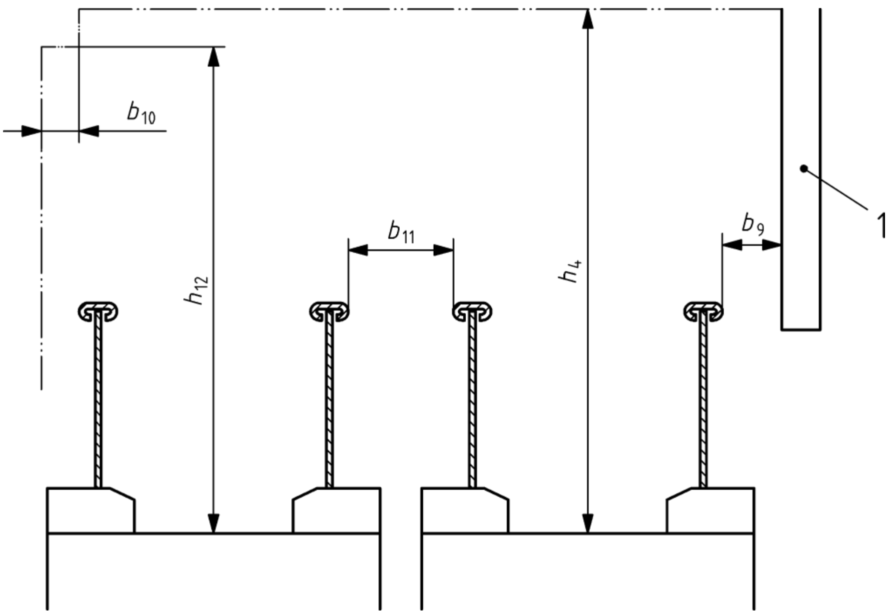
b) The floor of the working area.

A.3.7 In machinery spaces the clear height shall under no circumstances be less than 2,0m.

A.4 Electric power supply

Agreements shall be made between the owner and the manufacturer about electric supply and electric protection requirements (e.g. electric shock, short circuit; overload).

The installation shall with the requirements of the national rules of the country where it is installed.



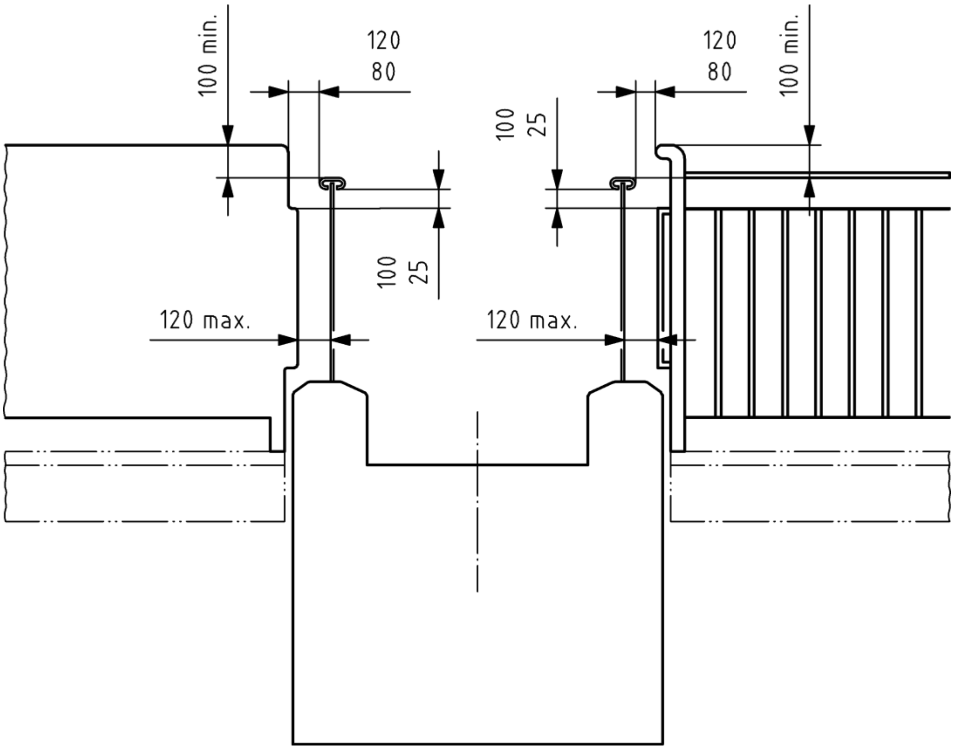
Key

1 obstacle(e.g.column)

Principaldimensions	Clause	Principaldimensions	Clause
b9 $\geq$ 400mm	A.2.4	h4 $\geq$ 2300mm	A.2.1
b10$\geq$80mm	A.2.2	h12$\geq$2100mm	A.2.2
b11$\geq$160mm	A.2.3		

NOTE This figure has not been drawn to scale. It only serves to illustrate the requirements.

FigureA.1—Clearances between building structure and escalator/moving walk units



NOTE This figure has not been drawn to scale. It only serves to illustrate the requirements.

FigureA.2— Example of barriers at landings

Annex B (informative)

Designguide-line for safety circuits

This design guide-line gives recommendations to avoid dangerous situations in the case when information is collected from the safety circuit for control purposes, for remote control, alarm control, etc.

Some dangerous situations are recognized coming from the possibility of bridging one or several electric safety devices by short circuiting or by local interruption of common lead (earth) combined with one or several other failures. It is good practice to follow the recommendations given below:

- Design the board and circuits with distances in accordance with specifications Connectors Terminals Plugs and Printed Circuit Board.

- Organise common lead so that the common lead for the control of the escalator/ moving walk comes behind the electronic components. Any rupture will cause a non-operation of the control (danger exists that changes in wiring occur during the life of the escalator/ moving walk).

- Make always calculations about the "worst case" condition.

- Always use outside (out of element) resistors as protective devices of inputelements; internal resist or of the device should not be considered as safe.

- Use only components according to listed specifications.

- Consider backwards voltage coming from electronics. Using galvanically separated circuits can solve the problems in some cases.

- The "worst case" calculation cannot be avoided, whatever the design. If modifications or add-ons are made after the installation of the escalator/ moving walk, the "worst case" calculation, involving newand existing equipment, must be carried out again

- Some failure exclusions can be accepted, according to electronics & electrical components.

- Failures outside the environment of the escalator/ moving walk need not be taken into consideration.

- "An interruption of the earth from the main supply of the building to the controller collection earth bar (rail).

can be excluded, providing the installation is made in accordance with local electrical rules and regulations.

AnnexC (normative)

Requirements on escalators and moving walks intended to transport shopping trolleys and baggage carts

C.1 Escalators

The use of both shopping trolleys and baggage carts on escalators is unsafe and shall not be permitted.

The principle reasons why the use of these products is considered to be unsafe are foreseeable misuse, overloading and width restriction.

Where shopping trolleys and/ or baggage carts are available in the area around escalator installations, suitable barriers shall be provided to prevent access.

Outline guid anceis given as follows:

Shopping trolleys or baggage carts which are chosen for use on an escalator must be specified between the shopping trolley or baggage cart manufacturer and the escalator manufacturer. If non-specified shopping trolleys or baggage carts are available in the escalator area, there is a serious risk of misuse. It is necessary to prevent access to the escalator entrance.

The width of the shopping trolley or baggage cart and its contents should be at least 400 mm less than the nominal step width. Passengers should be able to leave the escalator, even if shopping trolleys or baggage carts are on the escalator.

The escalators should be supplied with a horizontal step runoff 1,6 m at both landing areas, minimum transition radia of 2,6 m at the upper landing and2,0 m at the lower landing, and limiting the rated speed to 0,5 m/s and the inclination to 30°.

Combs should be designed with an angle β of max. 19° combined with a diameter of the shopping trolley or baggage cart roller of at least 120 mm diameter.

Additional stops for emergency situations at handrail level (taking into account A.2.2) with a distance between 2,0 m and 3,0 m before the step reaches the combinter section line should be provided. The stop for emergency situations near the transition curve should be reachable from inside the escalator and the stops for emergency situations at exit(s) shall be reachable from outside of the escalator.

Shopping trolleys or baggage carts should conform to the escalator design:

- The shopping trolley or baggage cart design should ensure a safe and correct loading.
- The maximum weight for a shopping trolley or baggage cart should be 160 kg when loaded.
- Shopping trolley or baggage cart should automatically lock themselves on the inclined part of escalators.
- Shopping trolleyor baggage cart should be fitted with a braking or blocking system.
- Shopping trolley or baggage cart should have deflectors (bumpers) to reduce the risk of clamping.
- For safe exit from the escalator, it is necessary that the rear rollers of the shopping trolley or baggage cart are able to push the front rollers over the comb. The front rollers and/or blocking system should easily release from the steps
- Deflectors and guiding devices should be added to the surrounding area to ensure correct alignment of shopping trolley or baggage cart when entering the escalator.

- Safety signs about safe and correct use of the shopping trolley or baggage cart should be added.

C.2 Moving walks

The use of suitably designed shopping trolleys and baggage carts on moving walks is permitted.

Shopping trolleys or baggage carts which are chosen for use on a moving walk shall be specified between the baggage cart manufacturer and the moving walk manufacturer. If non-specified shopping trolleys or baggage carts are available in the moving walk area, there is a serious risk of misuse. It is necessary to prevent access to the moving walk entrance.

The width of the shopping trolley or baggage cart and its contents shall be at least 400 mm less than the nominal pallet/ belt width. Passengers shall be able to leave the moving walk, even if shopping trolleys or baggage carts are on the moving walk.

For moving walks with an inclination greater than 6°, the rated speed shall be limited to 0,5m/s.

Combs shall be designed with an angle β of max. 19°combined with a diameter of the shopping trolley or baggage cart roller of at least 120 mm diameter.

Additional stops for emergency situations at handrail level (taking into account A.2.2) with a distance between 2,0 m and 3,0 m before the pallet reaches the comb intersection line shall be provided. The stop for emergency situations near the transition curve shall be reachable from inside the moving walk and the stops for emergency situations at exit(s) shall be reachable from outside of the moving walk.

Shopping trolleys or baggage carts shall conform to the moving walk design:

- The shopping trolley or baggage cart design shall ensure a safe and correct loading.

- The maximum weight for a shopping trolley or baggage cart shall be160 kg when loaded.

- Shopping trolley or baggage cart shall automatically lock themselves on the inclined part of moving walks.

- Shopping trolley or baggage cart shall be fitted with a braking or blocking system.

- Shopping trolley or baggage cart shall have deflectors (bumpers) to reduce the risk of clamping.

- For safe exit from the moving walk, it is necessary that the rear rollers of the shopping trolley or baggage cart are able to push the front rollers over the comb. The front rollers and/ or blocking system shall easily release from the pallet.

- Deflectors and guiding devices shall be added to the surrounding area to ensure correct alignment of shopping trolley or baggage cart when entering the moving walk.

- Safety signs about safe and correct use of the shopping trolley or baggage cart should be added.

D.2 Testing and assessing anti-slip properties

The procedure for testing anti-slip properties is governed by local rules.

Your attention is drawn to the fact that the intermediary medium of oil in the test procedure is not used to give the test a particularly adverse operating condition. The use of a specific, defined oil is used as a constant test parameter with which, as has been proved, better differentiation of the test results is achieved.

NOTE– This procedure is based on the people carrying out the test treading on the covering to be tested on an inclined plane. It is used as an aid to deciding whether the respective covering is suitable for use on escalators and moving walks.

The average inclination angle determined from a range of measurements is critical for classifying the covering in one of five assessment groups. The assessment group is used as a bench mark for the level of anti-slip properties where coverings in assessment group R 9 meet the lowest anti-slip requirements and those in assessment group R 13 the highest. The allocation of assessment groups to the angle ranges is shown in Table D.1.

Table D.1—Allocating the overall average values of the inclination angles to the anti-slip assessment groups

Overall average value	Assessment group
from6°to 10°	R9
over 10° to19°	R 10
over 19° to27°	R 11
over 27° to35°	R 12
greater than 35°	R 13

The assessment of the anti-slip properties of coverings with surface profiles arranged in a specific direction, e.g. a step covering with length wise grooves or cover plates with transverse grooves, shall be based on average values that take into consideration the place the coverings are laid and the direction the users walk on them.

Coverings that meet at least assessment group R9 are considered anti-slip for indoor installations and at least assessment group R10 for outdoor installations.

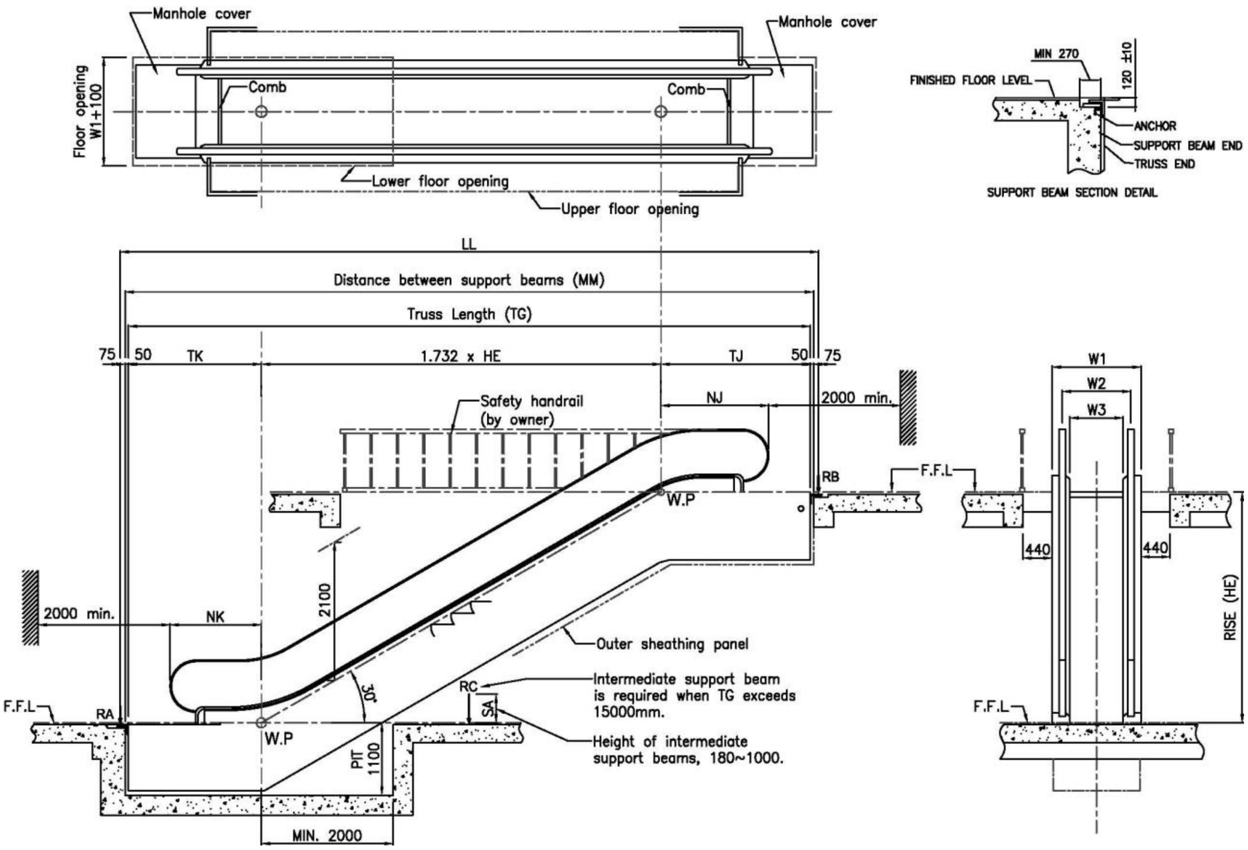
NOTE – If, at the landings of escalators and moving walks and their allocated floors, there are different assessment groups, it should be taken care that neighbouring floors shall only differ by one in their assessment groups.

The part of the test related to the area below the surface of cleated profiles is not used to assess the anti-slip properties of coverings on escalators and moving walks.

Standard Installation of Escalator for 30 ° Inclination Angle

All dimension in millimeters

Attach Figure-1



Dimensions (mm)

Dimensions (mm)

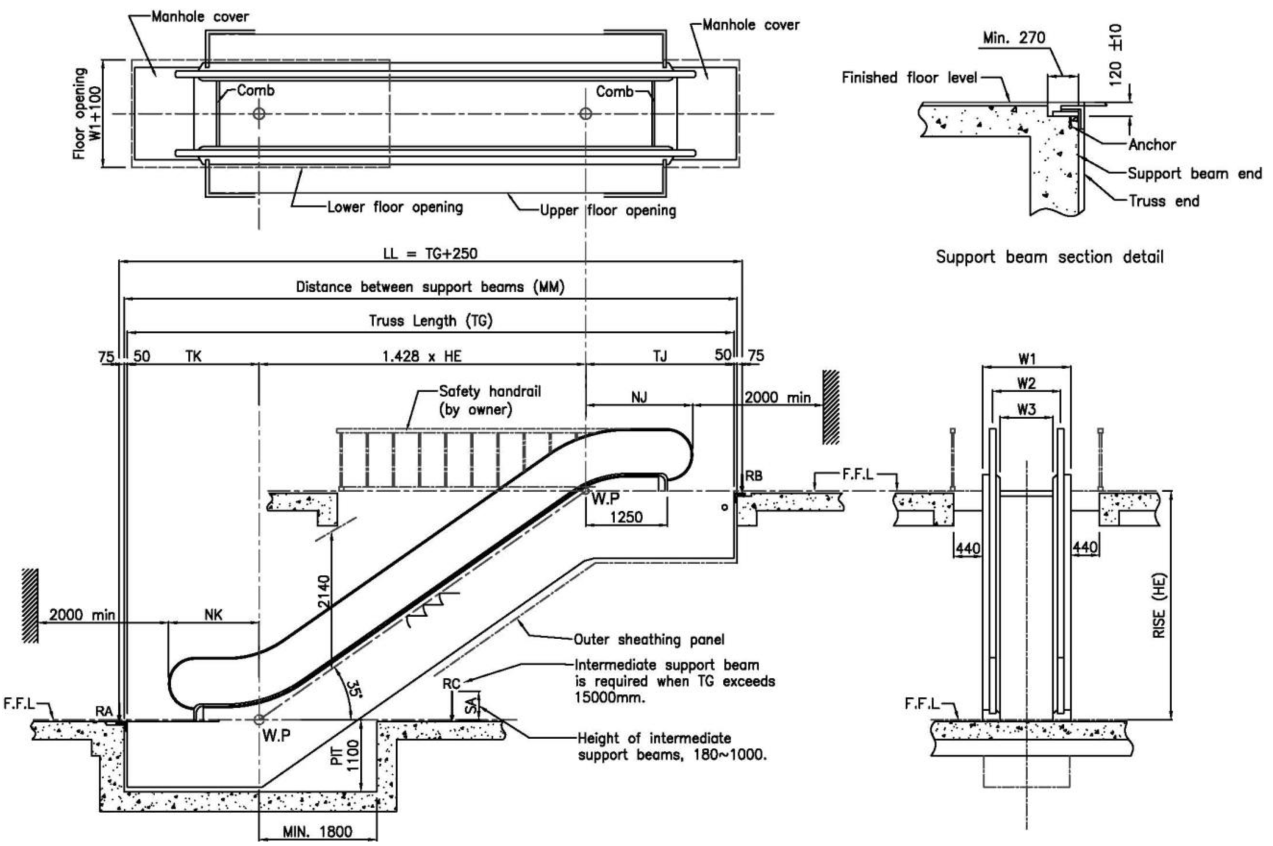
Type	Step width (mm)		
	600	**800**	**1000**
W1 (Escalator width)	1150	1350	1550
W2 (Between Moving Handrails)	840	1040	1240
W3 (Between Skirt Panels)	610	810	1010

Horizontal Steps	NK	NJ	TJ	TK
1.5 Steps (Nominal)	1385	1635	2265	2015
3 Setps	1975	2260	2890	2605

Standard Installation of Escalator for 35 ° Inclination Angle

All dimension in millimeters

Attach Figure-2



Dimensions (mm)

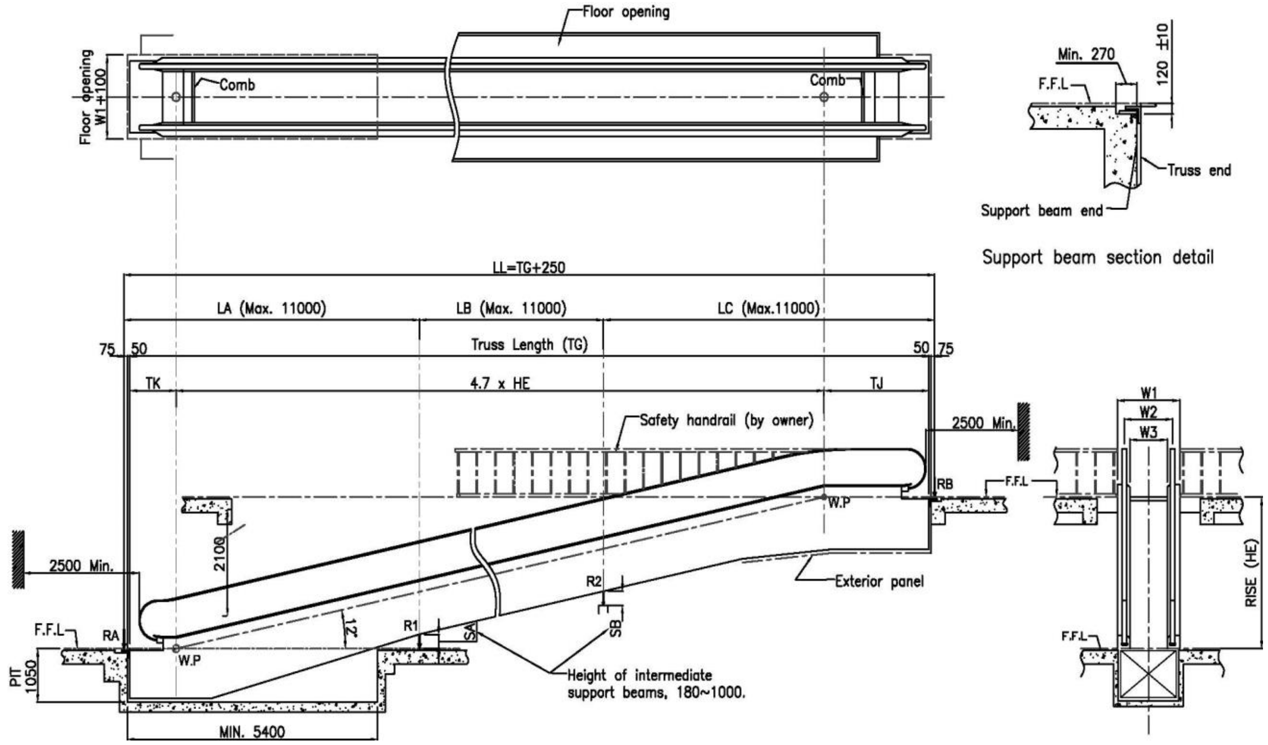
Type	Step width (mm)		
	600	800	1000
W1 (Escalator width)	1150	1350	1550
W2 (Between Moving Handrails)	840	1040	1240
W3 (Between Skirt Panels)	610	810	1010

