JKR 20500-0008-10

MECHANICAL SYSTEM DESIGN AND INSTALLATION GUIDELINES FOR ARCHITECTS AND ENGINEERS

2011





CAWANGAN KEJURUTERAAN MEKANIKAL

CONTENTS

INTRODUCTION

This **Mechanical System Design And Installation Guidelines For Architects And Engineers – 2011** was prepared and published as a revised edition to the 1st edition published in 1992.

The development of this 2nd edition guideline is to provide guidance for Architects and Engineers with the latest requirement of mechanical system design and installation in government building projects.

This revised edition have adopted latest guidelines, standards and requirement such as EPU guidelines, JKR mould guideline, standard JKR technical specification and criteria for sustainable building designs.

The objectives of the guidelines are as follows:

- Assist JKR professional to identify the architectural, structural and electrical requirement in the design and installation of mechanical system in the building.
- Provide latest reference for project supervision team and maintenance team.
- Improve quality of goverment building project implementation.

Special thanks to the committee members who were highly dedicated and who have contributed towards the successful completion of this guidelines.

CAWANGAN KEJURUTERAAN MEKANIKAL
IBU PEJABAT JKR MALAYSIA
KUALA LUMPUR.

SPECIAL REQUIREMENT

No.	Item	Mechanical Requirement	Action	Remark
1.0	Roof trusses.	All roof trusses must be able to support the load of all mechanical services such as ducts, pipes, grilles, fan coil units and etc.	Architect and Structural Engineer.	Estimated load to be provided by Mechanical Engineer.
2.0	Trenching.	Provide trenching for mechanical incoming pipe access into the building.		Size and location to be determine by Mechanical Engineer.
3.0	Cat walk.	Building design with double or multi volume, cat walk shall be provided inside the roof space.		For service, maintenance and safety purpose.
4.0	Service floor.	Dedicated service floor shall be provided for complicated building to specifically allocate and centralize the various services and equipment i.e. hospital, laboratory and etc.		Ease of maintenance.
5.0	Service tunnel.	Dedicated service tunnel shall be provided for complexity building for easy access and routing of various services i.e. university, airport and etc.		Ease of maintenance.
6.0	Maintenance scaffold.	Building design with double or multi volume, such as auditorium, mosque and multipurpose hall shall be provided with maintenance scaffold.		Ease of maintenance.

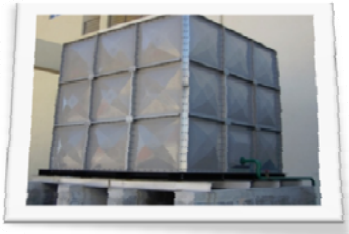
Checklist For Special Mechanical Requirement:

No.	Description	Yes	No	Remark
1.	Roof trusses			
2.	Trenching			
3.	Cat walk			
4.	Service floor			
5.	Service tunnel			
6.	Maintenance scaffold			

AIR CONDITIONING SYSTEM





SECTION 1

AIR-CONDITIONING SYSTEM

No.	Item	Mechanical Requirement	Action	Remark
1.0	**General requirement.**	Any air-conditioning equipment located outdoor shall be provided with decorative enclosure.	Architect and Structural Engineer.	
2.0	**Cooling tower. (if required)**			Cooling tower is required if air conditioning system is water-cooled.
	2.1 Location and facilities.	2.1.1 Cooling tower shall be located at an area with free air flow such as rooftop or large open space on ground level. Refer to **Table 1.1** and **Figure 1.4 for** space requirements.		
		2.1.2 For rooftop installation, access staircase must be provided for the purpose of maintenance. Cat ladder is not allowed.		
		2.1.3 Dedicated space for make-up water tank shall be provided. Refer to **Table 1.1** for make-up water tank capacity.		

No.	Item	Mechanical Requirement	Action	Remark
		2.1.4 Reinforced Concrete, (RC) plinths for cooling tower and make-up water tank have to be provided. Refer to **Table 1.1** and **Figure 1.3** for operating weight and plinth requirement of cooling tower.	Architect and Structural Engineer.	Configuration of RC plinths to be provided by Mechanical Engineer. Exact size to be provided during construction stage.
		2.1.5 If enclosure is required around the cooling tower for aesthetic reasons, then it shall allow free airflow through the cooling tower. Refer **Figure 1.4** for cooling tower space layout. Precast or aluminium grilles may be used.		
		2.1.6 Floor level for the cooling tower area shall be leveled to avoid any water ponding and slope gently towards drainage outlet.		To ensure good drainage in the plant room.
3.0	**Chiller plant room. (if required)**	The chiller area shall be free of column for ease of equipment installation.		Chiller plant room is required if total central air-conditioned area in building exceeds 3500 square metres.
	3.1 Dimensions.	Refer to **Table 1.4** to determine dimensions of plant room. Refer to **Figure 1.1** for suitable layout.		

No.	Item	Mechanical Requirement	Action	Remark
	3.2 Location.	3.2.1 Chiller plant room shall be located at ground level and accessible by road.	Architect and Structural Engineer.	Ease of maintenance, mitigation of noise and vibration.
		3.2.2 If possible chiller plant room to be separated from main building.		
		3.2.3 Chiller plant room shall not be located on above level.		
		3.2.4 Chiller plant room shall not be located near to noise and vibration sensitive areas such as meeting rooms, conference rooms and office area.		
	3.3 Access door.	Roller shutter door shall be as shown in **Figure 1.1**.		
	3.4 Floor.	3.4.1 Use non-slip epoxy paint for floor finish.		
		3.4.2 Floor level to slope gently towards drainage outlet.		To ensure good drainage in the plant room.

No.	Item	Mechanical Requirement	Action	Remark
	3.5 Ventilation.	Provide two fan openings of clear dimensions 500mm x 500mm for cross-flow forced ventilation.	Architect and Structural Engineer.	Actual size and location shall be determined by Mechanical Engineer.
	3.6 Hoisting facilities.	To provide hoisting beams capable of taking 3 tonnes load above the chillers and the pump sets. Refer to **Figure 1.1** for details.		
	3.7 Wall.	Chiller plant room attached to building shall be double brick wall.		
	3.8 Plinth.	Provide Reinforced Concrete, (RC) plinths of dimension 150mm height for pumps and chillers. Use non-slip epoxy paint.		Actual size and location shall refer to the Mechanical Engineer.
	3.9 Other facilities.	3.9.1 Provide suitable electric cable trenches.		
		3.9.2 Chiller plant room must be accessible by goods vehicles.		
		3.9.3 Provide water tap and floor trap adjacent to each other. The floor trap shall be located in a 600mm x 600mm x 50 mm sunken floor areas.		

No.	Item	Mechanical Requirement	Action	Remark
		3.9.4 Provide sufficient lighting and 13 amp socket outlet.	Electrical Engineer.	For service and maintenance purposes.
4.0	**AHU rooms.**		Architect and Structural Engineer.	AHU rooms are required for all central air-conditioning systems.
	4.1 Dimensions.	Refer to **Table 1.5** under AHU room dimensions.		
	4.2 Location.	4.2.1 Not to be located adjacent to toilets, staircase, electrical, meeting rooms or strong rooms.		
		4.2.2 AHU rooms shall be located such that the furthest supply air outlet shall be not more than the distance shown in **Table 1.5**. Refer to **Figure 1.2** for typical location of AHU in building.		
	4.3 Walls.	4.3.1 AHU room must have at least one external wall.		For fresh air intake.
		4.3.2 No louvers or window is allowed.		

No.	Item	Mechanical Requirement	Action	Remark
		4.3.3 All AHU room shall be brick wall type and build up to the beam soffit or floor slab.	Architect and Structural Engineer.	
		4.3.4 Suitable openings shall be provided in the wall or beam for the supply and return ducts.		Size and location of opening to be determined by Mechanical Engineer.
	4.4 Door.	4.4.1 Provide double-leaf solid door.		
		4.4.2 Minimum door width is 1.5m.		
		4.4.3 Door shall open outwards.		
		4.4.4 Provide door seal on each door.		For air tight.
	4.5 Floor.	4.5.1 Provide non-slip epoxy paint floor.		Ease of floor maintenance.
		4.5.2 AHU room floor shall be lower than outside floor level by 25mm and slope gently towards the floor trap.		

No.	Item	Mechanical Requirement	Action	Remark
		4.5.3 Provide water tap and floor trap for each AHU room. The floor trap shall be located in a 600mm x 600mm x 50 mm sunken floor areas.	Architect and Structural Engineer.	
		4.5.4 Provide an appropriate floor opening with a 50mm kerb all rounds.		To cater for riser pipes. Size and location of opening to be determined by Mechanical Engineer.
		4.5.5 Provide Reinforced Concrete, (RC) plinths of dimension 150mm height. Use non-slip epoxy paint.		Actual size and location shall refer to the Mechanical Engineer.
	4.6 Other facilities.	4.6.1 AHU rooms must have slab /fixed ceiling particularly for pitch-roofed structures.		
		4.6.2 No cross-beam is allowed.		
		4.6.3 No other services are allowed in AHU rooms.		
		4.6.4 Provide 13 amp socket.	Electrical Engineer.	
		4.6.5 Provide sufficient lighting.		

No.	Item	Mechanical Requirement	Action	Remark
5.0	**Air-conditioned area.**		Architect and Structural Engineer.	
	5.1 Access opening.	Where fan coil unit is installed within plasterboard ceiling area, a minimum 600mm x 600mm access opening shall be provided and clear of any obstruction.		Ease of maintenance. Exact location will be determined by Mechanical Engineer.
	5.2 Roof trusses.	All roof trusses must be able to support the load of all mechanical services such as ducts, pipes, grilles, fan coil units and etc. Otherwise, provide steel bar to support mechanical services load.		Estimated load to be provided by Mechanical Engineer.
	5.3 24-hours.	Where 24-hours or low temperature air-conditioning is required, the following conditions must be adhered to: a. Partitions and floors adjacent to non air-conditioned spaces must be thermally insulated.		Refer Guidelines On The Prevention Of Mould Growth In Buildings JKR 20500-0003-09 for detail.

No.	Item	Mechanical Requirement	Action	Remark
		b. Windows shall be double-glazed.	Architect and Structural Engineer.	
		c. Ceiling shall be PVC laminated gypsum boards or moisture resistance boards.		
	5.4 Other facilities.	5.4.1 All glass walls and windows shall be glazed or tinted.		No louvered window is allowed.
		5.4.2 If windows are provided it shall be casement type.		
		5.4.3 All doors opening to non-air-conditioned areas including toilets shall be provided with door closer. All space attached to non air-conditioning area and toilet shall be build up to the beam soffit or floor slab.		
		5.4.4 To provide aluminium tee to complement the frame of the supply and return air grilles in the case of aluminium ceiling tee.		

No.	Item	Mechanical Requirement	Action	Remark
6.0	**Ductings.**		Architect and Structural Engineer.	
	6.1 Ceiling space.	6.1.1 Provide adequate clear ceiling space for ductings. Refer to **Table 1.5** for 'clear ceiling space required'.		
		6.1.2 Where ceiling space cannot be adequately provided for, then beam holes may be necessary. Refer to **Table 1.5** under 'size of openings for supply duct' for beam hole dimensions.		Size and location of opening to be determined by Mechanical Engineer.
	6.2 Beam hole.	6.2.1 Beam holes must be in line with AHU room.		
		6.2.2 Where ceiling is flush with the soffit of beams, then beam holes shall be provided to allow for free flow of return air.		Size and location of opening to be determined by Mechanical Engineer.
7.0	**Air cooled split unit.**	7.1.1 Outdoor unit shall be located at an area with free air flow. Distance between indoor and outdoor unit shall not be more than 10 m.		For optimum performance.

No.	Item	`Mechanical Requirement	Action	Remark
		7.1.2 Provide dedicated location purposely for centralizing outdoor unit.	Architect and Structural Engineer.	For camouflage/ aesthetic value If outdoor unit need to be enclosed, refer to Mechanical Engineer for adequate requirement.
8.0	**Multi split unit.**	Outdoor unit shall be located at an area with free air flow. Distance between indoor and outdoor unit shall not be more than 150 m.		
	8.1 Location.	8.1.1 Provide sufficient space for outdoor unit.		Space and operating weight to be determined by Mechanical Engineer.
		8.1.2 Provide dedicated location purposely for centralizing outdoor unit.		For camouflage/ aesthetic value If outdoor unit need to be enclosed, refer to Mechanical Engineer for adequate requirement.
	8.2 Plinth.	Provide Reinforced Concrete, (RC) plinths of dimension 150mm height for outdoor unit.		Actual size and location shall refer to the Mechanical Engineer.

TABLE 1.1

APPROXIMATE COOLING TOWER AND MAKE-UP WATER TANK REQUIREMENTS

TOTAL AIR-CONDITIONED AREA IN BUILDING (m^2)	*SPACE (mm)		OPERATING WEIGHT OF EACH COOLING TOWER (kg)	MAKE-UP WATER TANK CAPACITY (litres)
	WIDTH Wr	LENGTH Lr		
< 1,000	11,000	14,000	2,500	5,000
1,001 – 2,500	16,000	14,000	2,500	12,500
2,501 – 3,500	16,000	15,000	3,500	17,500
3,501 – 4,700	17,500	15,500	4,000	22,800
4,701 – 9,300	19,000	18,000	7,000	45,700
9,301 – 15,000	26,500	21,500	11,500	70,200
15,001 – 21,000	34,500	22,000	14,500	103,300

NOTES:

1. For cooling tower layout requirement refer to **Figures 1.3 and 1.4**.
2. * These dimension space include cooling tower and make up water tank.

TABLE 1.2

APPROXIMATE COOLING TOWER AND MAKE-UP WATER TANK REQUIREMENTS

Single Unit Installations

Installation Next To A Wall.