Horizontal Steps	NK	NJ	TJ	TK
2 Steps	1630	1900	2530	2260

Standard Installation of Moving Walk for 12 ° Inclination Angle

All dimension in millimeters

Attach Figure-3

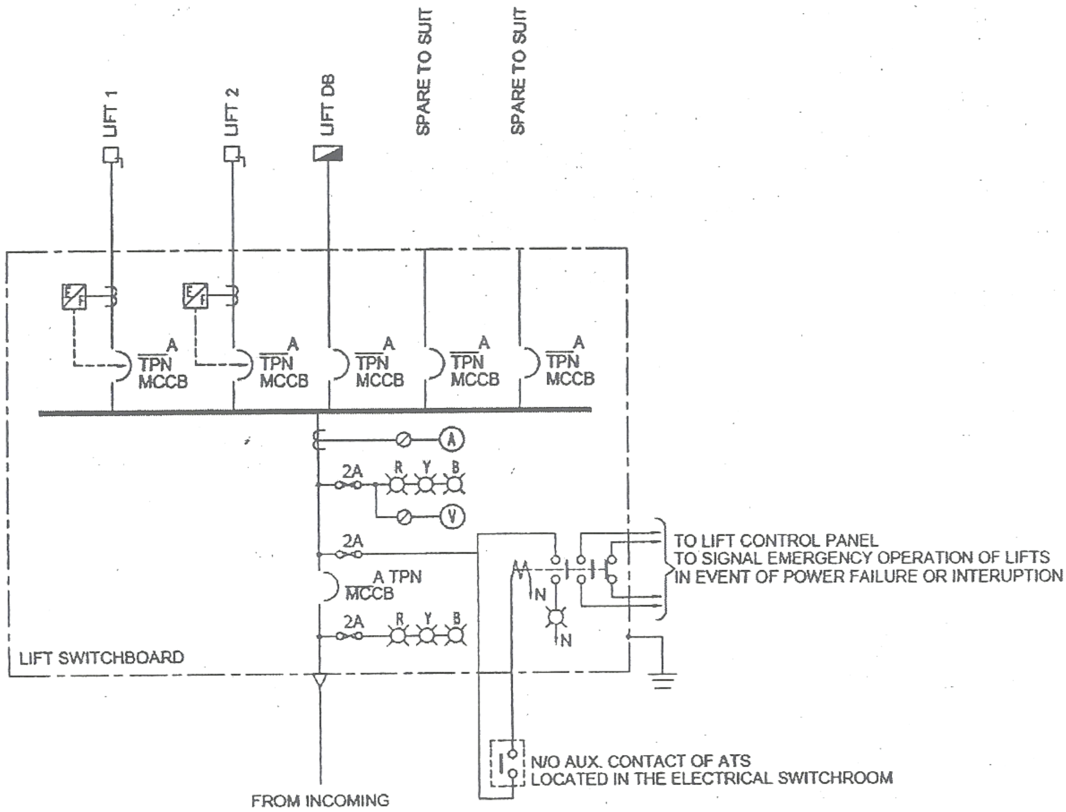


Dimensions (mm)

Type	1200
W1 (Escalator width)	1550
W2 (Between Moving Handrails)	1280
W3 (Between Skirt Panels)	1010
TK	990
TJ	2321 (HE ≤ 5400) 2675 (5400 ≤ HE ≤ 6500)

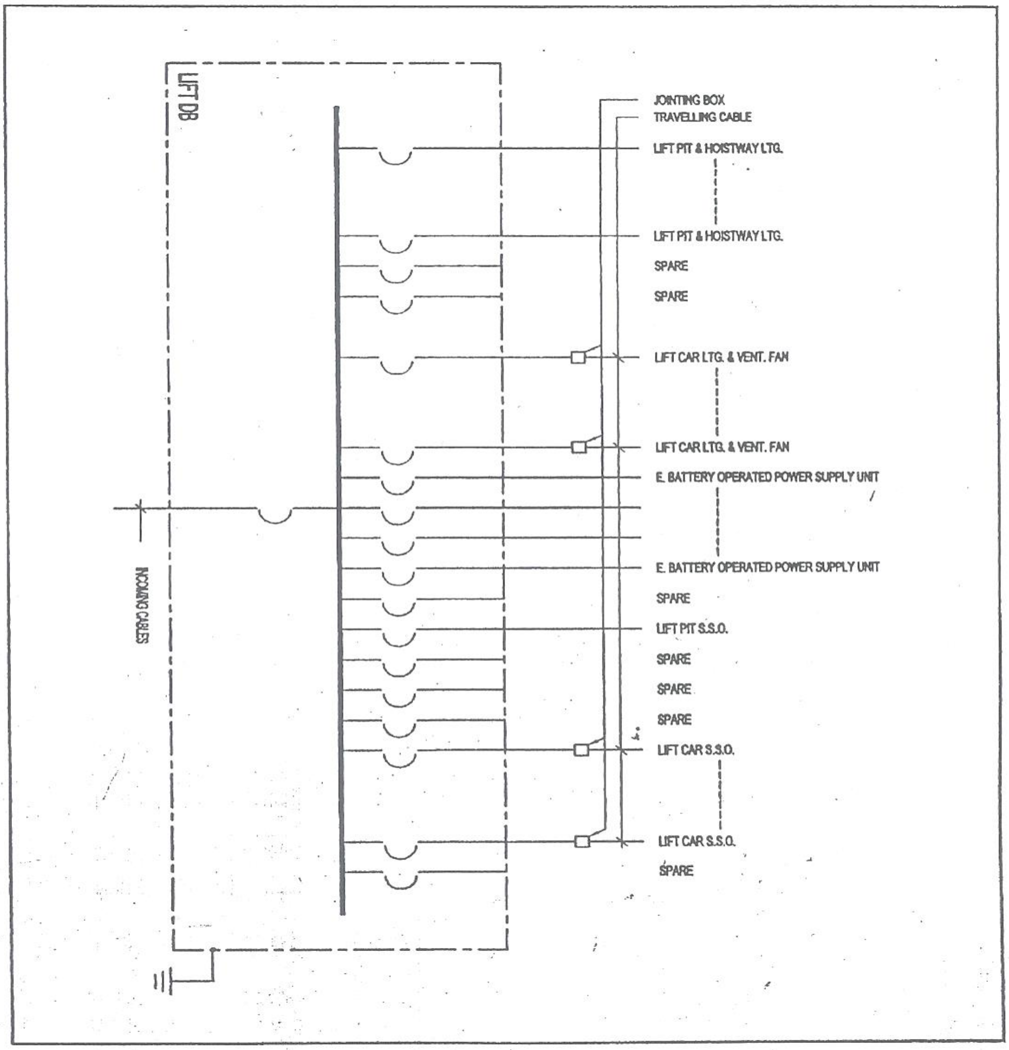
Typical example of lift switchboard in lift machine room

Attach Figure - 4



Typical example of lift distribution board in lift machine room

Attach Figure - 5



References

(1)		National Building Code of India Installation of lift & Escalator1970
(2)		National Building Code of India Installation of lift & Escalator1983
(3)		Myanmar Electricity Regulation 1985
(4)	EN 115: 1995	European Standard (Escalator)
(5)	EN 81 – 1 1998	European Standard (Elevator)
(6)	CP – 15 – 2004	Code of practice for installation, operation and maintenance of escalator and passenger conveyors.
(7)	SS550: 2009	Code of practice for Installation, operation and maintenance of electric passenger and goods lift
(8)		Myanmar National Building Code 2020, Part 5A, Lighting & Part 5B, Electrical and Allied Installations

TYPICAL CHECKLIST Ofi' VISUAL AND FUNCTIONAL CHECKS

lNVOLVl!D IN THE INSTALLATION OP LIFTS

Sr. No	Requirement	Result	Remarks
(i)	There shell be easy access from the top landing to the machine room	Accessible/Not Accessible	
(ii)	Steps along with handrail for the access to machine room to be provide	Provide / Not provide	
(iii)	Locking arrangement shall be provided and machine room shall be kept locked	Provide / Not provide	
(iv)	The machine room shall be used for the purpose of lift machinery only	Yes / No	
(v)	Machine room should be free from water entry	Yes / No	
(vi)	Rope hitches on the machine room are fixed as requied ans locked with nuts and split pins	Yes / No	
(vii)	The hoisting beams or hooks provided as per the required load and marked	Provide / Not provide	
(viii)	Trap door at the top of the lift well to lift the machine up or down from the machine room and to be located vertically below the hook provided in the machine room ceiling	Provide / Not provide	
(ix)	Rescue chart to be pasted in the machine room with proper identification	Yes / No	
(x)	The correct capacity main switch and protective device to be provided as per the requirement	Provide / Not provide	
(xi)	Grounding conductor is provided and of correct size	Provide / Not provide	
(xii)	Provision of log card pocket	Provide / Not provide	
(xiii)	Guards to be provided for moving parts such as over speed governor (OSG),machine sheave , etc	Provide / Not provide	
(xiv)	Three pin socket with switch and lighting arrangements	Provide / Not provide	

Sr. No	Requirement	Result	Remarks
(xv)	The machine room is painted and windows to be provided	Provide / Not provide	
(xvi)	There shall be adequate ventilation	Provide / Not provide	
(xvii)	Machine room shall be kept in clean condition	Clean / Unclean	
(xviii)	Provisin of caution notice indicating ‘DANGER’ on machine room door	Displayed / Not displayed	

A-2 POWER SUPPLY

<table>
<tr><th>Sr. No</th><th colspan="2">Requirement</th><th>Result</th><th>Remarks</th></tr>
<tr><td>(i)</td><td colspan="2">Incoming power supply to be 415V ± 10 percnet or as specified in the contract agreement</td><td>R-Y : ---------
Y-B : ---------
R-B : ---------</td><td></td></tr>
<tr><td></td><td colspan="2"></td><td>Ok / Not Ok</td><td></td></tr>
<tr><td>(ii)</td><td>Neutral – Earth Voltage</td><td>Ideal condition within (0-3)V</td><td>Value: -------
Ok / Not Ok</td><td></td></tr>
<tr><td>(iii)</td><td>Neutral – Earth Voltage</td><td>Running condition within (0-3)V</td><td>Value: -------
Ok / Not Ok</td><td></td></tr>
<tr><td rowspan="2">(iv)</td><td rowspan="2">Separate supply with MCB</td><td>Three phase supply</td><td rowspan="2">Provide / Not provide</td><td rowspan="2"></td></tr>
<tr><td>Single phase supply (For car lighting and shaft lighting)</td></tr>
<tr><td>(v)</td><td colspan="2">Check whether the power cables are connected with lugs for termination</td><td>Connected / Not connected</td><td></td></tr>
<tr><td>(vi)</td><td colspan="2">Shaft lighting to be provided</td><td>Provide / Not provide</td><td></td></tr>
</table>

A-3 MACHINE AND BRAKE ASSEMBLY

Sr. No	Requirement	Result	Remarks
Make:	SI No:	Rating: ---------------------------	
(i)	Is the machine fixation as per the installation manual	Yes / No	
(ii)	Are the electrical connections of the machine routed and well tightened	Yes / No	
(iii)	Machine earthing is done,routed and properly tightened	Yes / No	
(iv)	Are the machine isolation pads installed correctly (if applicable)	Yes / No	
(v)	Are the rope openings below the machine closed adequately as required	Yes / No	
(vi)	If applicable,is the machine lubricated as required	Yes / No	
(vii)	The height of the machine room shall not be less than 2 100mm at working areas	Yes / No	
(viii)	The clear height for the movement shall not be less than 1800 mm	Yes / No	
(ix)	The width of the clear space around the machine from any two sides shall not be less than 500mm	Yes / No	
(x)	Clear vertical distance of at least 300 mm is available above rotating equipment	Yes / No	
(xi)	Are all the components of the brake installed,nuts tightened and locked	Yes / No	
(xii)	Is the routing of the machine brake cables free from any moving parts	Yes / No	
(xiii)	Is the machine brake and switches properly adjusted with correct clearance	Yes / No	
(xiv)	Is the brake assembly clean,no debris and oil on disk or drum	Yes / No	
(xv)	Is the manual brake release device is available and easily accessible	Yes / No	

A-4 CONTROLLER

Sr. No	Requirement	Result	Remarks
Types : SI No..: Wiring drawing No:			
(i)	Is the controller fixed as per the GAD (General Arrangement Drawing)	Yes / No	
(ii)	Is the controller identified with the correct contract number	Yes / No	
(iii)	The controller should have an easy access to open and close with lock	Yes / No	
(iv)	The required warning stickers to be pasted	Provided / Not Provided	
(v)	All extra cables to be neatly arranged	Yes / No	
(vi)	Are the battery terminals covered	Yes / No	
(vii)	The field and controller wiring to be properly routed	Yes / No	

A-5 OVER SPEED GOVERNOR

Sr. No	Requirement	Result	Remarks
Make: Model: SI No: Tripping speed:			
(i)	Is the correct over speed governor provided and installed as per layout	Yes / No	
(ii)	The sticker/painted indication represents the down direction of rotation which will facilitate the safety gear actuation	Yes / No	
(iii)	Check whether the OSG is calibrated and sealed	Yes / No	
(iv)	The governor is aligned and rope passes though the holes without any obstruction	Yes / No	
(v)	The governor rope runs free does not contact any with any object in the hoist-way	Yes / No	
(vi)	The governor tripping mechanism is free and clean	Yes / No	

Sr. No	Requirement	Result	Remarks
(vii)	The electrical switch is provided and operates in both the directions	Yes / No	
(viii)	All fixation bolts are provided and adequately tightened	Yes / No	

A-6 GENERAL INSPECTION ON CAR ROOF

Sr. No	Requirement	Result	Remarks
Instructions before entering to the car top: (a) Allow the lift to move in down direction from the top terminal landing with no load. (b) Stop the lift from the controller by changing to maintenance mode,such that easy acess to enter the car top from the top terminal landing. (c) Switch on the shaft lighting. (d) Use the door open key to open the top terminal landing door. (e) Switch on the car top stop switch from the landing to enable the ‘ STOP’ mode. (f) And then enter into the car top and switch on the light point there. (g) Switch to maintenance mode from the car top and release the stop switch to move the lift in maintenance mode.			
(i)	Barricade on car roof to be provided	Provided / Not provided	
(ii)	Adequate lighting with proper protection is provided on the car roof	Yes / No	
(iii)	Wires and trunking are proper protection and does not hinder with any maintenance related equipment	Yes / No	
(iv)	The car fan is properly fixed with isolation	Yes / No	
(v)	Three pin plug socket with switch is available and is in working condition	Yes / No	
(vi)	The emergency stop switch that should be easily accessible from outside the lift is provided of manually opened and closed type	Yes / No	

Sr. No	Requirement	Result	Remarks
(vii)	Check whether the top car clearance meets the requirement. Value required: ------------------------	Value measured:- ------- Ok/Not Ok	
(viii)	If overhead dimension in WxHxD Value required: ------------------------	Value measured:- ------- Ok/Not Ok	
(ix)	Floor levelling switches are fixed as per requirement	Yes/ No	
(x)	Rope hitches on car roof are fixed as required and locked with nuts and split pins	Yes / No	
(xi)	Car sheave if available is adequately guarded from	Yes / No	
(xii)	The junction box is fixed securely and wires are adequately protected	Yes / No	
(xiii)	The car shoe liners/rollers are fixed as per requirement and adjusted properly	Yes / No	
(xiv)	Oil tank are provided and fixed with proper oil levels	Yes / No	
(xv)	Engagement of the car door coupler with the landing door at every landing	Ok / Not Ok	
(xvi)	Engagement of shaft limit switches	Ok / Not Ok	
(xvii)	The governor rope and linkage is correctly connected to the car	Yes / No	
(xviii)	The guide rail clips are fixed as per requirements and in the correct directions	Yes / No	
(xix)	The safty gear assembly and connecting rod should be free from from external disturbances	Yes / No	
(xx)	The safety switches have been verified for correct operation during travel	Yes / No	
(xxii)	The safety gear linkages is checked for operation and actuation and actuation of switches	Yes / No	

Sr. No	Requirement	Result	Remarks
(xxiii)	Clearance between the car door coupler and the landing still to be as per the manufacturer design at every landing	Ok / Not Ok	
(xxiv)	Clearance between the landing rollers with the car sill to be as per the manufacturer design at every landing	Ok / Not Ok	

A-7 PIT INSPECTION

Sr. No	Requirement	Result	Remarks
Instructions: (a) Allow a person in the car top and ask him to move the lift to the top most landing. (b) Open the bottom terminal landing door with door open key. (c) Switch on the pit stop switch from outside the pit. (d) Enter in to the pit.			
(i)	It should be clean and dry	Yes / No	
(ii)	Pit ladder to be provided if the pit depth exceeds I 500 mm as measured below the bottom most landing sill	Provided / Not Provided	
(iii)	Oil trays are available at the bottom of each guide rail	Provided / Not Provide	
(iv)	Two pit stop switches to be provided and one should be easily accessible from the bottom terminal landing	Provided / Not Provided	
(v)	Pit stop switches to be verified with the electrical circuit such that lift should not move further after the activation of pit stop switches	Ok / Not Ok	
(vi)	Counter weight screen should be provided and fixed	Provided / Not Provide	

Sr. No	Requirement	Result	Remarks
(vii)	Buffers provided for car and counterweight are correctly fixed and aligned and the electrical switch to be verified,if provided	Ok / Not Ok	
(viii)	The governor tension pulley is fixed at the correct height from the pit floor as per the manufacturer recommendation	Ok / Not Ok	
(ix)	The electrical switch for the tension pulley is verified, if provided	Ok / Not Ok	
(x)	Check whether the bottom car clearance meets the requirement Value required: -------------------------	Value measured:------- Ok / Not Ok	
(xi)	Check for the provision of car bottom light and its function	Ok / Not Ok	
(xii)	Is the travelling cable below car secured and correctly fixed and the excess cable is not secured below car	Ok / Not Ok	
(xiii)	The travelling cable is adjusted and clear of the pit floor with the car at the lowest position	Ok / Not Ok	
(xiv)	The bottom guide shoes or rollers are fixed as per requirement and adjusted for smooth travel	Ok / Not Ok	
(xv)	The car safety gear is properly adjusted as per the installation manual	Ok / Not Ok	
(xvi)	The compensation chain fixing arrangement is fixed as per requirement	Ok / Not Ok	

A-8 EARTHING

Sr. No	Requirement	Result	Remarks
(i)	Separate earth bar to be provided in the machine room	Provided / Not Provided	

Sr. No	Requirement	Result	Remarks
(ii)	Earthing to be done for all controllers and the machine	Yes / No	
(iii)	Earthing to be done for the shaft equipment and car top components	Yes / No	
(iv)	Earthing from controller to car top components to be linked through the travelling cable	Yes / No	
(v)	Routing of the earth from the controller to the main earth bar	Ok/ Not Ok	
(vi)	Connection of the lift earth bar to main earth bar	Ok/ Not Ok	

A-9 INSPECTION FROM THE LIFT CAR

Sr. No	Requirement	Result	Remarks
Instructions: (a) No one should be present in the pit as well as in the car top. (b) Make sure the lift to run in normal mode. (c) Enter the lift car from any of the landing.			
(i)	Car inside width Value required: -------------	Value at site:------ Ok/Not Ok	
(ii)	Car inside depth Value required: -------------	Value at site:------ Ok/Not Ok	
(iii)	Height below false ceiling. Value required: -------------	Value at site:------ Ok/Not Ok	
(iv)	Door opening width Value required: -------------	Value at site:------ Ok/Not Ok	
(v)	Door opening height Value required: -------------	Value at site:------ Ok/Not Ok	
(vi)	Car capacity to be displayed inside the lift car	Yes/No	
(vii)	Safety warning plate to be displayed (see Note)	Yes/No	
(viii)	Functioning of car display	Functioning/ Not functioning	

Sr. No	Requirement	Result	Remarks
(ix)	Functioning of floor announcement, ARD announcement, etc (if applicable)	Functioning/ Not functioning	
(x)	DO button and DC button functional check: For power operated door: 1) Press the DO button at level - Door should open 2) Press the DO button during running - Door should not open 3) While closing press the DO button at level- Door should open 4) DC button at level when the door is in open condition - Door should close	Functioning/ Not functioning	
(xi)	For manual operaied door: 1) Lift should not move if any of the door car/landing in open condition 2) If door is opened during run,lift should stop and Should not move further	Functioning/ Not functioning	
(xii)	Car alarm should function even though there is no power supply to the lift	Functioning/ Not functioning	
(xiii)	Function of intercom (see Note)	Functioning/ Not functioning	
(xiv)	Provision of fan and its operations	Ok / Not ok	
(xv)	Provision of fan and its operations	Provided/Not Provided	
(xvi)	Provision and working of cabin lights and shaft lights	Provided/ Not Provided	
(xvii)	Doors are verified for smooth opening and closing at each level	Ok/Not ok	
(xix)	Riding comfort – No rail knocks and vibration are heard while travelling several times in either directions	Ok/Not ok	
(xx)	Lift should not move for any safety failure	Ok/Not ok	

Sr. No	Requirement	Result	Remarks
(xxi)	Provision of grab bars inside the lift car (see Note)	Provided/ Not Provided	
(xxii)	Provision of buffer rail (applicable only for service lifts) at the rear panel of the lift car	Provided/ Not Provided	
Sr. No	**Requirement**	**Result**	**Remarks**

Note - Lifts open to public use shall also be inspected for requiements as per 13 of Part 3 ‘ Development Control Rules and General Building Requirments ’of the Code,including those relating to lift closing time, finishes of interior surfaces, etc..S

A-10 INSPECTION FROM THE FLOOR LANDINGS

Sr. No	Requirement	Result
(i)	Provision and functioning of landing door de-locking at every landing	Functioning/ Not functioning
(ii)	Condition of landing door at every floor	Ok/Not ok
(iii)	Functioning of landing display at every floor	Functioning/ Not functioning
(iv)	Functioning of landing call button	Functioning/ Not functioning
(v)	Functioning of duplex/group operation at every landing (if applicable)	Functioning/ Not functioning

A-11 RESCUE OPERATIONS

Sr. No	Requirement	Result	Remarks
(i)	Is the automatic rescue device (ARD)installed and operating as per the instructions	Yes / No	
(ii)	Does visual indicator and audible alarm function during operation	Yes / No	

Sr. No	Requirement	Result	Remarks
(iii)	Is the floor level acceptable during the automatic rescue operation	Yes / No	
(iv)	Whether the lift moves when the brake is opened depending upon the inertia	Yes / No	
(v)	Provision of emergency electrical rescue device and its functioning (if applicable)	Functioning / Not functioning	

A-12 FIRE OPERATION

Sr. No	Requirement	Result	Remarks
(i)	Phase I (a) When the fireman switch is activated, all the landing calls to be inoperative and the car shall report to the evacuation floor and the lift doors to be in opened condition (b) If the lift is moving away from the evacuation floor, then it shall reverse its direction at the nearest floor landing without opening its door,and return back to the evacuation floor and remains there itself with the doors open	Functioning / Not functioning	
(ii)	Phase II (if applicable) (a) it will be started after the completion of Phase I along with the fireman switch in ON position (b) In Phase II ,lift should not respond to landing call and when the car call button is prssed , the door should start closing.If the buttom is released before the full closing.If the button is released before the full closure of doors,then the doors should open automatically (c) After the full close of door,the lift should move on to the floor of registered car call (d) The doors should only open if the open button is pressed after reaching the level.If the open button is released before the full opening of doors, then the doors should reclose automatically		

A-13 SAFETY DEVICES

Sr. No	Requirement	Result	Remarks
Instructions: (a) The lift is in ideal condition and the following safety devices get activated,then it should not move further. (b) If the lift is in running condition and the following safety devices get activated, then the lift shall stop and should not move further.			
(i)	OSG – Over speed governor	Functioning/ Not functioning	
(ii)	Car door contact	Functioning/ Not functioning	
(iii)	Landing door contact	Functioning/ Not functioning	
(iv)	Car top stop switches	Functioning / Not functioning	
(v)	Pit stop switches	Functioning / Not functioning	
(vi)	Functioning of screen sensors and door safety edge: 1) Door should reopen,if we cut the screen. 2) Door should reopen,if it hit any object.	Functioning / Not functioning	
(vii)	Check where the car and counter buffers are installed as per the requirement.	Yes/No	
(viii)	Functioning of limit switches so that lift should not travel beyond the limit	Functioning / Not functioning	
(ix)	Brake on its own shall be capable of stopping the machine when the car is travelling downward at rated speed and with the rated load plus 25 percent.	OK/Not Ok	

Sr. No	Requirement	Result	Remarks
(x)	Safety gear test: 1) Lift car safety gear to be tested in down direction with 100 percent rated load in the lift car (during maintenance it shall be tested only in inspection speed) 2) If provided,counter weight safety gear to be tested in up direction of lift car with no load Lift stopping distance depends upon the tripping speed of the govemor and is to be within the range as per the Indian Standard.		

A-14 LEVELLING ACCURACY AND RUNNING CLEARANCE TEST

Instructions:

(a) The levelling accuracy shall be within ± 5 mm of the finished floor level.

(b) The running clearance between the lift car threshold and landing door still should be 30mm

No. of floors: --------------------------

Floors (Landing)	Levelling Accuracy		Running Clearance		
	UP	DN	LH	Centre	RH
1st					
2nd					
3rd					
4th					
5th					
6th					
…..					
…..					
RESULT OK/Not OK					

A-15 Load Test

Sr. No	**Load in Percent**	**Direction to Travel**	**Voltage**	**Current**
			V	**V**
Instructions: (a) With balanced load,the current value in both the up and directions to be same. (b) Check the current only after the lift reaches its rated speed.				
(i)	No load	UP		
		DN		
(ii)	Half load	UP		
		DN		
(iii)	Full load	UP		
		DN		

Item	**Checks**
Controller	Check cabinet is clean,dry and free from dust
Overspeed governor and tension pulley	Check moving parts for free movement and wear Check operation Check switch
Main rope diverter pulely (s)	Check condition and grooves for wear Check bearings for abnormal noise and/or vibrations Check gurading Check lubrication
Car/counter weight guides	Check for film of oil where required on all guide surfaces Check fixings
Car/balancing weight/jack guide shoes	Check guide shoes/rollers for wear Check fixings Check lubrication where necessary
Electric wiring	Check insulation
Lift car	Check emergency lighting , car buttons , key switches Check fixings of panels and ceiling

Item	Checks
Safety gear/pawl clamping devices	Check moving parts for free movement and wear Check lubrication Check fixings Check operation Check switch
Suspension ropes/chains	Check for wear,elongation and tension Check lubrication only where intended
Ropes/chains terminations	Check for deterioration and wear Check fixings
Landing entrances	Check operation of landing locks Check doors for free running Check door guiding Check door gaps Check wire rope,chain or belt when used for integrity Check emergency unlocking device Check lubrication

TYPICAL EXAMPLES OF CHECKS TO BE TAKEN INTO ACCOUNT IN MAINTENANCE INSTRUCTIONS

Item	Checks
Gneral	Check all components are clean and kept free from dust and corrosion
Pit area	Check for excess oil/grease at bottom of guides. Check the pit area is clean,dry and free from debris
Anti-rebound device and switch (where fitted)	Check for free movement and operation Check for equal tension of ropes Check switch where fitted Check lubrication
Buffers	Check oil level Check lubrication Check switch where fitted Check fixings

Item	Checks
Drive motor /generator	Check bearings for wear Check lubrication Check condition of commutator
Gear box	Check gear for wear Check lubrication
Traction sheave	Check condition and grooves for wear
Brake	Check braking system Check parts for wear Check shopping accuracy
Car door	Check door closed contact or lock Check doors for free running Check door guiding Check door gaps Check wire rope,chain when used for integrity Check lubrication
Floor level	Check stopping accuracy at landing
Final limit switches	Check operation
Motor run time limiter	Check operation
Electric safety devices	Check operation Check electric safety chain
Gneral	Check all components are clean and kept free from dust and corrosion
Pit area	Check for excess oil/grease at bottom of guides Check the pit area is clean,dry and free from debris
Buffers	Check oil level Check lubrication Check switch where fitted Check flxings
Tank unit	Check hydraulic fluid level Check tank and valve unit for leakage
Jack	Check for oil leakage
Telescopic jack	Check for synchronization
Controller	Check cabinet is clean,dry and free from dust

Item	Checks
Overspeed governor and tension pulley	Check moving parts for free movernment and wear Check operation Check switch
Main rope pulely (s)	Check condition and grooves for wear Check bearings for abnormal noise and/or vibrations Check gurading Check lubrication
Car/balancing weight/jack guides	Check for film of oil where required on all guide surfaces Check fixings
Car/balancing weight/jack guide shoes	Check guide shoes/rollers for wear Check fixings Check lubrication where necessary
Electric wiring	Check insulation
Lift car	Check emergency lighting,car buttons , key switches Check fixings of panels and ceiling

B-2 HYDRAULIC LIFTS

Safety gear/pawl clamping devices	Check moving parts for free movement and wear Check lubrication Check fixings Check operation Check switch
Suspension ropes/chains	Check for wear,elongation and tension Check lubrication only where intended
Ropes/chains terminations	Check for deterioration and wear Check fixings
Landing entrances	Check operation of landing locks Check doors for free running Check door guiding Check door gaps Check wire rop,chain or belt when used,for integrity

	Check emergency unlocking device Check lubrication
Car door	Check door closed contact or lock Check doors for free running Check door guiding Check door gaps Check wire rope or chain when used for integrity Check passenger door protection device Check lubrication
Floor level	Check stopping accuracy at landing
Final limit switch	Check operation
Motor run time limiter	Check operation
Electric safety devices	Check operation Check electric safety chain Check correct fuses are fitted
Emergency alarm device	Check operation
Landing controls and indicators	Check operation
Well lighting	Check operation
Anti-creep device	Check operation
Rupture valve/one way restrictor	Check operation
Pressure relief valve	Check operation
Manual lowering valve	Check operation
Hand pump	Check operation
Hose/pipe work	Check for damage and leakage
	Check correct fuses are fitted

EXAMPLES OF ELEMENTS TO BE TAKEN IN TO ACCOUNT IN ANY RISK ASSEMENT FOR MAINTENANCE OPERATIONS

Elements	Car	Machinery Spaces	Pulley Spaces	Area Outside the Lift	Pit	Car Roof
Unsuitable access (ladders not secure, no hand rails,unsuitable trap door,obsracle on car roof,etc)	NR	R	R	R	R	R
Unauthorized entry	NR	R	R	R	R	R
Inadequate lighting (including access)	R	R	R	R	R	R
Uneven floor surface (holes,projections)	R	R	R	R	R	R
Elements	**Car**	**Machinery Spaces**	**Pulley Spaces**	**Area Outside the Lift**	**Pit**	**Car Roof**
Slippery floor surface	R	R	R	R	R	R
Strength of floor	R	R	R	R	R	R
Unsuitable dimension (passages, main - tenance spaces)	R	R	R	R	R	R
Indentification of car position	R	R	NR	NR	NR	NR
Indirect contact with electricity	R	R	R	R	R	R
Switches	NR	R	R	R	R	R
Contact with moving parts (ropes,pulleys)	NR	R	R	R	R	R
Unexpected movements	R	R	R	R	R	R
Crushing by moving parts (car, counter-weight)	NR	R	R	R	R	R
Voids between car and well	NR	R	R	NR	NR	R
More than one lift in same area	NR	R	R	R	R	R
Overhead beams and sheaves	NR	R	R	R	R	R
Refuge volume (s)	NR	R	R	NR	R	R
Manual handling	NR	R	R	R	R	R
More than one maintenance person working	NR	R	R	R	R	R

Absence of means of communication	R	R	R	R	R	R
Ventilation and temperature for persons	R	R	R	R	R	R
Dangerous substances	R	R	R	R	R	R
Falling objects	R	R	R	R	R	R
Entrapment	R	R	R	R	R	R
Means/controls for rescue operations	R	R	R	R	R	R
Fire	R	R	R	R	R	R

‘R’ = Relevant and NR = Not relevant.

MNBC -2025 TECHNICAL WORKING GROUP (TWG-5C)
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MYANMAR

NATIONAL

BUILDING

CODE

2025

PART 5E

BUILDING SERVICES

(HEATING, MECHANICAL VENTILATION AND AIR-CONDITIONING SERVICES)

MYANMAR NATIONAL BUILDING CODE – 2025

PART - 5E HEATING, MECHANICAL VENTILATION AND AIR-CONDITIONING SERVICES

CONTENTS

HEATING, MECHANICAL VENTILATION AND AIR-CONDITIONING SERVICES

5E.1 Scope

5E.1.1 This code of practice supplies general guidance in the design, installation, selection, requirements, energy saving, environmental control, testing & commissioning, servicing & maintenance and fire mode requirements for heating, mechanical ventilation and air-conditioning system in the buildings.

5E.1.2 This code shall serve as minimum requirements of Heating, Mechanical Ventilation and Air-Conditioning Systems in buildings to enhance the aspect of Environmental, Occupational Health and Safety.

5E.1.3 However, if deviation from the code is necessary for the particular nature of the buildings and functionality of business, relevant codes / guidelines / standards from American National Standards Institute (ANSI), Air-Conditioning, Heating and Refrigeration Institute (AHRI), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Air-conditioning and Refrigeration European Association (AREA), International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), National Fire Protection Association (NFPA), Underwriters Laboratories (UL) and World Standards Corporation (WSC) shall be applied.

5E.2 Definitions

5E.2.1 Access (to)

That which enables a device, appliance or equipment to be reached by ready access or by a means that first requires the removal or movement of a panel, door or similar obstruction.

5E.2.2 Aggregate Floor Area

The sum of the gross areas of the several floors of a building, measured from the exterior faces of exterior walls or from the centre lines of walls separating two buildings.

5E.2.3 Air-Conditioning, Heating and Refrigeration Institute (AHRI)

Air-conditioning, Heating and Refrigeration Institute that test and certify the performance of Heating, Ventilation, Air-conditioning, Refrigeration and water heating equipment.

5E.2.4 Air Distribution System.

Any system of ducts, plenums and air-handling equipment that circulates air within a space or spaces and includes systems made up of one or more air-handling units.

5E.2.5 Air, Exhaust.

Air being removed from any space, appliance or piece of equipment and conveyed directly to the atmosphere by means of openings or ducts.

5E.2.6 Air Handling Unit

A central air conditioner station that handles the air that, usually, will be supplied into the buildings by the ventilation ductwork.

5E.2.7 Air Lock

A restriction of, or complete stoppage of liquid flow caused by gas trapped in a high point of a liquid-filled pipe system.

5E.2.8 Ambient Temperature

The temperature of the surrounding environment; technically, the temperature of the air surrounding a power supply or cooling medium.

5E.2.9 ATEX (Atmosphere Explosible)

ATEX directive (official instruction) which describes what equipment and work environment is allowed in an environment with an explosive atmosphere.

5E.2.10 Blow Down Loss

The amount of water that is drained from cooling tower to remove mineral from the circulating water of cooling tower.

5E.2.11 Building Envelope

The physical separator between the interior and exterior of a building. Components of the envelope are typically: walls, floors, roofs, fenestrations and doors. Fenestrations are any opening in the structure: windows, skylights, clerestories, etc.

5E.2.12 Building Permit

A permit required in most jurisdictions for new construction, or adding onto pre-existing structures, and in some cases for major renovations.

5E.2.13 Code

These regulations, subsequent amendments thereto, or any emergency rule or regulation that the administrative authority having jurisdiction has lawfully adopted.

5E.2.14 Condensate

The liquid phase produced by the condensation of vapour extracted from moist air through the cooling coils of air-conditioner.

5E.2.15 Condenser

A unit or device or pipe arrangement that condense a substance from its gaseous to its liquid state by removing of heat.

5E.2.16 Control

To regulate the operation of equipment.

5E.2.17 Commercial Kitchen

A room or part of a room used for cooking and food preparation in a commercial establishment to make food for selling purposes.

5E.2.18 Control System

Control system is an interconnection of components forming a system configuration that will provide a desired system response.

5E.2.19 Cooling Tower

A heat removal device that remove heat from the water stream through the evaporation process.

5E.2.20 Cooling Tower Institute (CTI)

A technical association dedicated to improvement in technology, design, performance and maintenance of cooling towers.

5E.2.21 Climate Zones

Divisions of the Earth's climates into general climate zones according to average temperatures and average rainfall. The three major climate zones on the Earth are the polar, temperate, and tropical zones.

5E.2.22 City Water

Water supply from city development committee.

5E.2.23 Combustion Air

Air that is supplied for burning of fuel such as gas, oil and wood.

5E.2.24 Damper

A manually or automatically controlled device to regulate draft or the rate of flow of air or combustion gases.

5E.2.25 Direct Heating Equipment

A device uses for space heating purposes such as space heaters, wall heaters, floor heaters, and room heaters, they are predominantly fired with natural gas or propane.

5E.2.26 Double Sealed

A device or mechanism to close off an opening to prevent the escape of a liquid or gas.

5E.2.27 Drift Eliminator

The block of thin PVC sheets which eliminates the water droplets and mist from escaping the cooling tower.

5E.2.28 Drift Loss

The amount of water droplets carrying over into the air stream of cooling tower discharge.

5E.2.29 Dry Bulb Temperature (DBT)

The temperature of air measured by a thermometer freely exposed to the air but shielded from radiation and moisture. DBT is the temperature that is usually thought of as air temperature, and it is the true thermodynamic temperature.

5E.2.30 Duct

A tube or passageway in a building or machine made with sheet metal or other suitable material for delivery of air.

5E.2.31 Duct System

A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling equipment and appliances.

5E.2.32 Energy

The capacity for doing work. It takes a number of forms that may be transformed from one into another such as thermal (heat), mechanical (work), electrical, and chemical.

5E.2.33 Energy efficiency

Using less energy to provide the same service.

5E.2.34 Energy Recovery Efficiency

Utilizing of waste energy to cool or heat the fresh air.

5E.2.35 Exit

A way out of a building or room from interior to exterior such as exit staircase, exit door, exit passageway, etc.

5E.2.36 Euro vent Class D1

European standard that require Mechanical strength of Casing with maximum relative deflection of 4mm per meter at design operating pressure.

5E.2.37 Euro vent Class L1

European standard that require Air Leakage rate of Casing with maximum leakage rate of 0.15 l/s per square meter at 400 Pascal negative pressure and 0.22 l/s per square meter at 700 Pascal positive pressure.

5E.2.38 Evaporator Loss

The amount of water being evaporated from a circulating water during evaporative cooling process of cooling tower.

5E.2.39 Fenestration

All areas (including the frames) in the building envelope that let in light, including windows, plastic panels, clerestories, roof monitors, skylights, doors that are more than one-half glass, and glass block walls.

5E.2.40 Fire Damper

A listed device installed in ducts and air transfer openings designed to close automatically upon detection of heat and to restrict the passage of flame. Fire dampers are classified for use in either static systems that will automatically shut down in the event of a fire, or in dynamic systems that continue to operate during a fire. A dynamic fire damper is tested and rated for closure under elevated temperature airflow.

5E.2.41 Fireplaces

A fire chamber and hearth (the floor of fire space) constructed of non-combustible material for use with solid fuel and provided with a chimney.

5E.2.42 Gross Roof Area

The area of the roof measured from the exterior faces of walls or from the centerline of compartment walls, gross.

5E.2.43 Heat Pump

A device that transfers heat from a colder area to a hotter area by using mechanical energy.

5E.2.44 Hydronic Heating Coils

A coil that uses of water or another liquid for heating purposes.

5E.2.45 Hydrostatic Pressure

The pressure exerted by a fluid at equilibrium at a given point within the fluid, due to the force of gravity.

5E.2.46 Ignition Source

A flame, spark or hot surface capable of igniting flammable vapors or fumes. Such sources include appliance burners, burner ignitors and electrical switching devices.

5E.2.47 Infiltration

Air that flows inward through a wall, door gaps, window gaps, etc.

5E.2.48 Institutional

The real estate development for religious, educational, professional, or social purpose.

5E.2.49 IP Rating

The International Protection Rating of a product representing the protection rating against solid foreign objects and the ingress of water.

5E.2.50 Japanese Industrial Standard (JIS)

The standard coordinated by the Japanese Industrial Standards Committee for industrial activities in Japan.

5F.2.51 Kitchen Exhaust

The exhaust from kitchen hoods to capture smoke and/or grease-laden vapor produced by a cooking process or the exhaust for cooking area of a kitchen or combination of the above.

5E.2.52 Kilowatt (kW)

The basic unit of electric power, equal to 1,000W (watt).

5E.2.53 Labeled

Equipment, materials or products to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and whose labeling indicates either that the equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

5E.2.54 Legionella Bacteria

A pathogenic group of Gram-negative bacteria which can cause a pneumonia type illness.

5E.2.55 Makeup Air

Outdoor air deliberately brought into the building from the outside and supplied to the vicinity of an exhaust hood to replace air, vapor, and contaminants being exhausted. Makeup air is generally filtered and fan-forced, and it may be heated or cooled depending on the requirements of the application. Makeup air may be delivered through outlets integral to the exhaust hood or through outlets in the same room.

5E.2.56 Makeup Water

Water supply into the cooling tower basin to make up the water loss caused by evaporation, drift loss and blow down process.

5E.2.57 Makeup Water Quality Test

Verification of chemical, physical, biological, and radiological characteristics of the water.

5E.2.58 Mean Radiant Temperature (MRT)

The uniform temperature of an imaginary enclosure in which the radiant heat transfer from the human body is equal to the radiant heat transfer in the actual non-uniform enclosure.

5E.2.59 Mean Value

The average value of the set of numbers.

5E.2.60 Natural Ventilation

The movement of air into and out of a space through intentionally provided openings, such as windows and doors, or through non-powered ventilators.

5E.2.61 Outdoor (outside) air

Air that is outside the building envelope or is taken from outside the building that has not been previously circulated through the building.

5E.2.62 Outdoor Opening

A door, window, louver or skylight openable to the outdoor atmosphere.

5E.2.63 Prescribed

State authoritatively or as a rule that (an action or procedure) should be carried out.

5E.2.64 pH Level

A figure expressing the acidity or alkalinity of a solution on a logarithmic scale.

5E.2.65 Professional Installer

People who carried out installation works of equipment / services approved or recognized by relevant manufacturers or government authorities.

5E.2.66 Registered Company

Company registered officially at government authorities under the current companies' acts and whose name is on the official records of Registrar of Companies.

5E.2.67 Reheating

Raising the temperature of air that has been previously cooled either by mechanical refrigeration or an economizer system.

5E.2.68 Relative Humidity

The ratio of the amount of water vapour present in air expressed as a percentage to the amount of water vapour in saturated air at the same temperature and pressure.

5E.2.69 Residential

The real estate development for residential purposes.

5E.2.70 Service Life

An expected lifetime, or the acceptable period of use in service.

5E.2.71 Space

A part of a building that is not necessarily separated by walls and floors. A space can be large, like an aircraft hangar, or small, like a personal office.

5E.2.72 Space Heating

Heating of spaces especially for human comfort by means of fuel, electricity, or solar radiation and etc.

5E.2.73 Skylight

A fenestration surface having a slope of less than 60 degrees from the horizontal plane. Other fenestration, even if mounted on the roof of a building, is considered vertical fenestration.

5E.2.74 Solar Heat Gain Coefficient (SHGC)

The ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

5E.2.75 Standard Plate Count Test

A determination of the degree of bacterial contamination of a sample.

5E.2.76 Thermal Comfort

The condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation.

5E.2.77 Thermal Conductivity

The property of a material to conduct heat.

5E.2.78 Thermal Resistance (R-value)

The reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions ($m^2 \cdot K/W$).

5E.2.79 Thermal Transmittance (U-factor)

Heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side ($W/m^2 \cdot K$).

5E.2.80 UL (Underwriters' Laboratories)

Underwriters' Laboratories which conduct product safety testing and certification.

5E.2.81 Unitary Air-Conditioner

One or more factory-made assemblies that normally include an evaporator or cooling coil and a compressor and condenser combination. Units that perform a heating function are also included.

5E.2.82 Unvented Fuel-Fired Appliances

A fuel-fired appliance that operates without positive vent static pressure and vent gas temperature.

5E.2.83 Ventilation

The process of exchanging or replacing air in any space to provide required indoor air quality which involves temperature control, oxygen replenishment, and removal of moisture, odors, smoke, heat, dust, airborne bacteria, and carbon dioxide.

5E.2.84 Water Hammer

Pressure surge or wave caused when a fluid (usually a liquid but sometimes also a gas) in motion is forced to stop or change direction suddenly (momentum change).

5E.2.85 Water Treatment

A process that makes water acceptable for a specific end-use.

5E.2.86 Water Turbulence

A phenomenon involving the irregular motion of fluids, studied in fluid dynamics.

5E.2.87 Well Water

The underground water that is held in the soil and in pervious rocks.

5E.2.88 Wet-Bulb Temperature (WBT)

The lowest level of temperature that can be obtained through evaporative cooling of a ventilated surface covered with ice or wet with water.

5E.2.89 Zone

A "zone" is a part of a building whose Air-Conditioning & Mechanical Ventilation system is controlled by a single sensor. The single sensor is usually, but not always, a thermostat. Either directly or indirectly, a thermostat controls the temperature at its location.

5E.3 Rules and Regulations to Comply

The heating, mechanical ventilation and air-conditioning system shall be designed and carried out to comply the relevant acts, regulations, laws, codes and associated documents issued by the following authorities and organizations.

A) Relevant Ministries

B) Myanmar Engineering Council

C) Federation of Myanmar Engineering Societies

D) High-Rise and Public Building Projects Committee (HPBC)

E) Myanmar Fire Services Department

5E.4 Heating System

This section covers the design and installation of the heating system.

5E.4.1 Space Heating System

5E.4.1.1 The space heating system should be provided for locations with low ambient temperature beyond the human comfort level. The interior spaces intended for human occupancy shall be maintained the indoor temperature of not less than 20°C at a point 900 mm above floor for heating.

5E.4.1.2 When calculating space heating load, typical load shall be envelope thermal heat loss and outdoor air treatment. Heat gains, such as solar heat gain and internal heat gain from lighting and occupants should not be considered.

5E.4.1.3 Space heating system shall be designed and installed in accordance with applicable safety standards such as UL Standards or equal or Energy Conservation Guidelines and Handbook from relevant Ministries.

5E.4.1.4 Adequate venting shall be provided for fuel-fired appliances to prevent accumulations of carbon monoxide and other toxic gases. Unvented fuel-fired appliances shall not be utilized for space heating.

5E.4.1.5 Adequate combustion air shall be provided in accordance with the appliance of manufacturer’s installation instructions and applicable codes.

5E.4.1.6 Heating system should not be installed in any hazardous locations. Electric heaters rated and certified for such hazardous application may be used with the approval from the authority having jurisdiction. Certification shall be ATEX, UL or equal. Fireplaces and solid fuel-burning appliances shall not be installed in hazardous locations.

5E.4.1.7 Adequate clearance for maintenance and safe operation of the appliances shall be provided as per manufacturer’s instruction and applicable safety standards.

5E.4.2 Air Heating Coils

5E.4.2.1. Electric Duct Heaters or Electric Heating Coils shall be installed in accordance with the manufacturer’s installation instructions and MNBC Part 5B Electrical and Allied Installation.

5E.4.2.2 The coil assembly shall comply with UL 1996 or equivalent safety standards. The coils shall be made of corrosion resistant heating elements.

5E.4.2.3 Electric duct heaters shall be provided with overheat protection, reset devices, air flow interlock switch, contactors, transformers, door interlock switch, local non-fused disconnect switch that is prewired, and controls for safe operation and maintenance.

5E.4.2.4 The maximum leaving air temperature shall not exceed 48.9°C. Maximum discharge air temperature at air diffuser should be limited to 35°C. Proportional controls such as SCR (Semiconductor-Controlled Rectifier) should be utilized for energy efficiency and temperature stability.

5E.4.2.5 Where heaters are indicated to be installed in ductwork, provide manufacturers recommended minimum size, upstream and downstream ductwork to prevent overheating. Minimum 1.2 meter of straight unlined sheet metal ductworks should be provided from downstream of any heat pumps, central air conditioners, air filters, or upstream of humidifier or any branch take-offs.

5E.4.2.6 As a general guide, minimum duct velocity should be designed so that the temperature rise across the heater should not exceed 34°C and the resulting duct velocity should be between 1.5 m/s to 6.0 m/s. Hydronic Heating Coils shall be installed in accordance with the manufacturer's installation instructions.

5E.4.3 Electric Unit Heaters

5E.4.3.1 Electric Unit Heaters shall be installed in accordance with the manufacturer's installation instructions. Unit heaters shall meet all requirements of UL listing standard 1025 and relevant standards.

5E.4.4 Fireplaces

5E.4.4.1 Masonry fireplaces shall be constructed in accordance with the Myanmar National Building Code (MNBC). International Building Codes (IBC) shall be referenced if the requirements are not specified in MNBC.

5E.4.4.2 Factory-built fireplaces shall be listed and labeled approved in accordance with UL 127 and relevant Standards.

5E.4.4.3 The central heating plant should be located at a convenient central location that can distribute a secondary heating medium (hot water or steam) throughout a building or a multi building complex. The diversity of individual zone loads and the maintenance activities should be taken into consideration when selecting the location of the plant.

5E.4.4.4 The choice of fuel should be made on the basis of life-cycle cost. Consider the dual-fuel burners (oil / propane or gas) when selecting combustion boilers. If electric boilers are considered, make a selection based upon more than just low first cost.

5E.4.4.5 The furnace as heat source for direct heating of air for space conditioning should be considered for small office buildings, residences, and industrial plants.