TOTAL AIR-CONDITIONED AREA IN BUILDING (m^2)	MINIMUM CLEARANCE (mm)	
	AT LOUVER COOLING TOWER (W) TO SOLID WALL	AT END WALL LENGTH COOLING TOWER (L) TO SOLID WALL
< 1,000 – 2,500	1,500	1,000
2,501 – 3,500	2,000	1,000
3,501 – 4,700	2,500	1,000
4,701 – 9,300	2,500	1,000

TABLE 1.3

APPROXIMATE COOLING TOWER AND MAKE-UP WATER TANK REQUIREMENTS

Multiple Unit Installations

1. Solid Wall Enclosure Or Wells

i. The minimum clearance louver cooling tower (W) to solid wall enclosure or wells.

TOTAL LOUVER WIDTH, W(mm)	MINIMUM CLEARANCE, D1(mm)
Below 4,500	3,500
Below 7,000	4,000
Below 10,000	6,000
Below 14,000	6,000

ii. End wall length cooling tower (L) to solid wall enclosure or wells, the minimum dimensions is 1000mm.

NOTE:

1. This table is to be read in conjunction with **Figure 1.4**.

2. Louvered Wall

i. The minimum clearance louver cooling tower (W) to louvered wall is 2500mm.
ii. End wall length cooling tower (L) to louvered wall is 1000mm.

TABLE 1.4

CHILLER PLANT ROOM DIMENSIONS

TOTAL AIR-CONDITIONED AREA IN BUILDING (m^2)	APPROXIMATE CAPACITY OF EACH CHILLER (Tons)	PLANT ROOM DIMENSIONS (mm)			OPERATING WEIGHT OF EACH CHILLER (kg)	REMARKS
		WIDTH Wr	LENGTH Lr	HEIGHT Hr		
3,500 – 4,700	150	14,500	11,000	4,000	8,500	Number of chillers (Duty + Standby) Meant to house 3 chillers. Refer to the Mechanical Engineer.
4,701 – 9,300	300	15,000	11,500	4,000	16,000	
9,301 – 15,000	500	16,000	12,000	4,200	18,000	
15,001 – 21,000	700	18,000	12,000	4,500	20,000	

NOTES:

1. For chiller plant room layout refer to **Figure 1.1**.
2. Wr, Lr and Hr are respectively room width, length and height.
3. Dimensions stated above are ‘clear dimensions’.
4. A larger plant room may be necessary if there is any structural column which may interface with equipment layout.
5. These plant room dimensions include chiller and pump.

TABLE 1.5

APPROXIMATE AHU ROOM DIMENSIONS AND DUCTING REQUIREMENTS

TOTAL AIR-CONDITIONED AREA PER ZONING IN BUILDING (m^2)	AHU ROOM DIMENSIONS WIDTH x LENGTH (m)	1* CLEAR CEILING SPACE REQUIRED (mm)	SIZE OF OPENINGS (THROUGH BEAMS OR WALLS)		MAXIMUM ALLOWABLE DISTANCE OF FURTHEST POINT OF AIR-CONDITIONED ZONE FROM THE AHU ROOM (m)
			FOR SUPPLY DUCT DEPTH x WIDTH (mm)	FOR RETURN DUCT DEPTH x WIDTH (mm)	
200	6.0 x 4.5	500	356 x 925	356 x 925	20
400	6.5 x 4.5	650	500 x 1,225	500 x 1,225	30
600	7.0 x 4.5	650	500 x 1,825	500 x 1,825	35
800	7.5 x 4.5	650	500 x 2,450	500 x 2,450	40

NOTES:

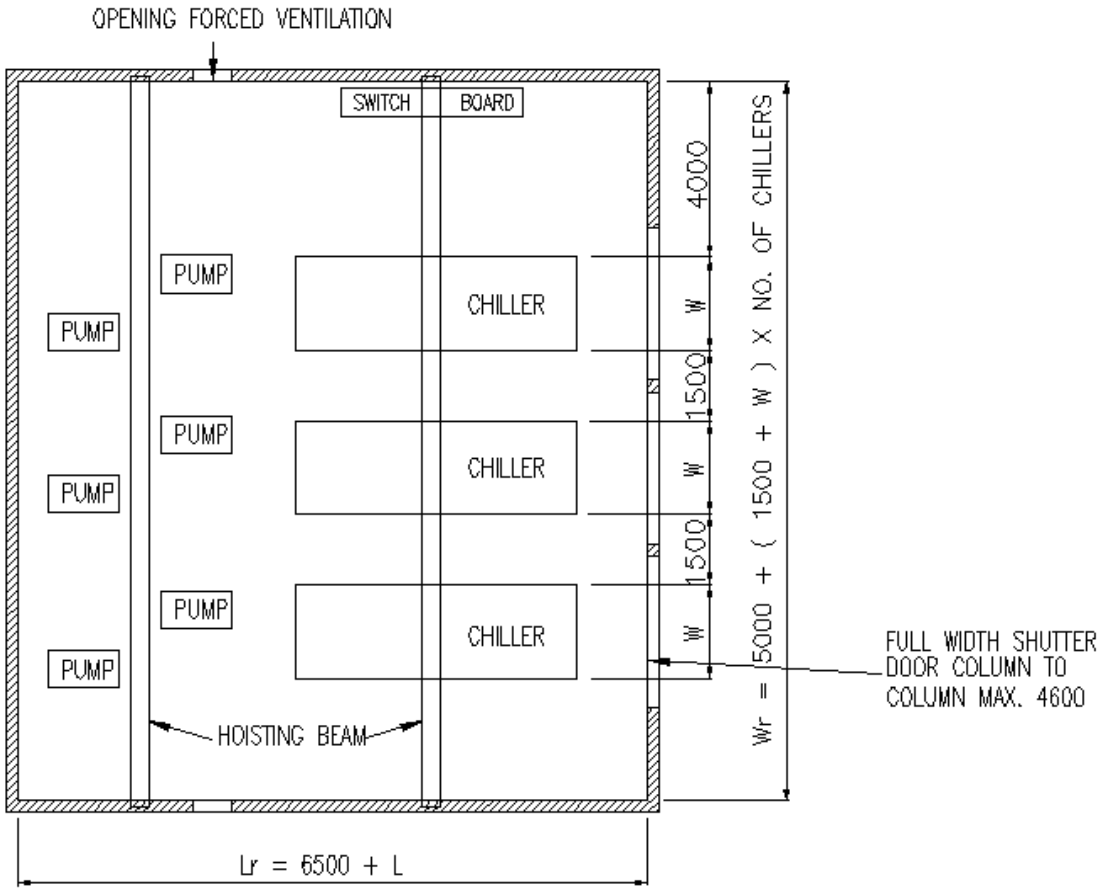
1*. Clear ceiling space is the vertical distance from the beam soffit to ceiling tee for ducting only. For other services such as lighting, conduit etc., architect shall consult with Electrical Engineer.

2. Coordination between all disciplines shall be required during design stage. (Opening at slabs, walls and etc. especially for IBS).