5E.5 Mechanical Ventilation System

This section covers the design and installation of the mechanical ventilation system

5E.5.1 Deliberations of Design

5E.5.1.1 General

5E.5.1.1.1 The purpose of the ventilation is to maintain the acceptable indoor air quality by changing the air in an enclosed space. The required amount of air in the space should be continuously withdrawn and replaced by the fresh air drawn from the external sources to maintain the required level of air purity, oxygen content and temperature as well as to control the contaminants, carbon dioxide, bacteria and odor.

5E.5.1.1.2 The appropriate air filters / filtration system shall be introduced at the fresh air intake to meet the requirement of indoor air quality specified in “Air Quality Control” section.

5E.5.1.2 Fire Damper Installation

5E.5.1.2.1 Fire dampers shall not be fitted in the following locations.

- Opening in the walls of a smoke extract shaft or return air shaft which also serves as smoke extract shaft
- Openings in the walls of protected shaft where the openings have a kitchen exhaust duct passing through it.
- Anywhere in an air pressurizing system
- Air outlet at exit staircases / internal exit passage way

5E.5.1.2.2 Fire dampers shall be fitted in the following locations.

- Ventilation duct passing directly through a fire compartment wall or floor
- Where the ventilation duct forms a protected shaft or is contained within a protecting structure, the duct shall be fitted with fire dampers at the inlets to the shaft and outlets from it.

5E.5.1.2.3 An inspection access door shall be provided for each fire damper installation either upstream or downstream as appropriate. The minimum dimension of the access door shall be 450mm (width) x 450mm (length). The dimension may be reduced for the smaller ducts according to width or depth of the duct.

5E.5.2 Ventilation Rates

5E.5.2.1 Outdoor Air Supply for Mechanical Ventilation

5E.5.2.1.1 The values given in Table 5E.5.2.1 is the minimum requirement of the air change per hour rate for non air-conditioning area. Designers shall make the judgment to further increase depending on the location of the building, the environmental condition, the outdoor air quality and the type of activities carried out in the building.

5E.5.2.1.2 If the requirement is not provided in Table 5E.5.2.1, the ventilation rate shall be further referred to the ASHRAE standard or it shall be determined by the Qualified Person (QP) subject to the approval of relevant authorities.

Table 5E.5.2.1
Outdoor Air Supply for Mechanical Ventilation in Non Air-conditioned Building or parts of Building with No Natural Ventilation

Building / Occupancy Category	**Minimum Outdoor Air Supply air-change / hour (ACH)**
Office	6
Workshop	6
Shopping Center	6
Market	6
Corridor	4
Lift Lobby	4
Restaurant & Canteen	10
General Store *	4
Electrical Rooms, Mechanical Rooms	6 or Room temperature not more than 5 Deg C from outdoor whichever is higher
Private Toilet	10
Public Toilet	15
Smoke Stop Lobby (during normal operation)	4
Fire Fighting Lobby (during normal operation)	4
Internal Exit Stair Case (during normal operation)	4

* Where hazardous gas/liquids are used or stored, Qualified Person's advice shall be sought on the ventilation rate and means of ventilation in the event of emergency situation and as advised by relevant authority.

5E.5.3 Car Parks

5E.5.3.1 General Requirements

5E.5.3.1.1 Mechanical Ventilation System shall be provided for the car parking areas in the building to remove carbon monoxide and other gases emitted from the combustion of materials from these areas.

5E.5.3.1.2 Minimum of six air-changes per hour is required for the mechanical ventilation system (supply and exhaust) for car parking areas in the building if natural ventilation is not available.

Where the ceiling height exceeds 2.5 m, the air-change rate will be calculated based on 2.5 m ceiling height.

5E.5.3.1.3 Carbon monoxide sensor / detector shall be installed at car parking areas including the driveway.

5E.5.3.1.4 If Carbon monoxide concentration level is below 25 ppm averaged over a one-hour duration, the mechanical ventilation system may be switched off (for residential building car parking areas) and may be operated at lower rate (for commercial building car parking areas).

5E.5.3.1.5 Minimum 50% of the exhaust air shall be extracted at low level (highest level is 650mm from finished floor level to top edge of the exhaust air grille).

5E.5.3.1.6 Exhaust air shall not be discharged to the face of any adjacent building and public walkways.

5E.5.3.1.7 Exhaust air discharge point shall not be less than five meters away from any fresh air intake points.

5E.5.3.1.8 Supply air shall be withdrawn directly from the outer surface of the building.

5E.5.3.1.9 Fume extract system shall be provided as follows

(a) The extract system shall be able to provide 1.2 air changes per hour;

(b) The supply part can be omitted;

(c) The extract points shall be wholly located at low level not exceeding 650 mm above the finished floor, as measured from the top of the grille to the finished floor;

5E.5.3.2 Aboveground Car Park

5E.5.3.2.1 Mechanical ventilation system shall be provided as per Table 5E.5.3.1

Table 5E.5.3.1

Mechanical Ventilation Requirements for Above ground Car Park

Natural Ventilation Opening *	**Mode of Ventilation to be provided**	**Distance between natural ventilation opening and car parking areas**
Not less than 15%	NV **	Within 12 m
Not less than 15%	Fume Extract (1.2 ACH)	Beyond 12 m
Not less than 2%	MV without supply	Within or beyond 12 m
Less than 2%	MV ***	Within or beyond 12 m

* % of the floor area served, ** Natural Ventilation, *** Mechanical Ventilation

5E.5.3.2.2 When a smoke purging system for the aboveground car park is required, it shall comply with the requirements of the Myanmar Fire Safety Code (MFSC).

5E.5.3.3 Basement Car Park

5E.5.3.3.1 It shall be maintained under negative pressure all the time to prevent the spread of poisonous gases into the adjacent areas.

5E.5.3.3.2 The quantity of replacement air shall not exceed that of exhaust air.

5E.5.3.3.3 The system shall be designed with minimum of two sections to comply the following requirements.

a) In the event of a failure of another section, the other section shall continue to operate and should be able to provide half of the total required air quantity for the areas.

b) In the failure of any section of the exhaust part, the relevant section of the supply part shall shut-down automatically and vice versa.

c) Secondary source of electrical power supply shall be provided to the exhaust and the supply parts to continue the operation automatically in the event of a failure in principal source of electrical power supply.

5E.5.3.3.4 Independent mechanical ventilation system shall be provided for individual different level of the car park.

5E.5.3.3.5 Mechanical ventilation system shall be provided as per Table 5E.5.3.2

Table 5E.5.3.2

Mechanical Ventilation Requirements for Basement Car Park

Natural Ventilation Opening *	**Mode of Ventilation to be provided**	**Distance between natural ventilation opening and car parking areas**
Not less than 15%	Fume Extract (1.2 ACH)	Within 12 m
Not less than 15%	Fume Extract (1.2 ACH)	Beyond 12 m
Not less than 2%	MV without supply	Within or beyond 12 m
Less than 2%	MV **	Within or beyond 12 m

* % of the floor area served, ** Mechanical Ventilation

5E.5.3.3.6 When a smoke purging system for the basement car park is required, it shall comply with the requirements of the Myanmar Fire Safety Code (MFSC).

5E.5.4 Kitchen

5E.5.4.1 Kitchen areas shall be mechanically ventilated. If the conditioned air supplied is required for the replacement of the kitchen exhaust, the energy saving requirement shall comply with the requirement stated in part of this code.

5E.5.4.2 Mechanical exhaust system for the kitchen shall be stand alone and independent. The system shall be designed, installed and operated in such a way that kitchen area shall always maintain in negative pressure.

5E.5.4.3 Grease filters shall be incorporated in kitchen hood wherever grease is present.

5E.5.4.4 The minimum ventilation rate required for the kitchen is 20 Air Change per Hour. However, it shall be higher than 20 Air Change per Hour depending on the type of hood, size of hood, type of appliances and usage of the kitchen.

5E.5.4.5 The ventilation rate may be reduced to 10 Air Change per hour when the kitchen hood is not in operation.

5E.5.4.6 The kitchen exhaust duct shall be designed in the way that the horizontal exhaust duct from the kitchen hood connecting to the vertical riser shall have minimum gradient / slope (not less than 0.5%) backward to the kitchen hood and it shall have grease collection point by providing the trap in the duct.

5E.5.4.7 The make-up air shall be interlocked with kitchen hood exhaust operation in order to supply the make-up air when the exhaust hood is in operation.

5E.5.4.8 For the commercial and/or heavy usage kitchen, the exhaust air shall be treated with appropriate filtration system before discharging to the environment.

5E.5.4.9 The kitchen exhaust shall be discharged directly to the outside of the building and away from the public areas of the building. The discharge point shall be located at the place that is more than 5m apart from the air intake openings.

5E.5.4.10 Ducts for the kitchen exhaust system shall be make from the below materials.

a) Mild steel of thickness not less than 1.2mm or
b) Stainless steel of thickness not less than 0.9mm

5E.5.5 Ventilation Duct System

5E.5.5.1 Mechanical ventilation system for each exit staircase and internal exit passage way, if provided, shall be an independent system.

5E.5.5.2 Supply air for the system shall be drawn directly from the external, with intake point not less than 5 m from any exhaust discharge openings.

5E.5.5.3 Where the supply air duct serving the exit staircase has to penetrate the staircase enclosure, the portion of the duct where it traverses outside the staircase shall be enclosed in masonry construction or drywall; it is at least same fire resistance as the elements of structure.

5E.5.5.4 The kitchen hood and ducts for the exhaust shall have a clearance of 500 mm from unprotected combustible materials.

5E.5.5.5 There shall be regular cleaning and maintenance of the kitchen exhaust system.

5E.5.5.6 The kitchen exhaust duct where it runs outside the kitchen shall be constructed with fire rated enclosure to give at least the same fire rating as the kitchen or that of the room through which it traverses, whichever is higher.

5E.5.5.7 The toilet area shall be well-ventilated by natural or mechanical means to remove odours and to keep the floors dry.

5E.5.5.8 The exhaust system shall dispel the air directly outdoors without causing any nuisance to neighboring premises.

5E.5.6 Equipment Selection

5E.5.6.1 Mechanical Ventilation Fan

5E.5.6.1.1 The followings shall be considered as minimum requirement for the selection of the fans. The fans shall be entirely suitable to their particular application.

- Volume flow rate
- Developed pressure (friction loss due to the air movement through convey medium such as ducting, filters, intake, outlet, etc.)
- Efficiency for both motor and fan
- Noise level
- Type of application
- Special attention for kitchen exhaust, corrosive fume, abrasive particles in the air stream, flammability or other hazardous application.

5E.5.6.1.2 It shall be selected in a way that minimum 10% increase in speed is allowed for alteration if necessary at site. Motors, starters, wiring and other components shall be selected accordingly.

5E.5.6.1.3 The following parameters shall be considered for the installation of the fans as minimum requirement.

- Space availability for installation and future maintenance
- Permissible weights and floor loading at final location as well as access route to deliver the fans
- Position of inlet (s) and outlet (s) and direction of discharge
- Recommended noise level at the installed location
- Vibration of the equipment
- Fire Hazards of the installed location

5E.5.6.1.4 The Fans shall be balanced both statically & dynamically and should be certified in accordance with the AMCA (Air Movement & Control Association) or another recognized/ approved standard.

5E.5.6.1.5 The full details but not limited to the followings shall be fitted with engraved identification. It shall be mechanically fixed where they can be easily seen and not prone to potential damage.

- Type
- Speed
- Power, Phase, Hz
- Pulley and Belt Size
- Type of grease required

5E.5.6.1.6 The motor shall not be within the air-stream for kitchen exhaust and similar application.

5E.5.6.1.7 All fans including motors within the air-stream of Smoke Control/ Purging System shall be able to withstand up to 250˚C for 2 hours.

5E.5.6.1.8 All fans including motors, electrical accessories, control panels, etc. mounting at the fuel storage area, LPG gas storage area or other area where it is sensitive to fire hazard shall be spark proof type as minimum requirement.

5E.5.6.2 Sound Control Devices

5E.5.6.2.1 The sound generated from equipment, piping, ducting, grilles and diffusers shall minimize / control to achieve the required noise level listed in clause 5E.10.3.2.

5E.5.6.2.2 The equipment shall be designed, located, selected and installed in a way that intensive consideration is given each and every step of the process to minimize the sound generating and transmission from the equipment.

5E.5.6.2.3 The followings devices/methods should be incorporated in the system to minimize the sound transmission from the equipment.

- Duct Attenuators – rectangular or circular cross section with various internal air passage ways formed by sound absorbing material such as glass wool or mineral wool which is incombustible, encased by the finely perforated galvanized steel or constructed with other approved method. It should be aerodynamically and acoustically designed to deliver required amount of attenuation across a broad spectrum of sound frequencies while maintain low pressure drop across the attenuator. The direction of airflow shall be clearly indicated.

- Duct Internal Acoustic Lining (duct internal insulation) – material shall comply with the requirement specified in clause 5E.7.3.6. It shall have high sound absorption coefficient to reduce the transmission of noise along the air distribution and may be designed to achieve the purpose of both sound absorption and thermal insulation. The same construction method with duct attenuators may adopt to minimize the ingress of lining material into airstream.
- Grilles, Louvers and Diffusers – It shall be selected and installed to avoid the noise generated due to excessive air velocity.
- Usage of Other Material for Reduction of Noise – When selecting other material such as external insulation of piping, ducting and duct fitting, the noise reduction should be considered as one of the important factor.

5E.5.6.3 Vibration Control Devices

5E.5.6.3.1 The anti-vibration devices such as spring isolator, spring and/or neoprene hanger, inertia base and combination of such devices shall be provided for all equipment with rotating or reciprocating components to prevent the transmission of vibration and structure borne transmission of sound through the building structure. No direct mounting on the building structure is allowed.

5E.5.6.3.2 Anti-vibration devices shall also be provided at the supporting system of pipe and duct to prevent the transmission of vibration to the building structure.

5E.5.6.3.3 In addition, appropriate flexible connection shall be utilized at the connection to the equipment. It shall apply to both pipe and duct connection.

5E.5.6.3.4 It is recommended that selection of such anti-vibration devices should be carried out by the competent person.

5E.5.6.3.5 Spring type isolator should be free standing, laterally stable and complete with top and bottom load plates and levelling bolt.

5E.5.6.3.6 Anti-vibration hanger shall consist of a steel spring or neoprene pad or combination of both in series and encased in a welded bracket. It shall be installed at the location where severe flow conditions, potential to water hammer or sensitive to vibration and noise.

5E.5.6.3.7 The mechanical equipment shall be directly mounted on the inertia base. The size, weight and material of the inertia base shall be in accordance with the manufacturer recommendation subject to approval.

5E.6 Air-conditioning System

This section covers the design and installation of the air-conditioning system.

5E.6.1 Deliberations of Design

5E.6.1.1 Air-conditioning system should consider availability of space, energy source, reliability and energy efficiency. Noise and heat from the condenser unit (outdoor unit) of air conditioner shall not create nuisance to the neighbours.

5E.6.1.2 The objective of air-conditioning system implementing in the building is to provide safe and comfort environment for the building occupants.

5E.6.1.3 The outdoor air intakes which is covered by the insect screen shall be kept a minimum 5 meter away from the any exhaust outlet, cooling tower and any other sources which can deteriorate the quality of indoor air.

5E.6.1.4 In addition, outdoor air intake shall be kept minimum 10 meter away from the noxious or dangerous exhaust which contains highly objectionable fumes or gases and/or exhaust air with potentially dangerous particles, bio aerosols, or gases at concentrations high enough to be considered harmful.

5E.6.1.5 The indoor design temperature for comfort air-conditioning should be 24±1 °C and relative humidity should not exceed of 65%.

5E.6.1.6 The air speed within the occupied space should be designed not to exceed 0.30 m/s measured at the occupants' level 1500mm from the floor.

5E.6.1.7 The Design Outdoor Air Conditions for the Capitals in Myanmar are shown in Table 5E.6.1.

Table 5E.6.1

The Design Outdoor Air Conditions for the Capitals in Myanmar

Sr No.	**State / Region**	**Capital**	**Weather Station**	**Dry-Bulb Temperature** (℃)	**Mean Coincident Wet-Bulb Temperature** (℃)
1	Naypyitaw Union Territory	Naypyitaw	Pyinmana	39.4	24.1
2	Kachin	Myitkyina	Myitkyina	34.0	21.0
3	Kayar	Loikaw	Loikaw	34.4	21.0
4	Kayin	Hpa-an	Hpa-an	37.9	25.7
5	Chin	Hakha	Hakha	25.4	15.0
6	Chin	Mindat*	Mindat	31.0	16.1
7	Sagaing	Sagaing	Sagaing	39.0	24.0
8	Tanintharyi	Dawei	Dawei	35.7	25.3
9	Bago	Bago	Bago	38.5	25.0
10	Magway	Magway	Magway	41.4	25.0
11	Mandalay	Mandalay	Mandalay	39.7	23.0
12	Mon	Mawlamyine	Mawlamyine	36.4	25.9
13	Rakhine	Sittwe	Sittwe	33.7	25.9

Sr No.	State / Region	Capital	Weather Station	Dry-Bulb Temperature (℃)	Mean Coincident Wet-Bulb Temperature (℃)
14	Yangon	Yangon	Kabaraye	38.2	25.7
15	Shan	Taunggyi	Taunggyi	30.1	17.0
16	Ayeyarwaddy	Pathein	Pathein	37.6	25.5

Remark
Mindat* is not the capital of Chin State. But the design outdoor temperature for Mindet is shown in table for cooling purpose.

5E.6.2 Outdoor Air Requirement for Comfort Air-conditioning

5E.6.2.1 The values given in Table 5E.6.2 is the minimum requirement of the outdoor air supply for the comfort air-conditioning. Designers shall make the judgment to further increase depending on the location of the building, the environmental condition, the outdoor air quality and the type of activities carried out in the building.

Table 5E.6.2 Minimum requirement of the outdoor air supply for the comfort air-conditioning

Building/Occupancy Category	Occupancy Load	Minimum Outdoor Air Supply base on people (l/s per person)	Minimum Outdoor Air Supply base on floor area (l/s per m2)
Office	10 m^2 /person	6	0.6
Conference/Seminar Room	2.5 m^2 /person	6	0.3
Hotel Guest Room	-	-	50 m^3 / hr per room
Workshop	10 m^2/person	3.5	-
Night Club	1.5 m^2 /person	10	7.0
Shopping Center	5 m^2 /person	3.5	1.1
Market	5 m^2 /person	3.5	1.1
Lobbies and Corridor	-	-	0.3
Class rooms	2 m^2 /person	3.8	0.6
Restaurant & Canteen	1.5 m^2 /person	6	3.4
Theatres, Auditorium and Cinemas	-	3 l/s per seat	2.0

5E.6.3 Air Quality Control

5E.6.3.1 Deliberation of Design

5E.6.3.1.1 Engineers who are undertaking the design of air quality control should be familiar with the fundamentals of indoor environmental health design, operation and maintenance of building and its associated systems.

5E.6.3.1.2 The system shall design to reduce the exposure of occupants to potential hazards.

5E.6.3.1.3 The indoor air quality parameters mentioned are ground level ozone, volatile organic chemicals, air temperature, relative humidity, carbon monoxide and carbon dioxide.

5E.6.3.1.4 Air Classifications

a) Class 1 – Air with low contaminant concentration, low sensory-irritation intensity and inoffensive smell.

b) Class 2 – Air with moderate contaminant concentration, mild sensory-irritation intensity or mildly offensive smell.

c) Class 3 – Air with significant contaminant concentration, significant sensory-irritation intensity or offensive smell.

d) Class 4 – Air with highly objectionable fumes or gases or with potentially dangerous particles, biological aerosols, or gases, at concentration high enough to be considered dangerous.

5E.6.3.1.5 Limitation for Air Recirculation

a) Class 1 air is allowed to recirculate or convey to any space.

b) Class 2 air is allowed to recirculate within the space of origin. It is allowed to convey to other class 2 or 3 spaces provided for the same usage and similar purpose with same pollutant sources. Class 2 air is not allowed to recirculate or convey to class 1 spaces.

c) Class 3 air is allowed to recirculate within the space of origin. Class 3 air is not allowed to recirculate or convey to any other space.

d) Class 4 air is not allowed to recirculate within the space of origin and not allowed to convey to any other space.

5E.6.3.1.6 Air from toilets, bathrooms, kitchen, storage areas for flammable and toxic gases and where dust and smell likely to be presented shall not be recirculated.

5E.6.3.1.7 Filtration of particles shall be provided for outdoor air and recirculated indoor air before convey to the space.

5E.6.3.1.8 The double stage air filtration shall be provided for cleaning the air in all air-handling units. The Minimum Efficiency Reporting Value (MERV) for air filtration shall be equivalent to the following requirements.

a) Primary Air Filtration – MERV 6 or better

b) Secondary Air Filtration – MERV 12 or better

5E.6.3.1.9 The air filtration for cleaning outdoor air to pre-cooled fan coil units /air handling units should be equivalent to MERV 6 or better.

5E.6.3.1.10 Suitable air treatment should be considered when the outdoor air introduced into the building at Air-conditioning & Mechanical Ventilation design. Minimum Efficiency Reporting Value (MERV) of 6 or better rated air filters should be provided to clean the outdoor air before introduction into the indoor environment.

5E.6.3.1.11 The number of people at occupancy space should be considered when designing the outdoor air requirement for Air-conditioning & Mechanical Ventilation system.

5E.6.3.1.12 Differential pressure sensor could be installed in the ACMV system to monitor the condition of air filters and to accurately determine when the filters should be replaced.

5E.6.3.1.13 Smoking areas should be separated from non-smoking areas and smoking areas should be at negative pressure with respect to any adjacent non-smoking areas.

5E.6.3.1.14 Recirculation or transferring of air from smoking areas to non-smoking areas is strictly prohibited.

5E.6.3.1.15 Exhaust ducts that convey potentially harmful contaminants shall be negatively pressurized relative to spaces through which they pass, so that exhaust air cannot leak into occupied spaces; supply, return or outdoor air ducts or plenums.

5E.6.3.1.16 Outdoor air intake for ventilation system shall be complied with the Table 5E.6.3.1

Table 5E.6.3.1 – Air Intake Minimum Separation Distance

Descriptions	**Minimum Distance (meter)**
Class 2 air exhaust / relief outlet	3
Class 3 air exhaust / relief outlet	5
Class 4 air exhaust / relief outlet	10
Cooling Tower Intake or basin	5
Cooling Tower exhaust	7.5
Driveway, street, or parking place	1.5
Garbage storage / pick up area, dumpsters	5
Thoroughfare with high traffic volume	7.5
Plumbing vents terminating less than 1 m above the level of the outdoor intake	3
Plumbing vents terminating at least 1 m above the level of the outdoor intake	1

Descriptions	Minimum Distance (meter)
Vents, chimneys and flues from combustion appliances and equipment	5
Truck loading area or dock, bus parking / idling area	7.5

5E.6.3.1.17 Louvers for outdoor intake shall be completed with insect screen and protected from rain entrainment.

5E.6.3.1.18 Louvers for exhaust air shall be completed with wire mesh.

5E.6.3.2 Guidelines for Good Indoor Air Quality in Office Premises

5E.6.3.2.1 Building owner should take responsibilities for the:

a) proper design for achievement of acceptable indoor air quality

b) assessment for the risks to health arising from the indoor air quality

c) Engaging of the competent persons who are adequately qualified and experienced for the assessment of indoor air quality problems

5E.6.3.2.2 Materials those emitted bacteria, chemicals, toxic gases and odours, chemicals and fungi to the supply air should not be used.

5E.6.3.2.3 The risk of leaks and consequences of damage caused by leak of sewerage,

drainage and water supply shall be taken into consideration during the installation of those services.

5E.6.3.2.4 Competent Person should design for Air-conditioning & Mechanical Ventilation system in order to get acceptable indoor air quality and to keep the potential spread of contaminants in the building is low.

5E.6.3.2.5 Competent persons should supervise and inspect the Air-conditioning & Mechanical Ventilation services during the construction stages to avoid unnecessary design discrepancies.

5E.6.3.2.6 Accessible places should be provided at supply and return air ducts of Air-conditioning & Mechanical Ventilation system for inspection and cleaning.

5E.6.3.2.7 Installation of services which can emit / produce toxic gases, vapours, foul smell and those objects affected to human health hazards are prohibited inside the air handling unit rooms.

5E.6.3.2.8 Air handling unit rooms should not be used as passage ways or storage areas and the doors should be air-tight.

5E.5.3.2.9 The entire Air-conditioning & Mechanical Ventilation system should be cleared of any construction debris and dirt and cleaned before operation starts.

5E.6.3.2.10 The minimum arrestance efficiency for the air filters for cleaning outdoor and indoor air should be 70% and 85% respectively.

5E.6.3.2.11 Air distribution to the designated areas should be effective, efficient and uniform and make sure there is no air stagnation at dead spaces.

5E.6.3.2.12 The air distribution should be balanced again after renovation of the building if air-conditioning system has been affected during renovation.

5E.6.3.2.13 Servicing and maintenance for Air-conditioning & Mechanical Ventilation system shall be carried out regularly.

5E.6.3.2.14 An audit should be conducted by the competent persons within 6 months after commencement of Air-conditioning & Mechanical Ventilation system operation to ensure that indoor air quality is acceptable.

5E.6.4 Equipment Selection

5E.6.4.1 Chiller

5E.6.4.1.1 General

a) The chiller shall be single piece factory-assembled equipment. Each chiller shall consist of compressor, motor, evaporator, condenser, lubrication system, initial oil and refrigerant operating charges, user friendly microprocessor control system with LCD display panel, unit mounted starter and a fully modulated capacity control from 20% to 100%.

b) The refrigerant shall be non-CFC type and acceptance to HCFC and HFC only. The refrigerant chosen shall not impose any potential health or safety hazard to the occupants in the building. OHSA non-hazardous refrigerant is acceptable.

c) Chiller shall bear firmly attached metal plates which state name of manufacturer, chiller unit model number, compressor type and the refrigerant used.

d) The chiller shall be tested in accordance to the Air-conditioning, Heating and Refrigeration Institute (AHRI) 551/591 standard or equivalent. The testing facility has been certified or approved to conduct testing in accordance to AHRI or equivalent standards. The chiller shall perform according to the manufacturer’s performance sheets.

5E.6.4.1.2 Compressor

a) Shaft and impellers shall be statically and dynamically balanced and shall have no critical speed within operating range. The compressor shall be the high performance type with capacity modulation from 20% to 100% of its rated capacity.

b) The compressor motor shall be accessible for servicing without removing the compressor base from the chiller. Compressor shall be flanged or bolted for easy disassembly.

c) Compressor bearings shall have a design life of minimum 15 years for continuous operation.

d) Compressor shall be provided with a factory-installed positive pressure lubrication system to deliver oil under pressure to bearings and rotors at all operating conditions. Lubrication system shall include oil pump, sensors, pressure regulator, filter with isolation valves to allow filter change without removal of refrigerant charge, heater, etc.

e) All wiring shall be pre-wired in the factory and checked for proper operation prior to shipment.

f) Compressor shall be fully field-serviceable. Compressors that need to be removed and returned to factory for service are unacceptable.

g) Automatic capacity control chiller shall be achieved by variable inlet guides vanes operating through arc of 90 deg, slide valve, variable frequency drive or other appropriate capacity control device(s) as recommended by the manufacturer. This shall provide continuous modulating control from 100% to 20% of full load without surging for excessive vibration.

h) Automatic capacity control rotary screw chiller shall be achieved by the use of slide valve to provide continuous modulating control from 100% to 20% of full load or variable frequency drive without excessive vibrations or surging.

i) Slide valve shall be actuated by hydraulic oil and controlled by external solenoid valves via the chiller control panel.

5E.6.4.1.3 Motor

a) Each compressor motor shall be of the squirrel cage type of sufficient size to efficiently fulfil the compressor brake horsepower requirements including gear drive losses. The starter for the electric motors shall be variable frequency drive, soft starter, solid state, auto-transformer, part winding and star-delta type.

b) The gear drive and the electric motor shall be suitable for the type of service and entirely compatible with the compressor.

c) Compressor motor shall be suitable for operation in a refrigerant atmosphere and shall be cooled by atomized refrigerant in contact with the motor windings.

d) Motor stator shall be arranged for service or removal with only minor compressor disassembly and without removing main refrigerant piping connections.

e) Full load operation of the motor shall not exceed nameplate rating.

5E.6.4.1.4 Evaporator and Condenser

a) Evaporator and condenser shall be of shell and tube type construction, each in separate shells. Units shall be fabricated with high-performance tubing, steel shell and tube sheets with fabricated water boxes.

b) Tubing shall be copper, high efficiency type with integral internal and external enhancement. Tube sheet holes shall be double grooved for joint structural integrity.

c) Pressure rating of water boxes and nozzle connections shall be compatible to chilled water system pressure. Water boxes shall have vents, drains and covers to permit tube cleaning.

d) The tube sheets of the evaporator and condenser shall be bolted together to allow for field disassembly and reassembly.

e) Water flow rate through the heat exchangers shall not exceed 3m/s for both the condenser tubes and evaporator tubes.

f) Evaporator shall be designed to prevent liquid refrigerant from entering the compressor. Flash chamber or economizer shall be provided as part of the assembly to increase the refrigeration cycle efficiency.

g) Heat exchangers shall be ASME stamp and nameplate certifying compliance with ASME Section VIII, Division 1 codes or approved equivalent stamp certifying compliance with code for unfired pressure vessels shall be provided for the cooler and condenser. Safety relief valves shall be installed on the evaporator and condenser.

5E.6.4.1.5 Insulation

a) The compressor, purge chamber, cooler, suction elbow, and miscellaneous piping shall be insulated with closed cellular rubber insulation or equivalent, glued to the steel surface and forming an effective vapour barrier.

b) The insulation shall be closed cell type minimum 25mm thick with a maximum thermal conductivity of 0.0404 W/m deg. C.

5E.6.4.1.6 Control and Display

a) Each chiller shall be protected and controlled by a factory made and assembled microprocessor based electronic control panel. The controls shall make use of non-volatile memory. Main processor board shall be field removable and replaceable for ease of use. Alphanumeric display showing all system status, parameters, set points, fault and abnormal conditions, date and time in English and numeric data in SI units and IP units.

b) The chiller control system shall be able to communicate with and interface with other Direct Digital Control (DDC) or Building Management System (BMS) through standard protocol and communication ports.

c) It shall be able to control on/off remotely or locally.

d) The default screen shall be able to display simultaneously the following minimum information:

- Date and time of day
- 24-character primary system status message
- 24-character secondary system status message
- Chiller operating hours
- Entering chilled water temperature
- Leaving chilled water temperature
- Evaporator refrigerant temperature
- Entering condenser water temperature
- Leaving condenser water temperature
- Condenser refrigerant temperature
- Oil supply pressure
- Oil pump temperature
- Motor operating current

e) In addition to the default screen, status screens shall be accessible to view the status of every point monitored by the control panel including:

- Evaporator pressure
- Condenser pressure
- Compressor speed
- Bearing oil supply temperature
- Compressor discharge temperature
- Motor winding temperature
- Number of compressor starts
- Control point settings
- Discrete output status of various devices
- Optional spare input channels
- Line current and voltage for each phase
- kW, kWh and demand kW

f) The control panel shall allow reset of the chilled water temperature set point based on any one of the following criteria:

- Remote temperature sensor
- Water temperature rise across the evaporator

g) The control panel shall be capable of limiting the compressor to its rated current or to a lower value based on:

- Factory preset value, or
- Demand limit set by user ranging from 40% to 100% of its rated capacity.

5E.6.4.1.7 Safety and Protective Features

a) Unit shall automatically shut down under any one or more of the following conditions:

- Motor overcurrent
- Low oil sump temperature
- Low evaporator refrigerant temperature
- High condenser pressure
- High motor temperature
- High compressor discharge temperature
- Low oil temperature
- Prolonged stall
- Loss of evaporator water flow
- Loss of condenser water flow

b) The control system shall detect conditions that approach protective limits and take self-corrective action prior to an alarm occurring. The system shall automatically reduce chiller capacity when any of the following parameters are outside their normal operating range:

- High condenser pressure
- High motor temperature
- Low evaporator refrigerant temperature
- High motor current

5E.6.4.1.8 Quality Assurance

a) Chiller performance shall be rated in accordance with AHRI Standard 550-590-2011: Performance Rating of Water Chilling Packages Using the Vapour Compression Cycle or its latest edition.

b) Chiller shall be in compliance with ANSI/ASHRAE 15-2007: Safety Code for Mechanical Refrigeration or its latest edition.

c) Each compressor assembly shall undergo a mechanical run-in test to verify vibration limits. Each compressor assembly shall be pressure-tested and leak-tested. The water side of each heat exchanger shall be hydrostatically tested at 1.5 times its rated working pressure.

d) Prior to shipment, the chiller automated controls test shall be executed to check for proper wiring and ensure correct controls operation.

e) Chiller shall be delivered from factory to site built up, fully sealed and pressurized/evacuated depending on the manufacturers' recommendation. Unit shall be stored and handled in accordance with manufacturer's inspection.

f) Unit shall be shipped with all refrigerant piping and control wiring factory-installed. Unit shall be shipped charged with oil and full charge of refrigerant or nitrogen holding charge as specified on the equipment schedule. Unit shall be shipped with firmly attached labels that indicate name of manufacturer, model number, serial number, type and quantity of refrigerant used.

g) The Contractor shall offer standard warranty of one year.

h) All noise level ratings shall be in accordance with the current ANSI/AHRI Standard 575: 2008 Standard for Method of Measuring Machinery Sound within an Equipment Space or equivalent standards.

i) All noise level ratings shall be in accordance with the current ANSI/ AHRI Standard 370, Standard for Sound Performance Rating of Large Air cooled Outdoor Refrigerating and Air-conditioning Equipment or equivalent standards.

j) A fully trained representative from the chiller manufacturer shall supervise the pressure testing, evacuation, dehydration, charging and initial start-up of the chillers.

5E.6.4.2 Cooling Tower

5E.6.4.2.1 Cooling tower shall be certified by Cooling Tower Institute (CTI), Japanese Industrial Standard (JIS) or its equivalent.

5E.6.4.2.2 Cooling tower shall be located at least 5 meter away (measured from base of cooling tower) from windows, area of public access, air intake of AHU and exhaust discharge of kitchen and generator.

5E.6.4.2.3 The weather data of respective geographical locations shall be obtained for selection of cooling tower.

5E.6.4.2.4 Cooling tower fan motors shall be rated to at least IP55 and furnished with extra protection from moisture on the windings and double sealed permanently lubricated bearings.

5E.6.4.2.5 Drift eliminator shall be provided to minimize the makeup water loss. Drift loss of cooling tower shall not be more than 0.0015% of circulated cooling water flow rate. Notwithstanding this, makeup water consumption of cooling tower including drift loss, evaporation loss and blow down loss shall not be more than 1.5% of circulated cooling water flow rate.

5E.6.4.2.6 Reliable makeup water system shall be provided. Water storage tank size of minimum one day usage of cooling tower at building full cooling load condition should be provided. It is recommended to carry out makeup water quality test at respective states and divisions of Myanmar to ensure available make up water is treatable for cooling water system.

5E.6.4.2.7 Structural opening of minimum of 50% of floor area shall be provided at two sides of each cooling tower to have sufficient air intake. Natural ventilation cooling tower is acceptable if it does not cause nuisance to the public and occupants.

5E.6.4.2.8 The maximum permissible noise level of cooling tower measured at horizontal distance of 5 meter away from intake louver shall be of 70dB(A) – 7am to 11pm and 65dB (A) – 11pm to 7am for all type of premises. Silencer should be provided inside the basin and discharge of cooling tower at noise sensitive location to achieve the specified noise level.

5E.6.4.2.9 The owner of property shall engage water treatment specialist to carry out water treatment such that pipe corrosion, scaling of heat exchanger and bacteria growth inside the cooling water system could be prevented. Water quality test such as makeup water quality test, monthly standard plate count test and quarterly Legionella bacteria test shall be carried out at accredited laboratory. Yearly disinfection of cooling tower shall be carried out so that cooling tower is free of bacteria. The top water basin should be covered to prevent bacteria growth.

5E.6,4,2.10 Chemical free water treatment is acceptable if it is technically and commercially feasible. Notwithstanding the type of water treatment, standard plate count test, and legionella bacteria test shall be conducted periodically.

5E.6.4.2.11 The pH level of discharge water from cooling tower shall be of 6 to 9. The discharge water from cooling tower shall be connected to sewer or sewer treatment tank. Floor trap shall be provided at each drain line to prevent foul smell from sewer or sewer treatment tank.

5E.6.4.2.12 Recycled water system should be considered to conserve makeup water subject to technical and commercial feasibility.

5E.6.4.2.13 The operation strategy shall be established for energy efficiency and optimum operation of cooling tower. Variable frequency drives for fan motors are recommended. The dry bulb and wet bulb temperature sensors at vicinity of cooling tower, water flow meter and temperature sensors at cooling water system should be installed to monitor cooling tower performance.

5E.6.4.2.14 Equalizer line should be sized for the flow rate equal to 15% of the design flow rate of the larger cell or tower, the friction loss in the equalizer lines, including entrance and exist losses should be equal or less than 25mm water column or as recommended by the manufacturer.

5E.6.4.2.15 Maintenance access such as catwalk and cat ladder should be provided for the sensors, valves and in-fills for maintenance.

5E.6.4.2.16 Vibration isolators and flexible pipe connection shall be provided to isolate the transmission of vibration from the cooling towers to adjacent structure.

5E.6.4.2.17 Material Selection

Basin : Cooling tower basin shall be free of water leakage.

Pipe & Valves : Cooling tower water pipe material should be made of galvanized iron, FRP, PPR, PE-X or its equivalent. Isolation valves shall be provided at every cell of cooling tower for maintenance purposes.

In-fills : In-fills material should be made of PVC or its equivalent.

Drive Mechanism : Drive mechanism should be Belt, Gear and direct drive.

5E.6.4.3 Water Pump

5E.6.4.3.1 Pump sets shall comply with ANSI (American National Standard Institute) or HI (Hydraulic Institute) standard or its equivalent.

5E.6.4.3.2 Pump set shall be capable of satisfying the flow and pressure requirements of chilled water system.

5E.6.4.3.3 High efficiency motor and pump should be considered to achieve less operating cost throughout its service life.

5E.6.4.3.4 Automatic Control system comprising control valve and water flow sensors should be provided to control desired system pressure. It is recommended to install variable frequency drive to optimize the electrical energy use.

5E.6.4.3.5 Vibration isolators and flexible pipe connection shall be provided to isolate the transmission of vibration from the pump sets. Pumps should be installed on inertia base so that transmission of vibration to adjacent structure could be minimized.

5E.6.4.3.6 Sufficient maintenance space and access should be provided for ease of future maintenance.

5E.6.4.4 Air Handling Unit (AHU, Chilled Water Type)

5E.6.4.4.1 The cooling coil of AHU shall comply with AHRI 410 coil performance or its equivalent.

5E.6.4.4.2 The casing of AHU shall comply to Eurovent Class D1 strength or its equivalent and air leakage rates complying to Eurovent Class L1 or its equivalent.

5E.6.4.4.3 High efficiency motor and fan should be considered to achieve less operating cost throughout its service life. Hygienic AHU should be considered for operation theatre and infectious patients' room at hospitals.

5E.6.4.4.4 Automatic Control system comprising control valve, temperature sensors and water flow sensors should be provided to control desired room temperature and humidity. It is recommended to install variable frequency drive for the fan to optimize the electrical energy use.

5E.6.4.4.5 The number of rows inside each cooling coil should satisfy intended coil leaving temperature, design differential chilled water temperature and targeted fan absorbed power.

5E.6.4.4.6 Fresh air shall be introduced to the AHU to achieve acceptable CO_2 level inside the room. Fresh air intake location for the AHU shall be kept minimum 5 meter distance away from any discharge of exhaust and the cooling tower.

5E.6.4.4.7 Vibration isolators and flexible duct connection shall be provided to isolate the transmission of vibration from the fan and motor assembly. Plinth height of minimum 150mm should be provided to minimize transmission of sound and vibration to other floor.

5E.6.4.4.8 Air handling units of cooling capacity greater than 35 kW shall be floor mounted.

5E.6.4.4.9 Cooling coil should have chilled water temperature difference of 5.5 °C and finned coils used in an air handler should not be more than 8-row deep.

5E.6.4.4.10 When AHU with air flow of more than 8500 CMH is not centrally controlled, emergency stop switch shall be provided at accessible location to manually shut down the AHU in the event of fire. Proper signage and instruction shall be displayed beside the emergency stop switch.

5E.6.4.4.11 It is recommended to install dust filters, electronic air cleaner and UV light to achieve longer life of cooling coil and good indoor air quality.

5E.6.4.4.12 Drain pan should be constructed such that all condensate collected are completely discharged throughout the daily cycle of operation.

5E.6.4.4.13 U trap shall be provided at condensate discharge pipe to prevent back flow of foul smell into the AHU.

5E.6.4.4.14 AHU room should be cleaned and free of storage material. Maintenance access such as catwalk and cat ladder shall be provided for maintenance.

5E.6.4.5 Fan Coil Unit (FCU, Chilled Water Type)

5E.6.4.5.1 The cooling coil of FCU shall comply with AHRI 440 coil performance or its equivalent.

5E.6.4.5.2 Automatic Control system comprising control valve and temperature sensors should be provided to control desired room temperature.

5E.6.4.5.3 The number of rows of cooling coil should satisfy design differential chilled water temperature and minimum fan absorbed power in terms of watt per CMH.

5E.6.4.5.4 Fresh air shall be introduced to the FCU for the comfort of air-conditioning space.

5E.6.4.5.5 Vibration isolators and flexible duct connection shall be provided to isolate the transmission of vibration from the FCU.

5E.6.4.5.6 It is recommended to install dust filters to achieve good indoor air quality.

5E.6.4.5.7 Drain pan should be constructed in such a way that all condensate collected are completely discharged throughout the daily operation.

5E.6.4.5.8 U trap shall be provided at condensate discharge pipe to prevent back flow of foul smell into the FCU.

5E.6.4.6 Water Treatment System

5E.6.4.6.1 The water treatment system, either chemical or non-chemical system shall be provided for the chilled water and condensing water system.

5E.6.4.6.2 Water treatment system shall be able to minimize the blowdown without compromising the heat transfer efficiency of the cooling tower. Possible cycle of concentration should be determined through the TDS (total dissolved solids) value of makeup water and the system should be able to maintain the cycle of concentration as practically possible.

5E.6.4.6.3 The followings are the guidelines of chilled and condenser water quality. Notwithstanding the above, as the chilled and condenser water quality is very much depended on the quality of water supply, appropriate quality should be achieved for chilled and condenser water.

Condenser Water

- Iron - less than 5.0 ppm
- Total Hardness - less than 300 ppm
- Total Alkalinity - less than 300 ppm
- Chloride - less than 125 ppm
- Copper - less than 0.2 ppm
- TDS - less than 1200 ppm
- PH - 7 ~ 9
- Legionella - Non-present
- Algae - Non-present

Chilled Water

- TDS - less than 3000 ppm
- Copper - less than 0.2 ppm
- Iron - less than 5.0 ppm
- Total Alkalinity - less than 300 ppm
- Corrosion rate - less than 0.5 mph for Cu and 3 mph for mild steel
- Bacteria - less than 1000 cfm/ml
- PH - 8 ~ 10

Note: TDS = Total Dissolved Solids

5E.6.4.7 Chilled Water Expansion Tank

5E.6.4.7.1 The expansion tank shall be provided for chilled water system at the highest point. The volume of the tank is sized in such a way that it can provide/contain the deficiency/excessive water in the system due to temperature fluctuation resulted from operation and/or change of weather.

5E.6.4.7.2 It shall be connected to the chilled water return of the system.

5E.6.4.7.3 Makeup water pipe with appropriate size shall be connected to the expansion tank.

5E.6.4.7.4 More than one expansion tank should be provided for the development with large footprint. Other appropriate system may be considered to replace the expansion tank for the wide and large development in terms of coverage.

5E.6.4.8 Air Cooled Split Air-conditioning Unit

5E.6.4.8.1 General

a) The units (indoor and outdoor unit) shall be single piece factory-assembled equipment.
b) Modification of imported units carried out locally is not allowed.

c) The units shall use ozone friendly refrigerant such as R410A or R407C.
d) Selected units shall be low vibration and low noise during operation.
e) Selected units shall be energy saving type.
f) Brackets / support for unit installation shall be hot-dipped galvanized.

5E.6.4.8.2 Indoor Units

a) The indoor unit shall consist of blower, motor, evaporator coils, filters, electrical & control devices and drain pan within the housing.
b) The blower shall be balanced.
c) The evaporator coil shall be of direct expansion type.
d) Fins shall be bonded mechanically to seamless copper tubes.
e) Spacing of fins shall not be more than 14 fins per one inch.
f) Capillary tube shall be built-in type.
g) Filter shall be washable type.
h) Drain pan shall be provided with insulation.

5E.6.4.8.3 Outdoor Units

a) The outdoor unit shall consist of fan, motor, condensing coils, compressor, expansion valves, solenoid valves and electrical & control devices housed together.
b) Housing for outdoor unit shall be suitable for outdoor installation.
c) The condensing coil shall be air-cooled type.
d) Spacing of fins shall not be more than 12 fins per one inch.
e) The condensing fan shall be balanced and direct driven type.
f) The motor shall be weatherproof type.
g) Fins shall be bonded mechanically to seamless copper tubes.

5E.6.4.8.4 Controls

a) The following minimum function shall be provided.
   - Fan Speed Selection
   - Room Temperature Setting
   - Timer
   - On / Off Selection
b) Control devices shall be factory assemble type.
c) Indoor unit and outdoor unit shall be interlocked.
d) Safety devices shall be provided at indoor and outdoor units.

5E.6.4.8.5 Installation

a) Sufficient space shall be provided for future maintenance.
b) No short circuit for air discharge at outdoor unit is allowed.
c) Manufacturer’s specification for maximum elevation difference between the indoor and outdoor unit shall comply.
d) The indoor and outdoor units shall be secured properly at bracket.
e) UPVC pipe shall be used for condensate drain pipe.
f) Condensate drain pipe shall be minimum 20mm in diameter and completed with insulation.
g) The units shall be installed by professional installers from registered company.

5E.7 Duct Works

This section covers the design and installation of the duct works for the mechanical ventilation and air-conditioning system.

5E.7.1 Deliberations of Design

5E.7.1.1 The purpose of this section is to provide design criteria for acceptable performance in duct works installation system.

5E.7.1.2 Selection of materials, fabrication of the ducts and optimum in ducts air velocities, etc. shall be taken into consideration when designing the duct work and air distribution system.

5E.7.1.3 It shall also be taken into consideration to prevent and mitigate the spread of smoke and fire throughout the whole building via duct work in the event of fire.

5E.7.2 Selection of Materials

5E.7.2.1 All metallic ducts shall be constructed as specified in the SMACNA HVAC Duct Construction Standards-Metal and Flexible.

5E.7.2.2 All air-conditioning or other ventilation ducts including framing thereof, shall be constructed of steel, aluminium, mineral wool batt or other approved material.

5E.7.2.3 All air-conditioning or other ventilation ducts shall be adequately supported.

5E.7.3 Installation and Construction

5E.7.3.1 Provision of access opening along the air duct is compulsory where combustible materials and debris may accumulate in the ducts and air plenum for proper operation and maintenance. Whole air ducts must be air tight without any opening except for those proper access opening.

5E.7.3.2 Sufficient size of removable air grille and diffusers can also take into consideration as an access opening.

5E.7.3.3 Duct system shall be designed and installed to supply the required distribution of air. The installation of an air distribution system shall not affect the fire protection requirements specified in the Myanmar Fire Safety Code (MFSC). Ducts shall be constructed, braced, reinforced and installed to provide structural strength and durability.

5E.7.3.4 Ducts installed within all buildings shall be sized in accordance with the ASHRAE Handbook of Fundamentals or other equivalent computation procedure.

5E.7.3.5 Side-walls and ceiling should apply with plastering and painting wherever the ceiling space is used as a return air plenum. This should also apply where possible, to the masonry shaft and risers which used as an air duct.

5E.7.3.6 Rock-wool or mineral wool, using as duct linings stick to the inner wall of ducts shall be protected to prevent the fibres spreading into the air-stream. Steel, aluminium or other approved materials shall be used for manufacturing rigid duct works.

5E.7.3.7 To prevent dust accumulation in the supply and return air duct, inner surface should be smooth and resistant to abrasion.