3. Limited zoning up to 800m^2 in building.

FIGURE 1.1

CENTRIFUGAL CHILLER PLANT ROOM LAYOUT



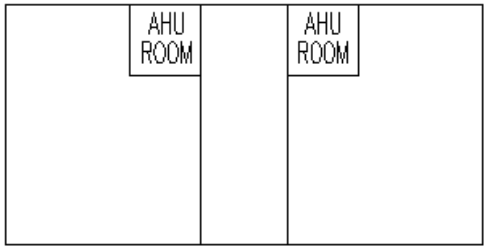
NOTES:

1. Wr, Lr and Hr are repectively room width(W), lenght(L) and height(H) of Chiller.
2. Hr = H + 1000mm.
3. This figure is to be read in conjuction with Table 1.4.
4. Hoisting beam point load to be read in conjuction with Table 1.4.
5. All dimensions are in millimeter (mm).

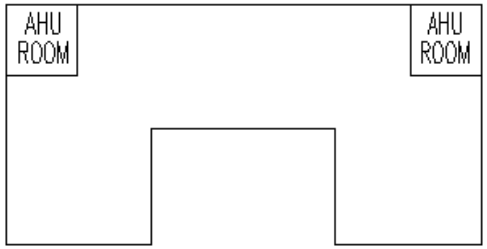
FIGURE 1.2

SUGGESTED LOCATIONS OF AHU ROOMS IN STANDARD BUILDING BLOCKS

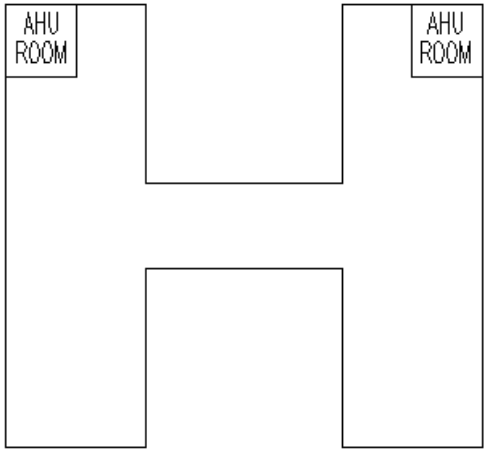
RECTANGULAR BLOCK



U – SHAPE BLOCK



H – SHAPE BLOCK



SQUARE BLOCK

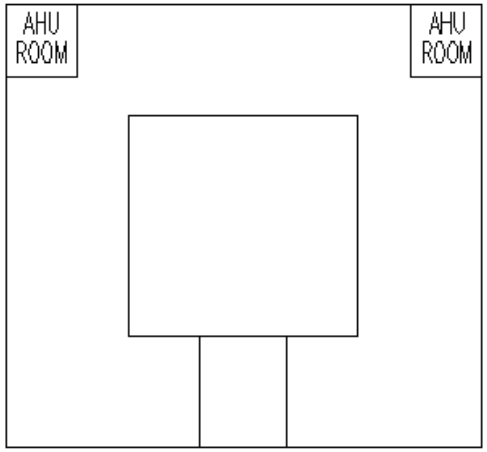
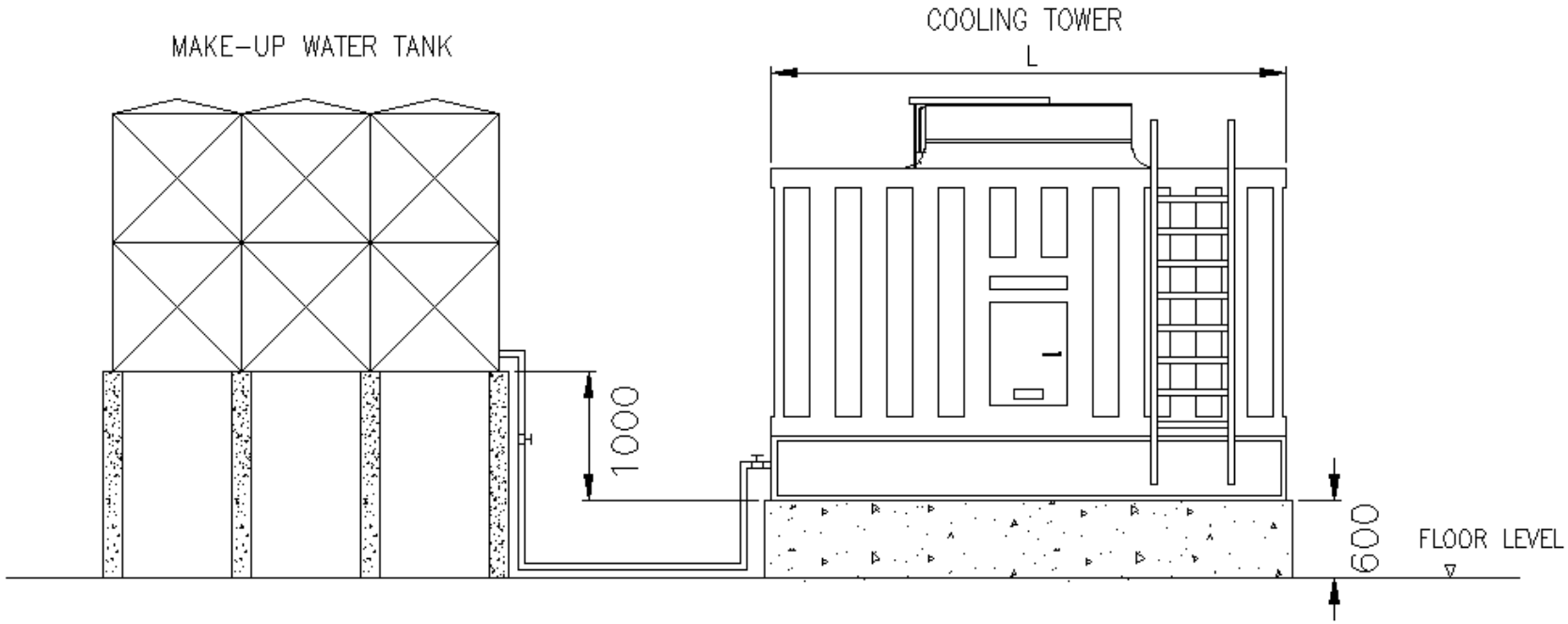


FIGURE 1.3

PLINTHS REQUIREMENT FOR MAKE-UP WATER TANK AND COOLING TOWER

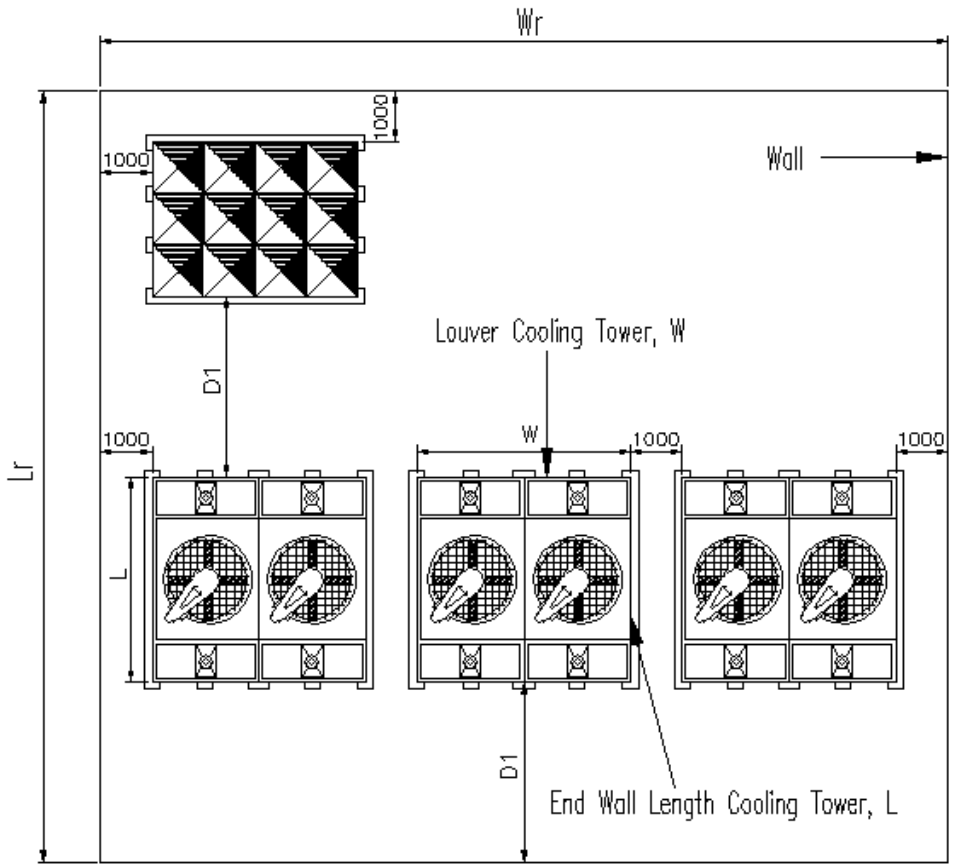


NOTES:

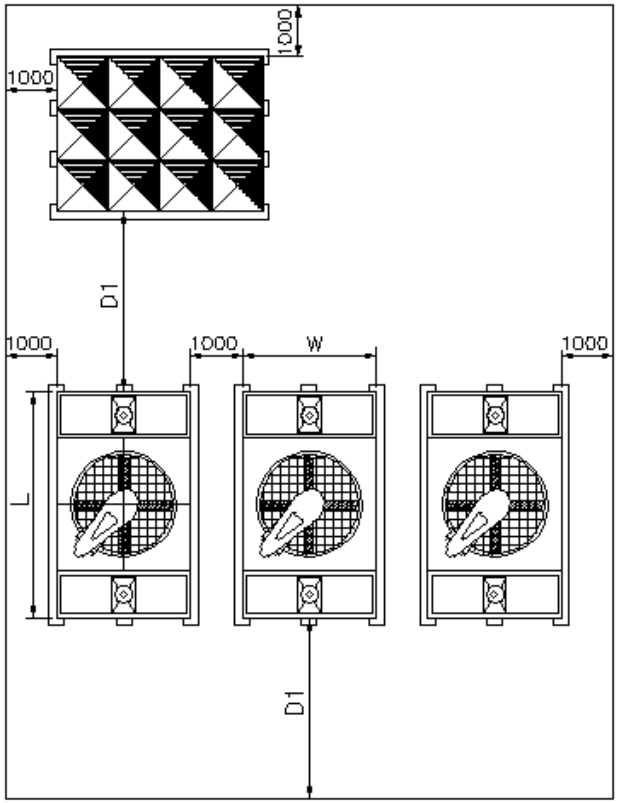
1. The bottom of the tank shall be higher than the cooling tower sump approximately 1000mm.
2. The actual size of make-up water tank and cooling tower concrete plinths shall refer to the Mechanical Engineer.
3. All dimensions are in millimeter (mm).

FIGURE 1.4

TYPICAL LAYOUT FOR COOLING TOWER



a. Modular Type



b. Single Type

NOTES:

1. This figure is to be read conjuction to Table 1.3.
2. Refer to the Mechanical Engineer for the arrangement and type of cooling tower.
3. All dimensions are in millimeter (mm).

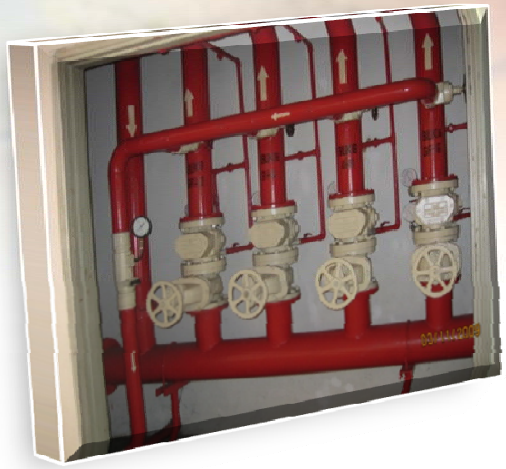
Checklist For Mechanical Requirement: Air-Conditioning System

No.	Description		Yes	No	Remark
1.	**General requirement**				
2.	**Cooling tower (if required)**				
	2.1	Location and facilities			
3.	**Chiller plant room (if required)**				
	3.1	Dimensions			
	3.2	Location			
	3.3	Access door			
	3.4	Floor			
	3.5	Ventilation			
	3.6	Hoisting facilities			
	3.7	Wall			
	3.8	Plinth			
	3.9	Other facilities:			
4.	**AHU rooms**				
	4.1	Dimensions			
	4.2	Location			
	4.3	Walls			
	4.4	Door			
	4.5	Floor			
	4.6	Other facilities:			

Checklist For Mechanical Requirement: Air-Conditioning System (Cont'd.)

No.	Description		Yes	No	Remark
5.	**Air-conditioned area**				
	5.1	Access opening			
	5.2	Roof trusses load			
	5.3	24-hours			
6.	**Ductings**				
	6.1	Ceiling space			
	6.2	Beam hole			
7.	**Air Cooled Split Unit**				
8.	**Multi Split Unit**				
	8.1	Location			
	8.2	Plinth			

FIRE FIGHTING SYSTEM



SECTION 2

FIRE FIGHTING SYSTEM

No.	Item	Mechanical Requirement	Action	Remark
1.0	**General requirement.**	1.1.1 Any fire fighting equipment located outdoor shall be provided with decorative enclosure.	Architect and Structural Engineer.	
		1.1.2 Refer to **Tables 2.1, 2.2, 2.3 and 2.4** for suitable system(s).		For more details, refer the Uniform Building By-Laws 1984 and Guide For Fire Protection in Malaysia.
2.0	**Hose reel system.**			
	2.1 Plant room. (for pumps and water tanks)	2.1.1 Preferably be located on ground level and with external excess.		
		2.1.2 Plant room size. Refer to **Figure 2.1**.		These dimensions are arrived at using metric-sized tanks.
		2.1.3 Provide louvered double-leaf door. Door shall open outwards.		For adequate ventilation.
		2.1.4 Provide high-level louvered glass.		
		2.1.5 Provide concrete plinths of 800mm height for a 10,000 litres capacity tank.		Configuration of tank, refer to the Mechanical Engineer.