5E.7.3.8 Ducts shall be classified based on the maximum operating pressure of the duct. The pressure classification of ducts shall equal or exceed the design pressure of the air distribution in which the ducts are utilized.

Ductwork and plenums shall be sealed in accordance with the table below, so as to meet the requirements of duct leakage test.

Table 5E.7.3.1 Ductwork Classification.

Static Pressure Class		**Maximum air velocity (m/sec)**	**Seal Class**
Positive (Pa)	**Negative (Pa)**		
250	250	12.5	Class C
500	500	12.5	Class C
750	750	20	Class B
1000	-	20	Class A
1500	-	-	Class A
2500	-	-	Class A

Table 5E.7.3.2 Ductwork Seal Requirements

Duct Type			
Duct Location	**Supply**	**Exhaust**	**Return**
Outdoor	A	C	A
Unconditioned Space	A	B	A
Conditioned Space	A	B	A

Where:

Class A: All transverse joints, longitudinal seams and duct wall penetrations shall be sealed. Pressure sensitive tape shall not be used as primary sealant.

Class B: All transverse joints and longitudinal seams shall be sealed. Pressure sensitive tape shall not be used as primary sealant.

Class C: Transverse joints only shall be sealed.

5E.7.3.10 Minimum sheet thickness for duct construction shall comply with SMACNA, HVAC Duct Construction Standards – Metal & Flexible.

5E.7.3.11 The requirement of the duct reinforcement and spacing shall follow in accordance with SMACNA duct construction schedule.

5E.7.3.12 Hangers and brackets for supporting ducts shall be of galvanized iron or metal and shall be strongly supported to the ducts.

5E.7.3.13 Non-combustible materials shall be used for duct lining, covering and flexible connection. Only if it complies with following conditions, combustible materials shall be used as necessary.

a) Surface flame spread rating shall be of minimum class-1, when testing according to the methods specified in Myanmar Fire Safety Code (MFSC). Unless otherwise specified, surface flame spread rating shall follow the requirement of flame spread rating required for the ceiling construction under the Myanmar Fire Safety Code (MFSC).

b) Those materials used in duct system should only generate a minimum amount of smoke and toxic gases when fire.

5E.7.3.14 Materials which is verified as not ignitable so easily shall be used for flexible joints.

5E.7.3.15 The support and construction of air ducts, plenums and fittings including joints, seams, stiffening, reinforcing and access openings shall conform to the appropriate requirements of the duct construction standards stated in ASHRAE Handbook, IHVE guide books or SMACNA Manuals.

5E.7.4 Testing for Duct Leakage

5E.7.4.1 Ductwork designed at static pressures more than 750 Pa shall be leak tested in accordance with test procedures specified in SMACNA or ASHRAE.

5E.7.4.2 Minimum 25% of the total installed duct area for the designated pressure class shall be tested. Duct systems with pressure rating greater than 750 Pa shall be highlighted on the drawings. The maximum permitted duct leakage shall be in accordance with the formula:

$$L_{max} = C_L (P^{0.65} / 1000)$$

Where:

L_{max} = maximum permitted leakage in I/s·m^2 duct surface area

C_L = duct leakage class, ml/s.m^2 at 1 Pa

= 8 for rectangular sheet metal, rectangular fibrous and round flexible duct

= 4 for round / flat oval sheet metal or fibrous glass ducts

P = test pressure, which shall be equal to the design duct pressure rating (Pa)

5E.8 Pipe Works

This section covers the design and installation of the piping work for air-conditioning system.

5E.8.1 Deliberations of Design

5E.8.1.1 The following parameters should take into consideration for designing and planning for piping system.

- Flow rate
- Materials used
- Pressure Drop caused by fluid friction (pipes, fittings, valves and accessories)
- Velocity
- Location (Above ground / underground)
- Noise Transmission
- Vibration
- Corrosion
- Leaking
- Water Hammer
- Water Turbulence
- Expansion and Contraction of Fluid
- Air Lock
- Servicing & Maintenance
- Other required parameters relating to piping system

5E.8.1.2 Pipe fittings shall be designed for maximum fluid temperature and pressure of the system.

5E.8.1.3 All the designed pipes shall have acceptable strength and able to withstand wear & tear, pressure or damage.

5E.8.1.4 All the pipes shall be supported by proper designed supporting system and supporting materials shall be metal.

5E.8.1.5 All pipe supporting system shall be verified and approved by Registered Professional Engineer.

5E.8.1.6 Registered Professional Engineer mentioned at clause 5E.5.8.1.5 shall be Civil (Structural) or Mechanical (A.R.M.V.H) or Mechanical (Building Services).

5E.8.1.7 All pipes shall be protected if those are installed at harmful areas.

5E.8.2 Deliberations of Installation

5E.8.2.1 All installed pipe work which is intended to contain / convey pressurized fluid shall conduct hydrostatic press test. Pressure drop shall not be more than 1.5% of tested pressure. Tested pressure shall be 1.5 times of the system pressure.

5E.8.2.2 Standard pipe fittings are recommended to use and shall be designed for maximum fluid temperature and pressure of the system.

5E.8.2.3 Selected materials shall be suitable for planned services.

5E.8.2.4 All pipes, valves and fittings shall be so arranged for accessible and replaceable conveniently.

5E.8.2.5 All pipes and fittings shall be thoroughly clean before installation and be free from scale, damage and burrs.

5E.8.2.6 Standard fittings are recommended to use.

5E.8.2.7 All piping shall be machine or hacksaw cut.

5E.8.2.8 Flame cutting shall be carried out for those pipes which are not able to cut by machine or hacksaw.

5E.8.2.9 Welding shall be done by appropriately qualified welders.

5E.8.2.10 Pipes shall be installed so that it is free to expend and contract without imposing undue stresses.

5E.8.3 Deliberations of Thermal Insulation

5E.8.3.1 Chilled water pipe, including valves and fittings shall be pre-insulated with rigid polyurethane foam with double sided vapour barriers of Class "0" with galvanized steel jacketing.

5E.8.3.2 Density of polyurethane shall be minimum of 48 kg/m^3 .

5E.8.3.3 Pre-insulated pipe with high density polyethylene (HDPE) is recommended for underground service.

5E.8.3.4 Thermal conductivity shall not be greater than 0.02 W/mK at 10 Deg C mean.

5E.8.3.5 Thermal insulation exposed to weather shall be suitable for outdoor service.

5E.8.3.6 Piping shall be thermally insulated in accordance with the Table 5E.8.1.

Table 5E.8.1 Insulation Thickness for Pipe

No	Pipe Nominal Diameter (mm)	Insulation Thickness (mm)
1	15	30
2	20	30
3	25	35
4	32	35
5	40	40
6	50	40
7	65	40
8	80	50
9	100	50
10	125	60
11	150	60
12	200	60
13	250	60
14	300	65
15	350	65
16	400	65
17	450	65
18	500	65

Conditions: 1) Ambient Temperature = 35 Deg C

2) Chilled Water Temperature = 6 Deg C

3) Relative Humidity = 85 %

4) Thermal Conductivity of Insulation, K = 0.02 W/mK

5E.8.4 Refrigerant Pipe Work

5E.8.4.1 Pipe work shall be copper to BS 2871: Part 2

5E.8.4.2 The length of pipes shall be considered in sizing on the refrigerant piping. The number of bends in the refrigerant piping shall not exceed the manufacturer's specifications.

5E.8.4.3 The maximum pipe length shall not be exceeded the manufacturer's specifications.

5E.8.4.4 The refrigerant pipe line between the outdoor and the indoor unit shall be carried out in a continuous length of pipework. No jointing is allowed if the distance between the outdoor and indoor unit is shorter than standard length of pipes used.

5E.8.4.5 The total length run of refrigerant pipe shall be shortest with least number of turns.

5E.8.4.6 All joints shall be brazed type. Flare connection is only allowed for accessories or fittings connections.

5E.8.4.7 All refrigerant pipework shall be run neatly inside PVC trunking.

5E.8.4.8 Pressure test for refrigerant pipes shall be carried out prior to connection to indoor and outdoor units with oxygen free nitrogen for 6 hours. The tested pressure shall comply to manufacturer's recommendation.

5E.8.4.9 The system shall be free of any leaks at test pressure.

5E.8.4.10 The system shall be vacuumed with pressure down to (-30) psig and held for 1 hour before charging the refrigerant to the system.

5E.8.4.11 Sight glass shall be provided along the refrigerant pipe near to outdoor unit.

5E.8.4.12 All refrigerant pipes shall be insulated with vapour sealed closed cell elastomeric foam type insulation having a K factor not higher than 0.038 W/m/ºC @ 0ºC.

5E.8.4.13 All fittings and joints in the pipe work shall be insulated.

5E.8.4.14 All fittings and joints shall be insulated by proper gluing of mating faces of each length using glue and method recommended by the manufacturer.

5E.8.4.15 Insulation shall be protected against weather when installed at outdoor.

5E.8.4.16 Insulation shall be fire and flame propagation tested to BS 476 Pt 7: 1990 and exhibit Class "O" performance.

5E.8.4.17 Insulation thickness shall be in accordance with the following recommendations.

- 19 mm (pipes pass through air-conditioning spaces)
- 25 mm (pipes pass through non-air-conditioning spaces)

5E.8.4.18 Adequate brackets / supports shall be provided for PVC trunking of refrigerant pipes.

5E.8.4.19 Gas and liquid pipe shall be insulated separately.

5E.8.4.20 Refrigerant pipe wall thickness shall be minimum of 0.71 mm or as per manufacturer recommendation.

5E.9 Electrical and Control Works

This section covers the design and installation of electrical and control works for the heating, mechanical ventilation and air-conditioning system.

5E.9.1 Electrical Works

All electrical works for this section shall comply with the following guides.

- Building Electrical Wiring Installation
- Guidelines for Electrical Works
- Myanmar National Building Code, Part 5B, Building Services, Electrical and Allied Installations

5E.9.1.1 Deliberations of Design

The following conditions should be taken into consideration for designing and planning for electrical system.

- Fans at Air Handling System should shut down in the event of fire for safety reason.
- Fire mode requirements mentioned at Section 5E.13 of this code.
- Fire mode requirements mentioned at Myanmar Fire Safety Code (MFSC).

5E.9.1.2 Secondary source of Power Supply

5E.9.1.2.1 Secondary source of power supply should be provided for equipment those are required to serve mechanical ventilation system during the fire mode to the following:

- Basement Carparks
- Exit Staircases Pressurization
- Exit Passageways
- Fire Fighting Lobbies
- Smoke Stop Lobbies
- Carpark Smoke Purging System
- Engineered Smoke Extraction System
- Flammable Liquid / Gas Storage Rooms
- Sprinkler Pump Room
- Emergency Generator Room
- Fire Command Center

5E.9.1.2.2 The electrical circuit cables for such equipment shall be fire resistant cables or protected along their entire length with fire rated enclosure.

5E.9.1.3 Essential Fans Remote Control Panel

5E.9.1.3.1 Essential fans remote control panel should supply and install at the fire command center.

5E.9.1.3.2 It should be installed at the guard house in the absence of fire command center in the building.

5E.9.1.3.3 Essential fans remote control panel should include start-stop control and indication light of operation for the following mechanical ventilation system.

- Basement Carparks
- Carpark Smoke Purging System
- Exit Staircases Pressurization
- Fire Fighting Lobbies
- Smoke Stop Lobbies

5E.9.2 Control Works

5E.9.2.1 Deliberations of Design

a) Each equipment or system shall operate with control system. The control system shall be designed to have energy efficient operation while maintaining the desired indoor conditions.

b) Areas with different cooling requirements served by single air-conditioning system shall be divided into sufficient number of zones.

c) Every air handling system and zone shall have at least one thermostat with suitable operating range to regulate or control the space temperature.

d) The system shall be able to shut off or partially restrict the cooling provided to each zone by accessible manual or automatic devices.

5E.9.2.2 Requirements for the System

a) Air-conditioning system or equipment shall be equipped with at least one of the following to shutdown automatically:

  - Seven days per week timer with manual override, or equivalent function that allows temporary operation of the system for up to two hours.
  - An occupancy sensor or a control system that is capable of shutting the system off when no occupant is sensed for a period of up to 30 minutes.
  - If security system is installed, air-conditioning equipment or system should be interlocked to that security system which shuts off when the security system is activated.

b) Automatic shutdown features as mentioned in 5E.9.2.2 (a) above is not required for the following systems:

  - Systems serving hotel guestrooms;
  - Systems intended to operate continuously such as clean rooms and data center; and
  - Systems having cooling capacity less than 5.0 kW.
  - System that are equipped with readily accessible manual on/off control.

c) Air handlers supplying 5 m^3/s or more of air should have an optimum start control. The control algorithm should be at least taken into account the difference between the temperature of the space and its set point and the length of time prior to the scheduled occupancy.

d) Zones that are intended to operate or be occupied non simultaneously should be grouped into isolation areas, with each isolation area not exceeding 2300 m^2 of floor area or one floor provided that:

   1) Central systems and plants serving these zones are provided with controls and devices that enable a stable system and equipment operation for any length of time while serving only the smallest isolation area; and

   2) The systems serving each isolation area, besides meeting the requirements of 5E.9.2.2 (a) for automatic shutdown, are also equipped with isolation devices and controls that can isolate them from the supply of outdoor air and the exhaust system.

e) The following are not required for the isolation devices and controls requirements given in 5E.9.2.2 (d) (2) above.

   1) The fan system for exhaust air and outdoor air connections to isolation zones is 2.4 m^3/s and smaller;

   2) Exhaust airflow from a single isolation zone of less than 10% of the design airflow of the exhaust system to which they connect; and

   3) Zones with continuous operation or intended to be operated only when all other zones are inoperative.

f) When air-conditioned spaces are not in use, all outdoor supply air dampers and exhaust systems serving air-conditioned spaces should shutoff automatically.

g) During the pre-occupancy building cool-down, the outdoor air dampers should shutoff automatically.

h) The air dampers shall have a maximum leakage rate of 100 $l/s/m^2$ damper area at 250 Pa.

i) Fans with motors greater than 0.5 kW used in the systems should have automatic controls, which comply with 5E.9.2.2 (a), to shut them off when their services are not required.

j) Systems with design outdoor air intake greater than 1.4 m^3/s serving areas with an average design occupancy density exceeding 1 person/ m^2 shall include means to automatically reduce outdoor air intake below the design rate, when spaces are partially occupied.

k) A minimum of one of the following control technologies shall be required for hotel with over 50 guest rooms so that all the power to the lights and switched outlets in the hotel guest room would be turned off when the occupant is not in the room and the space temperature would automatically set up by no less than 3 °C:

   1) Controls that are activated by the room occupant via the primary room access method-key, card, deadbolt;

   2) Occupancy sensor controls that are activated by the occupant's presence in the room.

5E.10 Energy Saving and Environmental Control

This section covers the design and general statements for energy saving and environmental control for the buildings.

5E.10.1 Energy Saving

This section specifies energy related requirements. It shall be applicable to all buildings with floor area greater than $3000m^2$ and aggregate air-conditioned area greater than $1500m^2$.

5E.10.1.1 Energy Saving Requirements

Engineer shall design the building project to comply with building envelope material and HVAC system requirements under section 5E.10.1.4 and 5E.10.1.6. It shall comply the minimum requirements for building envelope thermal transfer values, percentage of windows, skylight area with gross wall, roof area and heat, ventilation and air-conditioning system performance.

5E.10.1.2 Space Categories

It specifies for three conditioned spaces.

a) Non-residential conditioned space
b) Residential conditioned space
c) Semi-heated space (This requirement shall be under reserved)

5E.10.1.3 Building Envelope

Exterior building envelope requirements are specified for three categories under section 5E.10.1.2. Space shall assume as conditioned space and shall comply with the requirements for conditioned spaces at the time of construction regardless of mechanical or electrical equipment is included in the building permit application or installed at the time of application and/or construction.

5E.10.1.4 Allowable Limit of Window and Skylight

The building envelope components shall meet the minimum insulation, maximum U-factor and Solar Heat Gain Coefficient (SHGC) requirements listed in Table 5.5-1 Building Envelope Requirements for Climate Zone 1 (A, B, C) of ASHRAE 90.1-2013 (See appendixes, 5E.14.4). The window area should be less than 40% of the gross wall area, and the skylight area should be less than 3%of the gross roof area. Window area greater than the requirement shall be used of better thermal transfer value and solar heat gain coefficient.

5E.10.1.5 Heating, Ventilation and Air-Conditioning (HVAC)

The HVAC system shall meet the following criteria:

a) Fan power limitation specified in Table 5E.10.1.1
b) Pump power limitation specified in Table 5E.10.1.2
c) Energy efficient air-conditioned equipment specified in Table 5E.10.1.3a and 5E.10.1.3b.
d) Energy Conservation Guidelines and Handbook from relevant Ministries.

5E.5.10.1.6 Fan System Efficiency

The fan system design condition shall not exceed the allowable fan system motor nameplate kW or fan system input kW as shown in Table 5E.5.10.1.1 This requirement shall include supply fans, return fans, exhaust fans, fan coil unit and air handling unit fans.

Table 5E.10.1.1 Fan Power Limitation

	Fans Power ≥ 4kW Constant Volume ($kW/m^3/s$)	Fans Power ≥ 4kW Variable Volume ($kW/m^3/s$)	Fan Systems with Nameplate Motor Power <4kW
Fan System Motor Nameplate Power	1.7	2.4	-
Fan System Input Power	1.5	2.1	0.6

5E.10.1.7 Pump System Efficiency

HVAC pumping system having a total pump system power exceeding 7.5kW should design to modulate the variable fluid flow and should design to comply with pump power limitation requirements as shown in Table 5E.10.1.2.

Table 5E.10.1.2 Pump Power Limitation

	Chilled Water Pump System (kW/l-s)	Condenser Water Pump System (kW/l-s)
Pump System Power Limitation	0.349	0.301

5E.10.1.8 Energy Efficient Air-conditioned Equipment

Energy efficient air-conditioned equipment shall design to reduce energy consumption. Water Cooled Chiller Plant, Air Cooled Chiller Plant and Unitary Air-conditioners efficiency shall meet the minimum requirements prescribed in table 5E.5.10.1.3a and 5E.10.1.3b.

Table 5E.10.1.3a Water Cooled Chiller Plant

Prerequisite	Peak Building Cooling Load	
	≥ 500 RT	< 500 RT
Minimum Design System Efficiency for Central Chilled Water Plant	0.7 kW/RT	0.8 kW/RT

Table 5E.10.1.3b Air Cooled Chiller Plant and Unitary Air-conditioners

Prerequisite	Peak Building Cooling Load	
	≥ 500 RT	< 500 RT
Minimum Design System Efficiency for Central Chilled Water Plant	0.9 kW/RT	1.0 kW/RT

5E.10.1.9 Kitchen Exhaust System

Kitchen Exhaust System should apply to meet the following requirement.

(a) Replacement air introduced directly into the hood cavity of kitchen exhaust hood shall not exceed 10% of the hood exhaust air flow rate. Temperature difference between indoor and introducing temperature should not be more than 6°C.

(b) Conditioned supply air delivered to any space with kitchen hood shall not exceed the supply air required to meet the space cooling load.

(c) If a kitchen has a total kitchen hood exhaust air flow rate greater than 8500 cmh, each hood shall have an exhaust rate that complies with table 5E.10.1.4.

Table 5E.10.1.4 Maximum Net Exhaust Flow Rate, cmh per Linear Meter of Hood Length

Type of Hood	**Light Duty Equipment**	**Medium Duty Equipment**	**Heavy Duty Equipment**
Wall-mounted canopy	781	1170	1559
Single island	1559	1948	2340
Double island (per side)	976	1170	1559
Eyebrow	976	976	Not Allowed
Backshelf/pass-over	1170	1170	1559

5E.10.1.10 Laboratory Exhaust System

Buildings with laboratory total exhaust rate greater than 27,000 cmh shall have one of the following features;

a) VAV lab exhaust and room supply that capable of reducing exhaust and makeup airflow rates and/or include the heat recovery system to precondition the makeup air from laboratory exhaust.

b) Direct makeup air supply equal to at least 75% of exhaust airflow rate, cooled to no cooler than 2°C above room set point.

5E.10.2 Environmental Control

Air-conditioning systems are one of the most energy intensive components of the base building. The energy efficient air-conditioned equipment with the least environmental impact possible should be selected.

5E.10.2.1 Refrigerants

All air-conditioning system in the buildings should use refrigerants with a low ozone depletion potential and low global warming potential to mitigate climate change. The refrigerants should also be low hazardous of toxicity and flammability.

Zero use of chlorofluorocarbon (CFC) based refrigerants in new building heating, ventilation, air-conditioning and refrigeration systems.

A refrigerant leak detection system should also be installed in critical areas of plant rooms containing chillers and/or other equipment using refrigerants.

5E.10.2.2 Cycle of Concentration for Cooling Towers

For the building development with cooling towers, strategies to reduce the water consumption for cooling purposes should be considered. The project should demonstrate the use of water treatment system for cooling towers that 7 cycles of concentration (CoC) at an acceptable water quality and operational performance.

Refer to Section 5E.6.4.6 for the detail requirements.

5E.10.2.3 Thermal Comfort

The air-conditioning system should be designed to achieve thermal comfort for the occupants. Refer to 5E.6.1.5 on the thermal comfort requirement.

5E.10.2.4 Ventilation Rates

The air-conditioning system design should be designed in such a way that the volume outdoor air entering the building to ensure the minimum ventilation rates are being met during building operation. Refer to Section 5E.6.2 for the minimum ventilation rate required for different space usage

Demand Control Strategy: Demand control ventilation strategies including the use of carbon dioxide sensors or equivalent devices to regulate the quantity of fresh air and ventilation required in a space to achieve good indoor air quality whilst conserving energy through the ability to match the volume of fresh air with the space demand. Where demand control ventilations strategies are utilized, they should adhere to guidelines within ASHRAE Standard 62.1-2013 Section 6.2.7.1.2.

5E.10.2.5 Ultraviolet Germicidal Irradiation (UVGI) system to control airborne infective microorganisms

Ultraviolet Germicidal Irradiation is a method of sterilisation that uses ultraviolet (UV) light using UVC irradiation at a wavelength of 254 nanometres (nm) to lethally damage airborne microorganisms within the air distribution system to provide healthier air within the conditioned space. For the projects with provision of AHUs and/or FCUs, it should be considered to provide the UVGI system in all AHUs and FCUs**.**

5E.10.3 Noise and Vibration Control

5E.10.3.1 Deliberation of Design

The HVAC system design and application shall take all necessary precautions to ensure minimum noise generation and its transmission.

In general, the design and application of HVAC system should be carefully considered and address the following related noise issues.

1) Duct-borne noise
2) Radiated equipment noise
3) Break-in noise
4) Break-out noise
5) Terminal end noise

5E.10.3.2 Maximum Acceptable Sound Pressure Level

Table 5E.10.3.2.1 shows guide to maximum acceptable sound pressure level in rooms with different types of activities.

Table 5E.10.3.2.1

Activity and Type of Area	**Noise Rating (NR Value)**	**dB (A) (Average)**
Kindergartens	30	35
Auditorium	30	35
Library	30	35
Cinema	30	35
Concert Hall	30	35
Theater	30	35
Store (Retail)	35	40
Supermarkets	45	50
Office	35	40
School, Lecture Room	30	35
Hotel, Ballroom	30	35
Hotel, Lobby	35	40
Hotel, Restaurant	40	45
Car Park	50	55
Staircase	50	55

5E.10.3.3 Recommended Practices to Minimize Noise Generation

a) Double fire retardant flexible connections should be used to connect the ducts with equipment such as air handling unit, fan coil units, computer room air-con unit, fans, blowers, heat exchanger, etc

b) Vibration isolation pads of suitable thickness commensurate to loading for isolation of vibration should be provided under all equipment. The manufacturer should be consulted for proper selection of vibration isolators and inertia block if necessary.

c) Flexible conduit connections for electrical cables to motors should be used. All loops should be adequate to allow connections to remain flexible. Where the cables are not able to be housed in conduits due to the size of cable, the adequate cable slack should be provided. The type of cables shall comply with applicable electrical standards.

d) The floor supported piping should be mounted on pipe supports with minimum 7.5mm ribbed neoprene pads between the base plate of the pipes and the floors.

e) All items suspended from false ceiling should be isolated on separate hangers and if require, the spring isolators should be considered for heavy pipes.

f) In case of ducts, conduits, pipes & tubes the annular space between construction and penetrating element should be sealed with non-hardening sealant. If the penetration is required to be fire compartmented, and then approved fire stop material shall be used.

g) The supply duct starting from air handling unit & plenum and higher capacity fans should be provided with acoustic lining. The type of lining used shall comply with applicable codes and standards. The silencers may be required for some applications.

h) The terminal outlets such as diffusers, registers, grills, louvers and intake louvers should be carefully selected to meet the acoustic criteria of space/ room in which they are installed.