No.	Item	Mechanical Requirement	Action	Remark
		2.1.6 Provide incoming supply pipe to tank of at least 50mm diameter.	Architect and Structural Engineer.	
		2.1.7 Provide floor trap. Floor level shall slope gently towards drainage outlet. The floor trap shall be located in a 600mm x 600mm x 50 mm sunken floor areas.		
		2.1.8 Provide non-slip epoxy paint for plant room flooring.		
		2.1.9 Provide sufficient lighting and 13 amp socket outlet.	Electrical Engineer.	
	2.2 Pipe riser.	Provide pipe riser c/w floor openings of 100mm x 100mm at every floor.	Architect and Structural Engineer.	
	2.3 Hose reel riser compartment.	2.3.1 Refer to **Figure 2.2** for dimensions of the riser compartment. The riser compartment shall be recessed into the wall and the door shall be flush with the surface of the wall.		

No.	Item	Mechanical Requirement	Action	Remark
		2.3.2 The riser compartment shall be located along escape route and not more than 30m from the furthest point of the floor area/zone covered.	Architect and Structural Engineer.	
		2.3.3 Provide floor trap. Floor level shall slope gently towards floor trap. Refer to **Figure 2.2**.		
		2.3.4 The riser compartment shall have lockable door(s) and c/w suitable signage.		
3.0	**Dry riser system.**			
	3.1 Pipe riser.	3.1.1 Provide pipe riser c/w openings of 200mm x 200mm at every floor for the riser pipe within firemen's access staircase/protected lobby. Refer to **Figure 2.3**.		Preferably pipe riser is housed in a riser shaft.
		3.1.2 Furthest point served shall not be more than 35m from the landing valve.		

No.	Item	Mechanical Requirement	Action	Remark
		3.1.3 Provide floor trap. Floor level shall slope gently towards floor trap. Refer to **Figure 2.2**.	Architect and Structural Engineer.	
	3.2 Breeching inlets.	3.2.1 To be located on an external wall accessible to Bomba's fire engines.		Refer to the Mechanical Engineer.
		3.2.2 The cabinet shall be recessed into the wall and the door shall be flush with the surface of the wall. Refer to **Figure 2.5** detail for breeching inlet cabinet.		
	3.3 Canvas hose riser compartment.	3.3.1 To be located on every floor close to landing valves.		
		3.3.2 The riser compartment shall be recessed into the wall and the door shall be flush with the surface of the wall. Refer to **Figure 2.3** for dimensions of the riser compartment.		
		3.3.3 The dry riser canvas hose may share a common riser compartment with the hose reel.		

No.	Item	Mechanical Requirement	Action	Remark
4.0	**Wet riser system.**		Architect and Structural Engineer.	
	4.1 Pipe riser and landing valves.	4.1.1 Provide two openings of dimensions 200mm x 200mm and 150mm x 150mm at every floor for the pipe riser within firemen's access staircase/protected lobby. Refer to **Figure 2.3**.		Preferably riser pipe be housed in a riser shaft.
		4.1.2 Furthest point served shall not be more than 35m from the landing valve.		
		4.1.3 Provide floor trap. Floor level shall slope gently towards floor trap. Refer to **Figure 2.2**.		
	4.2 Canvas hose riser compartment.	4.2.1 To be located on every floor close to landing valves.		
		4.2.2 The riser compartment shall be recessed into the wall and the door shall be flush with the surface of the wall. Refer to **Figure 2.3** for dimensions of the riser compartment.		

No.	Item	Mechanical Requirement	Action	Remark
		4.2.3 The wet riser canvas hose may share a common riser compartment with the hose reel.	Architect and Structural Engineer.	
	4.3 Plant room. (for pump and water tank)	4.3.1 Refer to **Figure 2.6** for the dimensions of plant room.		
		4.3.2 Provide louvered double-leaf door. Door shall open outwards.		For adequate ventilation.
		4.3.3 Provide high-level louvered glass.		For adequate ventilation.
		4.3.4 Provide concrete plinths of 800mm height for a 50,000 litres capacity tank.		Configuration of tank, refer to the Mechanical Engineer.
		4.3.5 Ensure rate of incoming water supply is at least 455 litres/min.	Mechanical Engineer/ C&S.	
		4.3.6 Provide floor trap. Floor level shall slope gently towards drainage outlet. The floor trap shall be located in a 600mm x 600mm x 50 mm sunken floor areas.		

No.	Item	Mechanical Requirement	Action	Remark
		4.3.7 Provide non-slip epoxy paint for plant room flooring.	Architect and Structural Engineer.	
		4.3.8 Provide sufficient lighting and 13 amp socket outlet.	Electrical Engineer.	
5.0	**Sprinkler system.**		Architect and Structural Engineer.	
	5.1 Water tank.	5.1.1 Shall be located at fire appliance access level.		Water tank to be provided by Mechanical contractor.
		5.1.2 Refer to **Table 2.5** for tank capacity.		
		5.1.3 Refer to **Figures 2.7** and **2.8** for suitable layout.		
		5.1.4 Provide concrete plinths of 800mm height for a tank.		Actual size and location shall refer to the Mechanical Engineer.
		5.1.5 Provide incoming supply pipe to tank of at least 100mm diameter.		

No.	Item	Mechanical Requirement	Action	Remark
		5.1.6 Provide floor trap. Floor level shall slope gently towards drainage outlet.	Architect and Structural Engineer.	
	5.2 Pump room.	5.2.1 Preferably be located next to water tank.		
		5.2.2 Refer to **Figures 2.7** and **2.8** for suitable layout and the corresponding dimensions of pump room.		**Figures 2.7** and **2.8** shows a suitable pump room for 3 fire fighting systems.
		5.2.3 Provide louvered double-leaf door. Door shall open outwards. For adequate ventilation.		For adequate ventilation.
		5.2.4 Provide high-level louvered glass.		For adequate ventilation.
		5.2.5 Provide floor trap. Floor level shall slope gently towards drainage outlet. The floor trap shall be located in a 600mm x 600mm x 50 mm sunken floor areas.		
		5.2.6 Provide non-slip epoxy paint for plant room flooring.		

No.	Item	Mechanical Requirement	Action	Remark
		5.2.7 Provide at least one external wall for pump room. This wall must be accessible to Bomba's fire engines.	Architect and Structural Engineer.	Breeching inlet may be fixed onto this wall.
	5.3 Riser pipes.	5.3.1 Provide riser shaft with floor opening of dimensions 250mm x 700mm.		
		5.3.2 Provide floor trap. Floor level shall slope gently toward floor trap. Refer to **Figure 2.2**.		
	5.4 Distribution pipes.	5.4.1 Provide beam holes of dimensions 200mm x 200mm. These beam holes must all be in-line. Refer to **Figure 2.9**.		
		5.4.2 Position of beam holes shall be along both internal sides of the building. Refer to **Figure 2.9**.		
6.0	**Main fire alarm panel room.**			
	6.1 Location.	6.1.1 Provide at least one solid wall for fire alarm panel.		To install fire alarm panel.

No.	Item	Mechanical Requirement	Action	Remark
		6.1.2 Preferably be located on ground floor main lobby or at main entrance to the building accessible by Bomba.	Architect and Structural Engineer.	This room size is solely meant to house the main fire alarm panel. If other control panels are included, then the size of the room must be increased accordingly.
	6.2 Dimensions and construction.	Provide room of dimensions 3m x 4m.		For control room.
	6.3 Central monitoring system. (CMS)	Provide direct telephone line connection.	Electrical Engineer.	Every large premises/ building exceeding 30.5m height. Refer to UBBL, clause 238.
7.0	**Gas cylinder for total flooding fire extinguishing system.**			
	7.1 Unoccupied space. Plant room-(Substation TNB/JKR)	Provide storage area for gas cylinder adjacent to protected room.		Size of storage area, refer to the Mechanical Engineer.
	7.2 Occupied space. (server room, arkib, strong room and etc.)	Provide storage area for gas cylinder adjacent to protected room.		Size of storage area, refer to the Mechanical Engineer.

TABLE 2.1

FIRE FIGHTING SYSTEM SELECTION – OFFICE BUILDINGS

SIZE OF BUILDING	EXTINGUISHING SYSTEM	FIRE ALARM SYSTEM
4 storeys and less OR less than 1,000 m² gross floor area	Not required	Not required
5 storeys and over OR exceeding 1,000 m² gross floor area	Hose reel	Break glass
Exceeding 18 m in height BUT less than 10,000 m²	Hose reel Dry riser	Break glass Fire detectors
Exceeding 30 m in height OR 10,000 m² gross floor area	Hose reel Wet riser Sprinklers	Break glass

TABLE 2.2

FIRE FIGHTING SYSTEM SELECTION – HOSTELS AND DORMITORIES

BUILDING	EXTINGUISHING SYSTEM	FIRE ALARM SYSTEM
Single storey	Not required	Not required
2 storeys to 3 storeys	Hose reel	Break glass
4 storeys to 10 storeys	Hose reel	Break glass Fire detectors
11 storeys and over	Hose reel Wet riser Sprinklers	Break glass

TABLE 2.3

FIRE FIGHTING SYSTEM SELECTION – HOSPITALS & NURSING HOMES (FOR IN-PATIENT TREATMENT)

Not exceeding 250 m² per floor.

BUILDING	EXTINGUISHING SYSTEM	FIRE ALARM SYSTEM
Single storey	Not required	Not required
2 storeys	Not required	Visual alarm
3 or 4 storeys	Hose reel	Visual alarm
5 or 6 storeys	Hose reel	Visual alarm Fire detectors
18m and over	Hose reel Sprinkler	Visual alarm
Operating theatres	Hose reel	Visual alarm

TABLE 2.4

FIRE FIGHTING SYSTEM SELECTION – HOSPITALS & NURSING HOMES (FOR IN-PATIENT TREATMENT)

Exceeding 250 m² per floor.

BUILDING	EXTINGUISHING SYSTEM	FIRE ALARM SYSTEM
Single storey	Not required	Not required
2 storeys	Hose reel	Visual alarm
3 or 4 storeys	Hose reel	Visual alarm Fire detectors
5 or 6 storeys	Hose reel Sprinkler	Visual alarm

NOTE:

1. Details classification of hazard in accordance with the type of building, refer to Annex A, BS EN 12845: 2004.

TABLE 2.5

SPRINKLER SYSTEM TANK CAPACITY SELECTION

HAZARD CLASSIFICATION	BUILDING	HEIGHT OF THE HIGHEST SPRINKLERS ABOVE THE LOWEST SPRINKLERS	TANK CAPACITY
Light Hazard	I.e. schools, institutions (certain area)	Not exceeding 15m	9,000 litres
		Not exceeding 30m	10,000 litres
		Not exceeding 45m	11,000 litres
Ordinary Hazard Group 1	I.e. offices, restaurants, hotels, libraries and hospitals	Not exceeding 15m	55,000 litres
		Not exceeding 30m	70,000 litres
		Not exceeding 45m	80,000 litres

NOTE:

1. Details classification of hazard in accordance with the type of building, refer to Annex A, BS EN 12845: 2004.

TABLE 2.5

SPRINKLER SYSTEM TANK CAPACITY SELECTION (CONT'D.)

HAZARD CLASSIFICATION	BUILDING	HEIGHT OF THE HIGHEST SPRINKLERS ABOVE THE LOWEST SPRINKLERS	TANK CAPACITY
Ordinary Hazard Group 11	I.e. laundries, bakeries, museums and factories	Not exceeding 15m	105,000 litres
		Not exceeding 30m	125,000 litres
		Not exceeding 45m	140,000 litres
Ordinary Hazard Group 111	I.e. car parks, departmental stores , large retail shops and cinemas, clothing and paint factories	Not exceeding 15m	135, 000 litres
		Not exceeding 30m	160, 000 litres
		Not exceeding 45m	185, 000 litres

NOTE:

1. Details classification of hazard in accordance with the type of building, refer to Annex A, BS EN 12845: 2004.

TABLE 2.5

SPRINKLER SYSTEM TANK CAPACITY SELECTION (CONT'D.)