5E.11 Testing and Commissioning

5E.11.1 Objectives

Upon completion of system and equipment installation, testing and commissioning shall be carried out to ensure equipment is performed according to the design intent.

Testing and commissioning shall be carried out by competent person who has knowledge in design, installation and testing and commissioning. The factory trained personnel should be engaged as necessary.

5E.11.2 Pre Testing and Commissioning

Pre commissioning procedure shall be carried out in accordance to OEM (Original Equipment Manufacturer) recommendation. Proper procedure, method statement, check list, flow chart and coordination with various trades should be established to ensure smooth and safe commissioning.

5E.11.3 Testing and Commissioning

a) Prior to actual commissioning, the competent person shall establish operational risk assessment to prevent incidents and accidents during commissioning. The operational risk assessment shall be jointly reviewed and endorsed by OSHE (Occupational, Safety, Health and Environment) officer and the Mechanical & Electrical project manager.

   Actual onsite installation such as equipment location, electrical and control panel location, duct/pipe layout shall be checked and verified against as built drawing prior to the commissioning.

b) The Calibrated instruments shall be used to measure temperatures, pressures, rotational speeds, electrical characteristics, velocities, and air and water quantities for an evaluation of equipment and system performance.

c) The final setting of balancing devices such as dampers and valves, adjusting fan speeds and pump impeller sizes, in addition to automatic control devices such as thermostats and pressure controllers shall be carried out to achieve maximum specified system performance and efficiency during normal operation.

d) The balancing of fluid flows (air or water) through the use of acceptable procedures should be carried out to achieve the desired or specified airflow or water flow.

e) The Testing and commissioning methods established by following organization are recommended:
   1) ASHRAE guide line 1.1
   2) NEBB (National Environmental Balancing Bureau)

5E.11.4 Post Testing and Commissioning

a) The Testing and commissioning records shall be compiled in Operation and Maintenance Manual and handed over to facility (maintenance) team deployed by the owner / client.

b) The training to the facility team shall be conducted to ensure personnel maintaining the system and equipment have adequate knowledge on the real time operation and to deal with system trouble shooting.

c) Daily monitoring of equipment operating data and periodic review of equipment performance shall be done to ensure system and equipment are operating within acceptable control range.

d) The contact of supplier and vendor, as-built drawing, operation and maintenance manual shall be readily available at facility department.

e) The emergency response plan shall be established to take immediate action in the event of emergency whether equipment break down or human incidents.

5E.12 Servicing and Maintenance

This section covers the requirements for servicing and maintenance for equipment and system.

5E.12.1 General Requirements

5E.12.1.1 In order to maintain efficient operation, energy saving and useful life of equipment, genuine and well ordered servicing and maintenance shall carry out for equipment and associated system.

5E.12.1.2 Well-trained maintenance staffs shall carry out for servicing and maintenance for equipment and system.

5E.12.1.3 All the necessary documents such as as-built drawings, operation & maintenance manuals, manufacturers' instruction, catalogues, single line and control circuit diagrams of electrical and control system shall be recorded and maintained systematically for future references for servicing and maintenance.

5E.12.1.4 All records and reports of faults, breakdown, repairs, trouble shooting, overhaul etc shall maintain for future references.

5E.12.2 Maintenance Frequencies

5E.12.2.1 The following equipment shall be maintained monthly.

- Chillers
- Cooling Towers
- Pumps
- Air Handling Units
- Fan Coil Units
- Condensing & Indoor Unit (DX System)
- Water Treatment System
- Auto Tube Cleaning System

5E.12.2.2 The following equipment shall be maintained quarterly.

- Mechanical Ventilation System Fans
- Local Control Panels for Equipment
- DDC Panels (For ACMV System)
- MIMIC Panels (For ACMV System)

5E.12.2.3 The following equipment shall be maintained yearly.

- Motor Control Centre (MCC)
- Overhauling of Pumps if necessary
- Overhauling of Air Handling Units
- Overhauling of Condensing Units (DX System)
- Overhauling of Fan Coil Unit if necessary
- Chilled Water Expansion Tank if necessary
- Cooling Tower Make-up Water Tank if necessary

5E.12.3 Maintenance Check Lists

5E.12.3.1 Chiller

- Check for pressure, refrigerant temperature, water in and water out temperature, water in and out pressure and flow rate of cooler.
- Check for pressure, refrigerant temperature, water in and water out temperature, water in and out pressure and flow rate of condenser.
- Check for Oil reclaim output, bearing temperature, oil level, sump temperature, discharge temperature, discharge superheat temperature, vaporizer temperature, rotor inlet temperature, motor winding temperature, ampere, Line and average voltage of Compressor.
- Check for Oil differential pressure and oil pump ampere.
- Inspect the condition of joints, isolation valves, leaks, safety devices, control devices, sensors and filters. Repair or replace if required.

5E.12.3.2 Cooling Tower

- Check the function of the cooling tower and associated control system.
- Check on structure and condition of towers and repair if necessary.
- Check the spray weir of the tank and strainer in the recirculating water pipe of the water basin.
- Check and clean infill surfaces and drift eliminators with low pressure hose.
- Check and clean water basin and surface of internal pipes.
- Check belt tension and adjust if necessary.
- Check on water treatment system and make sure that comply environmental authority requirements.
- Lubricate the bearing of fan if necessary.
- Check operating water level and adjust ball valve if necessary.
- Check atmospheric condition near cooling tower and existence of obstacle which block ventilation.

5E.12.3.3 Pump

- Check the function of pump and make sure that pump is operating as per designed condition.
- Check the water seals, vibration, noise, and alignment and repair / rectify if necessary.
- Check the bearing and add grease if necessary.

5E.12.3.4 Air Handling Unit (AHU)

- Check the function of air handling unit and associated control system.
- Check the air filter, unit casing and cooling coils and wash / replace if necessary.
- Check and clean the condensate drain pan and drain pipe.
- Check the tension of belt and adjust if necessary.
- Check the bearing of blower and add grease if necessary.
- Check the operation of sensors, thermostat, modulating valves, isolation valves, pressure gauge and thermometer and replace if necessary.
- Check the abnormal noise and vibration. Replace bearing and spring isolator if necessary.
- Check the Y Strainer and clean if necessary.
- Check the electrical components function and rectify if necessary.

5E.12.3.5 Fan Coil Unit (FCU)

- Check the function of fan coil unit and associated control system.
- Check the air filter, unit casing and cooling coils and wash / replace if necessary.
- Check and clear the condensate drain pan and drain pipe.

- Check the bearing of blower and add grease if necessary.
- Check the operation of sensors, thermostat, modulating valves and isolation valves and replace if necessary.
- Check the abnormal noise and vibration. Replace bearing and spring isolator if necessary.
- Check the Y Strainer and clean if necessary.
- Check the electrical components function and rectify if necessary.

5E.12.3.6 Motor

- Check the operation of the motor and associated control.
- Check for abnormal noise and vibration. Add lubricant bearing if necessary.
- Check the running ampere of motor and make sure that it is operating in order.
- Check the electrical components such as protection device, starter, contactor, fuses and cable termination and adjust and rectify if necessary.
- Check the belt tension and adjust and rectify if necessary.

5E.12.3.7 Local Control Panel (LCP)

- Check the indicator light and replace if bulb is blown. (Use Lamp Test Button)
- Check and clean the internal and external enclosure.
- Remove the dust from the enclosure if required.
- Check and tighten all cable termination if necessary.
- Check the cable insulation test and record.
- Check and test the function of protection devices and make sure all are in order.

5E.12.3.8 Motor Control Centre (MCC)

- Check the indicator light and replace if bulb is blown. (Use Lamp Test Button)
- Check and clean internal and external enclosure.
- Remove the dust from the enclosure if required.
- Check and tighten all cable and bus duct termination if necessary.
- Check the cable and bus duct insulation test and record.
- Check and test the function of protection devices and make sure all are in order.

5E.12.3.9 Mechanical Ventilation Fan

- Check the operation of the fan and associated control.
- Check the abnormal noise and vibration. Add lubricant bearing of necessary.
- Check the fan casing and metal components and rectify / paint if necessary. (Yearly)
- Check fan blades for wear and tear. Clean the blade if necessary.
- Check the motor running ampere and ensure the motor is operating under normal condition.

- Check the cable termination and tighten if necessary.
- Check the tension of belt and adjust and tighten if necessary.
- Check the flexible connector and vibration isolators and replace if necessary.
- Check the filter and replace if necessary.
- Check the fan shaft alignment and adjust if necessary (Yearly)
- Check the bolt & nut connection and tighten if necessary (Yearly)

5E.13 Fire Mode Requirements

This section covers the requirements of fire mode for essential equipment of mechanical ventilation and air-conditioning system.

The mechanical ventilation systems serve the essential rooms in section 5E.13.1 shall continue to operate and/or activate to operate in the event of / and during a fire. A secondary source of power supply shall be provided to mechanical ventilation systems serve the essential rooms in section 5E.13.1 in accordance with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1 Requirements for Mechanical Ventilation System

5E.13.1.1 Exit Staircase and Internal Exit Passage Way

The ventilation rate for exit staircase and internal exit passage way shall be supply mode of minimum 4 air changes per hour. Design and operation of facilities shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.2 Pressurization in Internal Corridors in Hotel

The internal corridors in hotel to be pressurized in accordance with BS 5588 Part 4 where required by Myanmar Fire Safety Code (MFSC).

Design and operation of facilities shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.3 Smoke Stop Lobby and Fire-Fighting Lobby

The ventilation rate for smoke stop lobby and fire-fighting lobby during normal operation shall be in accordance with section 5E.5.2.1.2. The supply mode of minimum 10 air changes per hour when activated by building fire alarm system.

Design and operation of facilities shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.4 Pressurization System for Exit Staircase

The exit staircase to be pressurized in accordance with BS 5588 Part 4 where required by Myanmar Fire Safety Code (MFSC).

Design and operation of facilities shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.5 Fire Command Centre

Fire Command Centre should be designed either Natural Ventilation, Mechanical Ventilation or Air-conditioning independently of each other. Where Mechanical Ventilation is provided, design and operation of facilities shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.6 Fire Pump Room

The mechanical ventilation system should design to maintain the temperature in fire pump room does not raise the temperature beyond 5°C above ambient temperature at pumps running rated load.

The mechanical ventilation system shall be activated by pump status upon building fire alarm system for status feedback. Design and operation of facilities shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.7 Emergency Power Generator Room

The ventilation system should design to maintain the temperature in standby generator room either mechanical means or natural means for removal of heat generated by radiator from standby diesel generator in the room. Where mechanical ventilation is provided, it should design to maintain the temperature in standby generator room does not raise the temperature beyond 5°C above ambient temperature and it shall be activated by building fire alarm system and automatically shut down after the load bank and its cooling fans are deactivated.

Design and operation of facilities shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.8 Kitchen

The kitchen ventilation system shall be in accordance with section 5E.5.4.

Design and operation of facilities shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.9 Room Contains Flammable/Gas Substances

The Mechanical Ventilation system shall provide supply and exhaust and ventilation rate of not less than 20 air changes per hour. The room design and operation shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.10 Room Stores Flammable Liquids

Amount of flammable liquids storage requirements shall comply with Myanmar Fire Safety Code (MFSC). Mechanical Ventilation system for flammable liquid storage shall comply with the followings:

a) The termination points for the air supply and exhaust shall be immediately above the upper limit of spillage compound and shall be located along the longer side of the storage room on opposing walls to optimize effectiveness.

b) Vapours from flammable liquids are heavier than air as to design scavenge vapours from lower parts of the store.

c) The room shall keep under negative pressure.

d) The system shall provide with the exhaust rate of 0.3m^3/m^2 of floor area per minute or 5m^3/min, whichever is higher. The supply air velocity shall not be less than 5m/s.

e) The flammable liquids storage room design and operation shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.11 Basement Car Parks

The ventilation rate for basement car parks during normal operation shall be in accordance with section 5E.5.3.3. Minimum smoke purging rate of not less than 9 air change per hour shall provide to total basement carpark area greater 2000m^2. Design and operation facilities shall comply with requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.12 Basement Occupancies Other Than Carparks

Design and operation facilities shall comply with the requirements of smoke control system of Myanmar Fire Safety Code (MFSC).

5E.13.1.13 Engineered Smoke Control System

The following spaces shall require to provide the engineered smoke control system in accordance with BR 186 - Design principles for smoke ventilation in enclosed shopping centre and BR 258 - Design approaches for smoke control in atrium buildings:

a) Basement total floor area for usage larger than 2000 m^2 (other than carpark)

b) Atrium

c) Auditorium space larger than 500m^2.

Engineered Smoke Control system shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.1.14: Design and operation of pressurization systems for exit facilities shall comply with the requirements of Myanmar Fire Safety Code (MFSC).

5E.13.2 Requirements for Air-Conditioning System

Smoke detectors shall automatically stop their respective AHU on detecting the presence of smoke in the return air stream. Smoke detectors listed for use in air distribution system shall be located at prior to return system of air handling unit meeting one of the following conditions:

a) AHU serving more than one storey or fire compartment

b) AHU flowrate of greater than 15,000cmh

c) Any AHU as may be required by the authority.

Probe type or spot detector are suitable for AHU with high air flowrate.

5E.14 Miscellaneous

5E.14.1 References

The following documents are referred for the application of this code.

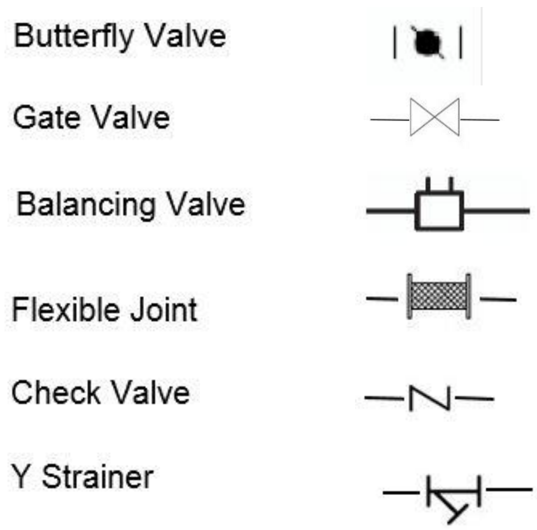
1. ANSI / ASHRAE Standard 62.1 Ventilation for Acceptable Indoor Air Quality
2. ANSI / ASHRAE Standard 90.1 Energy Standard for Buildings Except Low Rise Residential
3. SS 530 : 2006 Code of Practice for energy efficiency standard for building services and equipment, Singapore
4. SS 532 : 2007 Code of practice for the storage of flammable liquids, Singapore
5. SS 553 : 2016 Code of Practice for Air-conditioning and Mechanical Ventilation in Buildings, Singapore
6. SS 554 : 2016 Code of Practice for Indoor Air quality for air-conditioned building, Singapore
7. Fire Code 2013, Singapore Civil Defense Force
8. BCA Green Mark, Building & Construction Authority, Singapore
9. LEED Guidelines, U.S.A

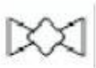
5E.14.2 Symbols

5E.14.2.1 Pipe Work

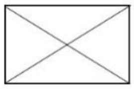
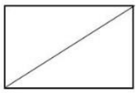
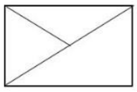
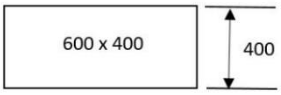
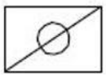
Chilled Water Supply	CHWS
Chilled Water Return	CHWR
Condenser Water Supply	CWS
Condenser Water Return	CWR
Drain	D
Refrigerant Discharge	RD
Refrigerant Suction	RS
Make Up Water	MU

5E.14.2.2 Valves and Accessories



Drain Cock	
Ball Valve	
Plug Valve	
Globe Valve	

5E.14.2.3 Duct Work

Supply Duct Section	
Return Duct Section	
Exhaust Duct Section	
Duct Layout or Elevation	
Volume Control Damper	

5E.14.2.4 Grilles, Diffusers & Accessories

Weather Proof Louver	WPL
Exhaust Air Louver	EAL
Fresh Air Louver	FAL
Supply Air Diffuser / Grille	SAD / SAG
Return Air Diffuser / Grille	RAD / RAG
Fresh Air Grille	FAG
Exhaust Air Grille	EAG
Variable Air Volume Box	VAV
Constant Air Volume Box	CAV
Fire Damper	FD
Supply Air Linear Diffuser	SALD
Return Air Linear Diffuser	RALD

5E.14.3 Color Codes for Services

5E.14.3.1 The following color codes and labels shall be used to identify the pipelines using in air-conditioning system.

Table 5E.14.3.1 Color Codes and Labels

Pipeline	**Label**	**Color**
Chilled Water Supply	CHWS	Light Blue
Chilled Water Return	CHWR	Dark Blue
Condenser Water Supply	CWS	Light Green
Condenser Water Return	CWR	Dark Green
Make Up Water	MU	Medium Blue
Condensate Drain Water	D	Black

5E.14.3.2 Respective labels shall be provided with “Arrow Sign” to indicate the flow direction of conveying fluids inside pipelines.

5E.14.3.3 Labels and arrow signs shall be painted black color and shall be visible from the ground level. Using of good quality stickers shall be considered as an option.

5E.14.3.4 The distance between adjacent two labels completed with arrow sign shall be 3 meter in minimum.

5E.14.4 Appendixes

5E.14.4.1 ASHRAE 90.1 Building Envelope Requirements for Climate Zones.

Table 5.5-1 Building Envelope Requirements for Climate Zone 1 (A,B,C)*

	Nonresidential		Residential		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation Entirely above Deck	U-0.273	R-3.5 c.i.	U-0.220	R-4.4 c.i.	U-1.240	R-0.7 c.i.
Metal Building[a]	U-0.233	R-1.8 + R-3.3 FC	U-0.233	R-1.8 + R-3.3 FC	U-0.653	R-1.8
Attic and Other	U-0.153	R-6.7	U-0.153	R-6.7	U-0.459	R-2.3
Walls, above Grade						
Mass	U-3.293	NR	U-0.857[b]	R-1.0 c.i.[b]	U-3.293	NR
Metal Building	U-0.533	R-0 + R-1.7 c.i.	U-0.533	R-0 + R-1.7 c.i.	U-1.998	NR
Steel Framed	U-0.705	R-2.3	U-0.705	R-2.3	U-1.998	NR
Wood Framed and Other	U-0.504	R-2.3	U-0.504	R-2.3	U-1.660	NR
Wall, below Grade						
Below Grade Wall	C-6.473	NR	C-6.473	NR	C-6.473	NR
Floors						
Mass	U-1.825	NR	U-1.825	NR	U-1.825	NR
Steel Joist	U-1.986	NR	U-1.986	NR	U-1.986	NR
Wood Framed and Other	U-1.599	NR	U-1.599	NR	U-1.599	NR
Slab-on-Grade Floors						
Unheated	F-1.264	NR	F-1.264	NR	F-1.264	NR
Heated	F-1.766	R-1.3 for 300 mm	F-1.766	R-1.3 for 300 mm	F-1.766	R-1.3 for 300 mm
Opaque Doors						
Swinging	U-3.975		U-2.839		U-3.975	
Nonswinging	U-8.233		U-2.839		U-8.233	

Fenestration	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/SHGC**
Vertical Fenestration, 0%–40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-2.84[c]			U-2.84[c]			U-5.28		
Metal framing, fixed	U-3.24[c]			U-3.24[c]			U-6.81		
Metal framing, operable	U-3.69[c]	SHGC-0.25	1.10	U-3.69[c]	SHGC-0.25	1.10	U-6.81	NR	NR
Metal framing, entrance door	U-6.25[c]			U-6.25[c]			U-6.25[c]		
Skylight, 0%–3% of Roof									
All types	U-4.26	SHGC-0.35	NR	U-4.26	SHGC-0.35	NR	U-10.22	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

b. Exception to Section 5.5.3.2 applies for mass walls above grade.

c. For locations in Climate Zone 1 with a cooling design temperature of 35°C and greater, see Section 5.5.4.3 for the maximum U-factors for vertical fenestration.

Table 5.5-2 Building Envelope Requirements for Climate Zone 2 (A,B)*

Opaque Elements	Nonresidential Assembly Maximum	Nonresidential Insulation Min. R-Value	Residential Assembly Maximum	Residential Insulation Min. R-Value	Semiheated Assembly Maximum	Semiheated Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.220	R-4.4 c.i.	U-0.220	R-4.4 c.i.	U-0.982	R-0.9 c.i.
Metal Building[a]	U-0.233	R-1.8 + R-3.3 FC	U-0.233	R-1.8 + R-3.3 FC	U-0.545	R-2.8
Attic and Other	U-0.153	R-6.7	U-0.153	R-6.7	U-0.300	R-3.3
Walls, above Grade						
Mass	U-0.857[b]	R-1.0 c.i.[b]	U-0.701	R-1.3 c.i.	U-3.293	NR
Metal Building	U-0.533	R-0 + R-1.7 c.i.	U-0.533	R-0 + R-1.7 c.i.	U-0.920	R-2.3
Steel Framed	U-0.479	R-2.3 + R-0.7 c.i.	U-0.365	R-2.3 + R-1.3 c.i.	U-0.705	R-2.3
Wood Framed and Other	U-0.504	R-2.3	U-0.504	R-2.3	U-0.504	R-2.3
Wall, below Grade						
Below Grade Wall	C-6.473	NR	C-6.473	NR	C-6.473	NR
Floors						
Mass	U-0.606	R-1.9	U-0.496	R-1.5	U-1.825	NR
Steel Joist	U-0.214	R-5.3	U-0.214	R-5.3	U-0.390	R-2.3
Wood Framed and Other	U-0.188	R-5.3	U-0.188	R-5.3	U-0.376	R-2.3
Slab-on-Grade Floors						
Unheated	F-1.264	NR	F-1.264	NR	F-1.264	NR
Heated	F-1.558	R-1.8 for 600 mm	F-1.489	R-2.6 for 600 mm	F-1.766	R-1.3 for 300 mm
Opaque Doors						
Swinging	U-3.975		U-2.839		U-3.975	
Nonswinging	U-2.839		U-2.839		U-8.233	

Fenestration	Nonresidential Assembly Max. U	Nonresidential Assembly Max. SHGC	Nonresidential Assembly Min. VT/SHGC	Residential Assembly Max. U	Residential Assembly Max. SHGC	Residential Assembly Min. VT/SHGC	Semiheated Assembly Max. U	Semiheated Assembly Max. SHGC	Semiheated Assembly Min. VT/SHGC
Vertical Fenestration, 0%–40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-2.27			U-2.27			U-5.28		
Metal framing, fixed	U-3.24			U-3.24			U-6.81		
Metal framing, operable	U-3.69	SHGC-0.25	1.10	U-3.69	SHGC-0.25	1.10	U-6.81	NR	NR
Metal framing, entrance door	U-4.71			U-4.37			U-4.71		
Skylight, 0%–3% of Roof									
All types	U-3.69	SHGC-0.35	NR	U-3.69	SHGC-0.35	NR	U-10.22	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

b. Exception to Section 5.5.3.2 applies for mass walls above grade.

Table 5.5-3 Building Envelope Requirements for Climate Zone 3 (A,B,C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.220	R-4.4 c.i.	U-0.220	R-4.4 c.i.	U-0.677	R-1.3 c.i.
Metal Building[a]	U-0.233	R-1.8 + R-3.3 FC	U-0.233	R-1.8 + R-3.3 FC	U-0.545	R-2.8
Attic and Other	U-0.153	R-6.7	U-0.153	R-6.7	U-0.300	R-3.3
Walls, above Grade						
Mass	U-0.701	R-1.3 c.i.	U-0.592	R-1.7 c.i.	U-3.293	NR
Metal Building	U-0.533	R-0 + R-1.7 c.i.	U-0.410	R-0 + R-2.3 c.i.	U-0.920	R-2.3
Steel Framed	U-0.435	R-2.3 + R-0.9 c.i.	U-0.365	R-2.3 + R-1.3 c.i.	U-0.705	R-2.3
Wood Framed and Other	U-0.504	R-2.3	U-0.365	R-2.3 + R-0.7 c.i. or R-3.5	U-0.504	R-2.3
Wall, below Grade						
Below Grade Wall	C-6.473	NR	C-6.473	NR	C-6.473	NR
Floors						
Mass	U-0.420	R-1.8 c.i.	U-0.420	R-1.8 c.i.	U-0.780	R-0.7 c.i.
Steel Joist	U-0.214	R-5.3	U-0.214	R-5.3	U-0.296	R-3.3
Wood Framed and Other	U-0.188	R-5.3	U-0.188	R-5.3	U-0.288	R-3.3
Slab-on-Grade Floors						
Unheated	F-1.264	NR	F-0.935	R-1.8 for 600 mm	F-1.264	NR
Heated	F-1.489	R-2.6 for 600 mm	F-1.489	R-2.6 for 600 mm	F-1.766	R-1.3 for 300 mm
Opaque Doors						
Swinging	U-3.975		U-2.839		U-3.975	
Nonswinging	U-2.839		U-2.839		U-8.233	

Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC
Vertical Fenestration, 0%–40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.99			U-1.99			U-4.94		
Metal framing, fixed	U-2.84			U-2.84			U-6.81		
Metal framing, operable	U-3.41	SHGC-0.25	1.10	U-3.41	SHGC-0.25	1.10	U-6.81	NR	NR
Metal framing, entrance door	U-4.37			U-3.86			U-4.37		
Skylight, 0%–3% of Roof									
All types	U-3.12	SHGC-0.35	NR	U-3.12	SHGC-0.35	NR	U-9.65	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

MNBC -2025 TECHNICAL WORKING GROUP (TWG-5E)

Participants List

1.	U Yin Htwe Thet	Group Leader
2.	U Tin Oo	Member
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4.	Dr. Ei Mon	Member
5.	U Soe Naing Win	Member
6.	Daw Aye Sabal Aung	Member

MYANMAR NATIONAL BUILDING CODE 2025

PART 5F

BUILDING SERVICES

FIRE SAFETY, FIRE PROTECTION SYSTEMS AND MEANS OF ESCAPE

MYANMAR NATIONAL BUILDING CODE - 2025
PART-5F BUILDING SERVICES FIRE SAFETY, FIRE PROTECTION SYSTEMS AND MEANS OF ESCAPE

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MYANMAR NATIONAL BUILDING CODE–2025
PART 5F BUILDING SERVICES
FIRE SAFETY, FIRE PROTECTION SYSTEMS AND MEANS OF ESCAPE

5F.1 General

5F.1.1 Background

The Myanmar Fire Safety Code-2020 (MFSC-2020) was in the process of being approved and published when the Myanmar National Building Code-2020 (MNBC-2020) was published. As a result, MNBC-2020 Part 5F served as a supplement to the complete volume of MNBC-2020, featuring concise general definitions to prevent any conflicts with the forthcoming MFSC-2020.

5F.1.2 Myanmar Fire Safety Code – 2020

The MNBC-2025 Part 5F amendment is essential for compliance with the published Myanmar Fire Safety Code-2020.

(a) On December 30th, 2020, the Fire Services Department, Ministry of Home Affairs released the Myanmar Fire Safety Code - 2020 with the notification number (1999/2020). The MFSC-2020 covers all aspects of fire safety measures, describing the minimum requirements for fire safety systems and means of escape, structural fire precautions, firefighting appliances planning, external extinguishing proposals, and firefighting systems based on the occupancy type.

(b) In this amendment, MNBC-2025 Part 5 F, the Fire Safety, Fire Protection Systems, and Means of Escape refers to the MFSC-2020 for compliance with all fire safety aspects in planning, designing, installation, maintaining, application, and approval processes. Subsequently, a Fire Safety Certificate must be obtained. Prior approval from the Myanmar Fire Services Department is required if references are made to other codes and standards.

5F.1.3 Fire Safety Certificate

In Section 17 of Myanmar Fire Force Law (2015), it is stated that the relevant government department or organization shall, for the purpose of fire safety, obtain the recommendation of the Inspection on fire safety of the Department of Fire Services before granting permission. Therefore, A Fire Safety Certificate shall be applied for and submitted when applying for a building or business permit to the relevant organizations.

5F.2 Classification of Building

5F.2.1 In Myanmar National Building Code-2020, all buildings, structures, and spaces are classified based on use and occupancy into ten groups as follows-

(a) Group A: Assembly (A1 to A5)
(b) Group B: Business
(c) Group E: Educational
(d) Group F: Factory and Industrial (F1 & F2)
(e) Group H: Hazardous
(f) Group I: Institutional (I1 to I5)
(g) Group M: Mercantile
(h) Group R: Residential (R1 to R6)
(i) Group S: Storage (S1 to S2)
(j) Group U: Utility and Miscellaneous (U1 to U3)

Comparison between Myanmar Fire Safety Code: Purpose for which Building or Part of the Building is intended to be used Vs. Myanmar National Building Code: Classification of Buildings by Use and Occupancy

Myanmar National Building Code			Myanmar Fire Safety Code			Remarks
Group	Sub-Group	Classification of buildings by use and occupancy	Purpose Group	Classification	Purpose for which building or part of the Building is intended to be used	
Assembly (Group A)	A-1	Assembly uses, usually with fixed seating, intended for the production and viewing of the performing arts or motion pictures including, but not limited to: Motion picture theatres Symphony and concert halls Television and radio studios admitting an audienceTheatres, etc.	VII	Place of Public Resort	Premises used for social, recreational or business purposes to include hotels , holidays resorts, boarding houses , service apartments, convention centres, private clubs, community centres, museums, public art galleries, exhibition centres, theatres , cinemas, concert halls, public libraries, religious buildings, public sports complex, stadium , public swimming complex, recreational buildings , amusement centres, eating houses, restaurants, coffee shops, hawker centres, fast food outlets , bus terminals, train stations, airport and ferry terminals .	
	A-2	Assembly uses intended for food and/or drink consumption including, but not limited to: Banquet halls, Clubs, Restaurants, Food courts, Bars				
	A-3	Assembly uses intended for worship, recreation or amusement and other assembly uses not classified elsewhere in Group A including, but not limited to: Amusement arcades, Art galleries, Bowling alleys, Community halls, Courtrooms, Dharma Halls, Dance halls, Exhibition halls, Funeral parlours, Gymnasiums, Indoor swimming pools, Indoor tennis courts, Lecture halls, Libraries, Museums, Places of religious worship: Pagodas, Temples, Churches, Mosques, etc., Pool and billiard parlours Waiting areas in transportation terminals, etc.				
	A-4	Assembly uses intended for viewing of indoor sporting events and activities with spectator seating including, but not limited to: Arenas, Skating rinks, Swimming pools, Tennis courts, etc.				
	A-5	Assembly uses intended for participation in or viewing outdoor activities including, but not limited to: Amusement park structures Grandstands Stadiums				

Comparison between Myanmar Fire Safety Code: Purpose for which Building or Part of the Building is intended to be used Vs. Myanmar National Building Code: Classification of Buildings by Use and Occupancy

Myanmar National Building Code			**Myanmar Fire Safety Code**			Remarks
Group	Sub-Group	Classification of buildings by use and occupancy	Purpose Group	Classifi cation	Purpose for which building or part of the Building is intended to be used	
Business (Group B)	_	Business occupancy includes, among others, the use of a building or structure, or a portion thereof, for office, professional or service- type transactions, including storage of records and accounts. Business occup - ancies including, but not limited to: Airport traffic control towers ,Ambulatory health care facilities, Veterinary, Banks Barber and beauty shops,Car wash Clinic-outpatient, Dry cleaning and laundries: pick-up and delivery stations and self-service,Electronic data processng: public internet access centre, Laboratories: testing and research, Motor vehicle, showrooms, Post offices,Print shops, Professional services (architects,attor neys, dentists, physicians, engineers, etc.), Radio and television stations Telephone exchanges, Training and skill development not within a school or academic program, etc.	IV	Office	Office or premises used for office purposes meaning the purposes of administration , clerical work (including book-keeping, accounting, drawing and editorial work etc) telephone and telegraph operating and banking or as premises occupied with an office for the purposes of the activities therein carried on.	
Educa-tional (Group E)	Group E	Educational occupancy includes, among others,the use of a building or structure, or a portion thereof, by sis or more persons at any time for educational purposes of the basic education (Group E1) and higher education (Group E2). Assembly areas of Group E occupancy having more than 50 occupant loads are considered as Group A-3 occupancy. Religious educational rooms and religious auditoriums, which are accessory to places for religious worship in accordance with assembly portion and have occupant loads of less than 50, shall be classified as A-3 occupancies.	III	Institu-tional	Establishments used for treatment , care or maintenance of persons suffering from disabilities, or educational purposes and accommodations, including hospitals , clinics, polyclinics, student hostels, dormitories, old folks homes, orphanages , children's homes, day-care centres, infant care ,kindergartens, army camps, detention /correction centres, schools, colleges , commercial schools, vocational institutions, polytechnics and universities.	
	E-1	Basic Education Schools, Day Care, Vocational Training Centres, Etc.				
	E-2	Educational occupancies for students above High School				

Comparison between Myanmar Fire Safety Code: Purpose for which Building or Part of the Building is intended to be used Vs. Myanmar National Building Code: Classification of Buildings by Use and Occupancy

Myanmar National Building Code			Myanmar Fire Safety Code			Remarks
Group	Sub-Group	Classification of buildings by use and occupancy	Purpose Group	Classifi cation	Purpose for which building or part of the Building is intended to be used	
Factory and Industrial (Group F)	F-1	Factory industrial uses which are not classified as Factory Industrial F-2 Low Hazard (which can be small, medium or large industries according to the 1990 Private Industrial Enterprises Law) shall be classified as F-1 Moderate Hazard including, but not limited to: Aircraft (manufacturing, not to include repair), Appliances, Athletic equipment, Automobiles and other motor vehicles, Bakeries, Beverages: over 16 percent alcohol content, Bicycles, Boats, Brooms or brushes, Business machines Cameras and photo equipment, Canvas or similar fabric, Carpets and rugs (includes	VI	Factory	A factory refers to any industrial premises with manufacturing, processing, servicing or testing activities.	
		cleaning), Clothing, Construction and agricul -tural machinery, Disinfectants, Dry cleaning and dyeing, Electric generation plants, Elect -ronics, Engines (including rebuilding), Food processing, Furniture, Fibrous products, Incine -ration Plant, Jute products, Laundries, Leat -her products, Land Fill Gas Plant, Machi -nery, Metals, Millwork (sash and door), Mot-ion pictures and tele-vision filming (without spectators), Musical instruments, Optical goods, paper mills or products, Photographic film, Plastic products, Printing or publishing, Recreational vehicles, Refuse incineration, Shoes, Soaps and deter -gents, Textiles, Tob -acco,Trailers, Upholster- ing, Woodworking (cabinet, etc.), Wood; disti -llation, etc.	VI	Factory	A factory refers to any industrial premises with manufacturing, processing, servicing or testing activities.	

Comparison between Myanmar Fire Safety Code: Purpose for which Building or Part of the Building is intended to be used Vs. Myanmar National Building Code: Classification of Buildings by Use and Occupancy

Myanmar National Building Code			Myanmar Fire Safety Code			Remarks
Group	Sub-Group	Classification of buildings by use and occupancy	Purpose Group	Classifi cation	Purpose for which building or part of the Building is intended to be used	
	F-2	Factory industrial uses that involve the fabrication or manufacturing of non comb -ustible materials which during finishing, packing or processing do not involve a signifi- cant fire hazard shall be classified as F-2 occupancies (which can be small, medium or large industries according to the 1990 Private Industrial Enterprises Law) including, but not limited to: Beverages: up to and including 16-percent alcohol content, Brick and masonry, Ceramic products, Cottage industries, Foundries, Glass products, Gypsum, Ice, Metal products (fabrication and assembly), etc.				
High Hazard-ous (Group H)	H-1	Storage and handling of hazardous and highly flammable material,	VIII	Storage	Place of storage (including godowns, warehouses, stores etc), deposit or parking of goods, materials and / or vehicles.	
	H-2	Storage and handling of flammable material, dry cleaning plants using flammable liquids, paint stores with bulk handling, paint shops and spray painting rooms.	VIII	Storage	Place of storage (including godowns, warehouses, stores etc), deposit or parking of goods, materials and / or vehicles.	
	H-3	Wood working establishments, painting mills and box factories, shops, factories where loose combustible fibers or dust are manu -factured ,processed or generated, ware-houses where high combustible material is stored	VI	Factory	A factory refers to any industrial premises with manufacturing, processing, servicing or testing activities.	
	H-4	Repair garages	VIII	Storage	Place of storage (including godowns, warehouses, stores etc), deposit or parking of goods, materials and / or vehicles.	
	H-5	Aircraft repair hangars.	VI	Factory	A factory refers to any industrial premises with manufacturing, processing, servicing or testing activities.	

Comparison between Myanmar Fire Safety Code: Purpose for which Building or Part of the Building is intended to be used Vs. Myanmar National Building Code: Classification of Buildings by Use and Occupancy

Myanmar National Building Code			Myanmar Fire Safety Code			Remarks
Group	Sub-Group	Classification of buildings by use and occupancy	Purpose Group	Classification	Purpose for which building or part of the Building is intended to be used	
Institu-tional (Group I)	I-1	This occupancy shall include buildings, structures or parts thereof housing more than 16 persons, on a 24-hour basis, who because of age, mental disability or other reasons, live in a super-vised residential environment that provides personal care services. The occupants are capable of responding to an emergency situation without physical assistance from staff. This group shall include, but not limited to: Alcohol and drug centres, Home for Handicapped, Old aged Centres, Residential board and care facilities,Social rehabilitation facilities,Old Aged Centres, etc.	III	Institu-tional	Establishments used for treatment , care or maintenance of persons suffering from disabilities, or educational purposes and accommodations, including hospitals , clinics, polyclinics, student hostels, dormitories, old folks homes, orphanages , children's homes, day-care centres, infant care ,kindergartens, army camps, detention /correction centres, schools, colleges , commercial schools, vocational institutions, polytechnics and universities.	
	I-2	This occupancy shall include buildings and structures used for medical, surgical, psychiatric, nursing or custodial care for persons who are not capable of self-preservation. This group shall include, but not limited to : Child care facilities, Detoxification facilities,Hospitals,Mental hospitals, Nursing homes (both intermediate care facilities and skilled training), etc.	III	Institu-tional	Establishments used for treatment , care or maintenance of persons suffering from disabilities, or educational purposes and accommodations, including hospitals , clinics, polyclinics, student hostels, dormitories, old folks homes, orphanages , children's homes, day-care centres, infant care ,kindergartens, army camps, detention /correction centres, schools, colleges , commercial schools, vocational institutions, polytechnics and universities.	
	I-3	This occupancy shall include buildings and structures that are inhabited by more than five persons who are under restraint or security. Facility of An I-3 is occupied by persons who are generally incapable of self-preservation due to security measures not under the occupants' control. This group shall include the following :Correctional Centres,Detention Centres,Jails,Prisons, etc.				

Comparison between Myanmar Fire Safety Code: Purpose for which Building or Part of the Building is intended to be used Vs. Myanmar National Building Code: Classification of Buildings by Use and Occupancy

Myanmar National Building Code			Myanmar Fire Safety Code			Remarks
Group	Sub-Group	Classification of buildings by use and occupancy	Purpose Group	Classification	Purpose for which building or part of the Building is intended to be used	
	I-4	This group shall include buildings and structures occupied by persons of any age who receive custodial care for less than 24 hours by individuals other than parents or guardians, relatives by blood, marriage or adoption and in a place other than the home of the person cared for.				
	I-5	This occupancy shall include buildings, structures or parts thereof in which people are provided for public service facilities. This group shall include the following :Civic administration, Fire Station, Police Station, etc.				
Mercan-tile (Group M)	_	Mercantile Group M occupancy includes, among others, the use of a building or structure or a portion thereof, for the display and sale of merchandise and involves stocks of goods, wares or merchandise incidental to such purposes and accessible to the public. Mercantile occupancies including, but not limited to: Department stores, Drug stores, Fuel Stations, Markets Motor fuel-dispensing facilities, Retail or wholesale stores, Sales rooms	V	Shop	Shop or shopping centre including departmental stores, shopping arcades, supermarkets , drugstores, showrooms for sale of goods, hairdressing and beauty salons, ticketing agencies, pawnshops, laundries and/ or any other similar trades or businesses.	
Residen-tial (Group R)	R-1	Residential occupancies where the occupants are primarily permanent in nature, including : Buildings that do not contain more than two dwelling units, e.g., Detached and Duplex houses, Congregate living facilities with 16 or fewer persons	I	Small Residential	Private dwelling house such as bungalows, semi-detached houses	
	R-2	Residential occupancies where the occupants are primarily permanent in nature, containing more than two dwelling units, including : Aparment houses, Condominium, Executive Residences	II	Other residen-tial	Accommodation for residential purposes other than any premises comprised in Group I to include flats, maisonettes, apartments etc.	

Comparison between Myanmar Fire Safety Code: Purpose for which Building or Part of the Building is intended to be used Vs. Myanmar National Building Code: Classification of Buildings by Use and Occupancy

Myanmar National Building Code			**Myanmar Fire Safety Code**			Remarks
Group	Sub-Group	Classification of buildings by use and occupancy	Purpose Group	Classification	Purpose for which building or part of the Building is intended to be used	
	R-3	Residential occupancies containing sleeping units where the occupants are primarily permanent in nature, including : Convents, Dormitories, Hostels, Monasteries	III	Institu-tional	Establishments used for treatment , care or maintenance of persons suffering from disabilities, or educational purposes and accommodations, including hospitals , clinics, polyclinics, student hostels, dormitories, old folks homes, orphanages , children's homes, day-care centres, infant care ,kindergartens, army camps, detention /correction centres, schools, colleges , commercial schools, vocational institutions, polytechnics and universities.	
	R-4	Residnetial occupancies shall include buildings arranged for occupancy as residential care/assisted living facilities not more than 16 occupants, excluding staff.				
	R-5	Residnetial occupancies containing sleeping unites or more than two dwelling units or care/assisted living facilites where the occupants are primarily permanent in nature, including: Home for the aged, Nursing home, Retirement home, Orphanage.				
	R-6	Residential occupancies containing sleeping units where the occupants are primarily transient in nature, including: Inns, guest houses, Hotels, Motels, Service Apartments (transient)	VII	Place of Public Resort	Premises used for social, recreational or business purposes to include hotels , holidays resorts, boarding houses , service apartments, convention centres, private clubs, community centres, museums, public art galleries, exhibition centres, theatres , cinemas, concert halls, public libraries, religious buildings, public sports complex, stadium , public swimming complex, recreational buildings, amusement centres, eating houses, restaurants, coffee shops, hawker centres, fast food outlets, bus terminals, train stations, airport and ferry terminals.	

Comparison between Myanmar Fire Safety Code: Purpose for which Building or Part of the Building is intended to be used Vs. Myanmar National Building Code: Classification of Buildings by Use and Occupancy

Myanmar National Building Code			Myanmar Fire Safety Code			Remarks
Group	Sub-Group	Classification of buildings by use and occupancy	Purpose Group	Classification	Purpose for which building or part of the Building is intended to be used	
Moderate-hazard storag (Group S)	S-1	Buildings occupied for storage uses that are not classified as Group S-2, but not limited to: Aerosols, Levels 2 and 3 Aircraft hangar (storage and repair) I Bags: cloth, burlap and paper, Bamboos and rattan, Baskets, Belting: canvas and leather, Books and paper in rolls or packs Boots and shoes, Buttons, including cloth covered, pearl or bone, Cardboard and cardboard boxes, Clothing, woollen wearing apparel, Cordage, Dry boat storage (indoor), Furniture, Furs, Glues, mucilage, pastes and size, Grains, Horns and combs, other than celluloid, LeatherLinoleum, Lumber, Motor vehicle repair	VIII	Storage	Place of storage (including godowns, warehouses, stores etc), deposit or parking of goods, materials and / or vehicles.	
		garages, Photo engravings, Resilient flooring, Silks, Soaps, Sugar, Tires, bulk storage of Tobacco, cigars, cigarettes and snuff, Upholstery and mattresses, Wax candles				
Low-Hazard storage	S-2	Group S-2 includes, among others, buildings used for the storage of non-combustible materials such as products on wood pallets or in paper cartons with or without single thickness divisions; or in paper wrappings. Such products are permitted to have a negligible amount of plastic trim, such as knobs, handles or film wrapping. Group S-2 storage uses shall include, but not limited to: Asbestos, Beverages up to and including 16-percent alcohol in metal, glass or ceramic containers, Cement in bags, Chalk and crayons, Dairy products in non waxed coated paper containers, Dry cell	VIII	Storage	Place of storage (including godowns, warehouses, stores etc), deposit or parking of goods, materials and / or vehicles.	

Comparison between Myanmar Fire Safety Code: Purpose for which Building or Part of the Building is intended to be used Vs. Myanmar National Building Code: Classification of Buildings by Use and Occupancy

Myanmar National Building Code			Myanmar Fire Safety Code			Remarks
Group	Sub-Group	Classification of buildings by use and occupancy	Purpose Group	Classification	Purpose for which building or part of the Building is intended to be used	
		batteries, electrical coils, Electrical motors, Empty cans, Food products, Foods in non-combustible containers, fresh fruits and vegetables in non plastic trays or containers, Frozen foods, Glass,Glass bottles, empty or filled with non-combustible liquids, Gypsum board,Inert pigments, Ivory, Meats, Metal cabinets, Metal desks with plastic tops and trim, Metal parts, Metals, Mirrors, Oil-filled and other types of distribution transformers, Parking garages open or enclosed, Porcelain and pottery, Stoves, Talc and soap, Washers and dryers, etc.				
Utility and Miscellaneous (Group U)	U-1	Group U-1, Agricultural uses, including, but not limited to:Livestock Shelters or Buildings, including Shade Structures & Milking barns, Poultry Buildings or Shelters, Barns, Storage of equipment & machinery used exclusively in agriculture, Horticultural Structures including Crop Protection Shelters, Sheds, Grain Silos, Stable, Greenhouse	VIII	Storage	Place of storage (including godowns, warehouses, stores etc), deposit or parking of goods, materials and / or vehicles.	
	U-2	Group U-2 shall include, but not limited to: Fences over 6 feet (1829 mm) high, Retaining Walls	–	–	–	
	U-3	Group U-3 shall include, but not limited to: Aircraft Hangars, Carports Private Garages, Generator Houses Sheds, Telephone Booth, Kiosk, Media Corner, Stables, Tanks, Towers Public Bath, Garbage Yards	VIII	Storage	Place of storage (including godowns, warehouses, stores etc), deposit or parking of goods, materials and / or vehicles.	

Please note that the comparison of the occupancy types of the mentioned buildings is provided for easy reference only. Specific requirements must comply with the provisions outlined in the Myanmar Fire Safety Code 2020, based on the intended use of the buildings and the fire hazard concerns. If needed, please contact the Fire Services Department to get fire safety instructions.

5F 2.2 In Myanmar Fire Safety Code-2020, the buildings are classified by purpose group number, a total of eight based on their use and occupancy types as follows-

(a) Group 1: Small residential
(b) Group 2: Other residential
(c) Group 3: Institutional
(d) Group 4: Office
(e) Group 5: Shop
(f) Group 6: Factory
(g) Group 7: Place of Public Resort
(h) Group 8: Storage

5F 2.3 Since the ten groups listed in MNBC-2020 and eight groups listed in MFSC-2020 are slightly different, a comparison table is described in MNBC-2025 to make it easier to reference and classify the buildings.

5F 2.4 Regarding the construction of EV charging station building, it is necessary to comply with fire safety directives, regulations, and procedures issued by the Fire Services Department from time to time for the purpose of fire safety.

MNBC -2025 TECHNICAL WORKING GROUP (TWG-5F)

Participants List

1.	U Yin Htwe Thet	Group Leader
2.	U Thein Tun Oo	Deputy Group Leader
3.	Daw Khaing Mar Win	Member
4.	U Tint Khaing	Member
5.	U Bhone Kyaw	Member
6.	Daw Kyawt Kay Khaing	Member
7.	Daw Zun Pann Lwin	Member

MYANMAR

NATIONAL

BUILDING

CODE

2025

PART 5A,

PART 5B,

PART 5C,

PART 5E

&

PART 5F