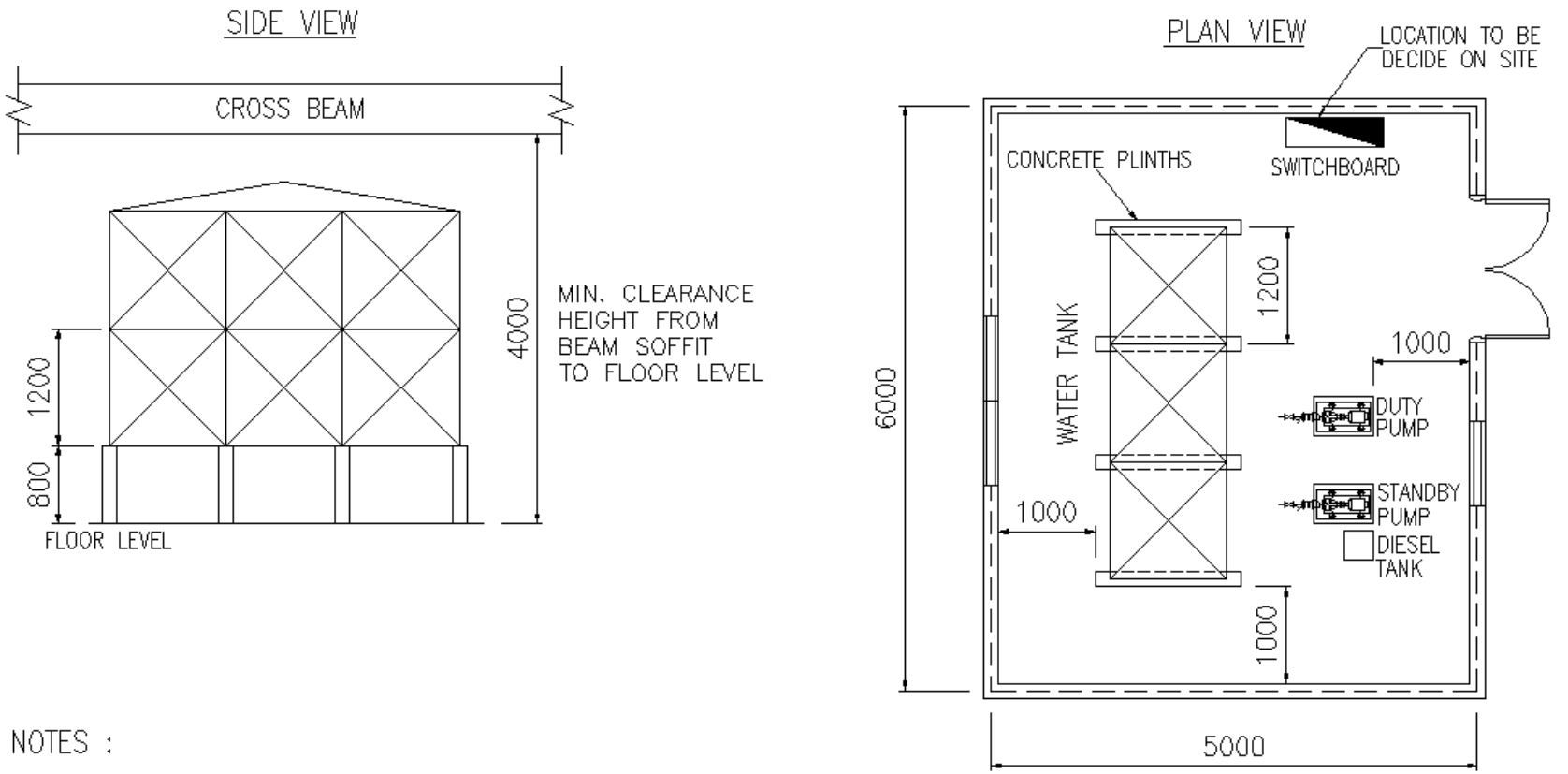
HAZARD CLASSIFICATION	BUILDING	HEIGHT OF THE HIGHEST SPRINKLERS ABOVE THE LOWEST SPRINKLERS	TANK CAPACITY
Ordinary Hazard Group 1V	I.e. exhibitions hall, saw mills and plywood factories.	Not exceeding 15m	160, 000 litres
		Not exceeding 30m	185, 000 litres
		Not exceeding 45m	200, 000 litres
High Hazard	For commercial and industrial occupancies having abnormal fire loads covering process hazards, high piled storage hazards and oil and flammable liquid hazards.	Tank capacities refer to the Mechanical Engineer.	

NOTE:

1. Details classification of hazard in accordance with the type of building, refer to Annex A, BS EN 12845: 2004.

FIGURE 2.1

PLANT ROOM LAYOUT AND DIMENSIONS FOR HOSE REEL SYSTEM



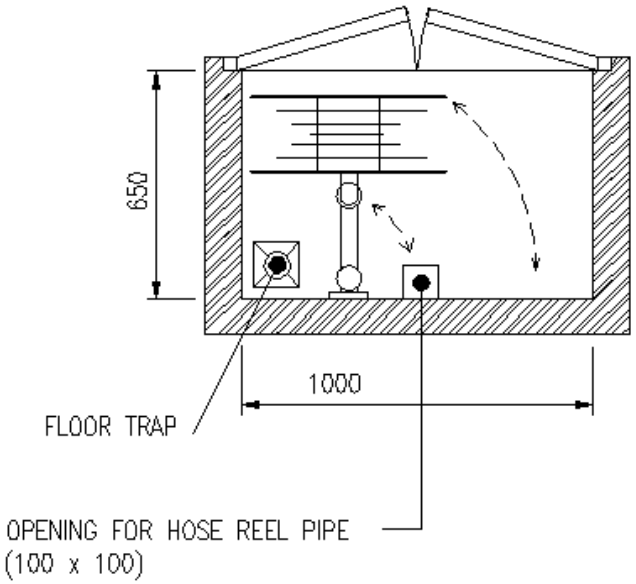
NOTES :

1. Tank to be provided by Mechanical Contractor.
2. The size of pump room shall be not less than 3000mm x 3000mm for external water tank.
3. Each tank panel size are 1200mm x 1200mm x 1200mm (Base on two stack).
4. Minimum distance pump to wall and plinth to wall is 1000mm.
5. All dimensions are in millimeter (mm).

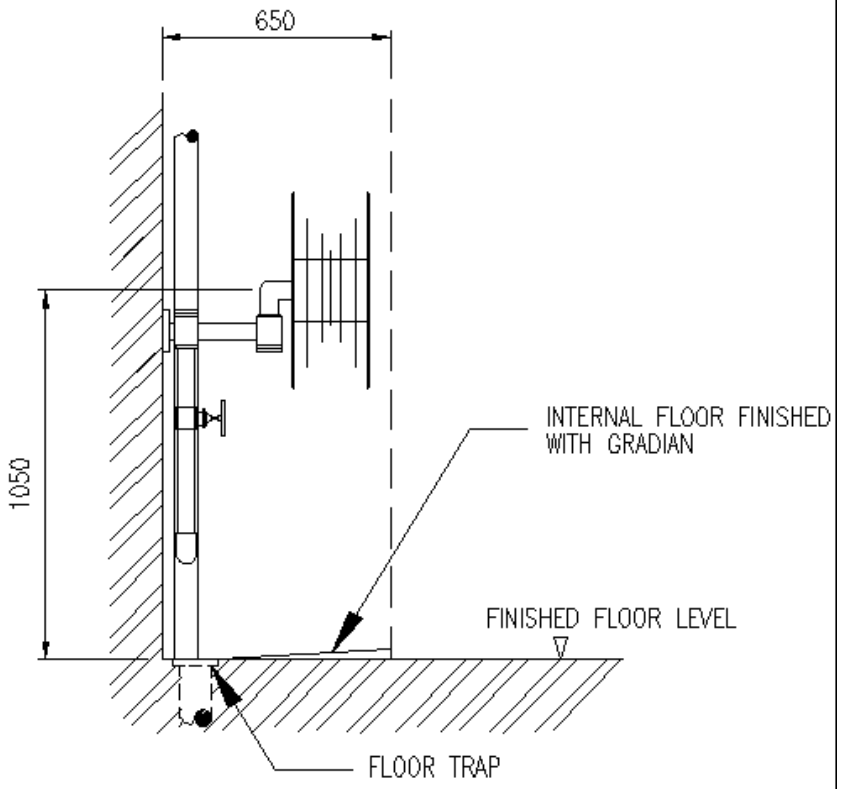
FIGURE 2.2

DIMENSION OF RISER COMPARTMENT (HOSE REEL)

PLAN VIEW



SIDE VIEW

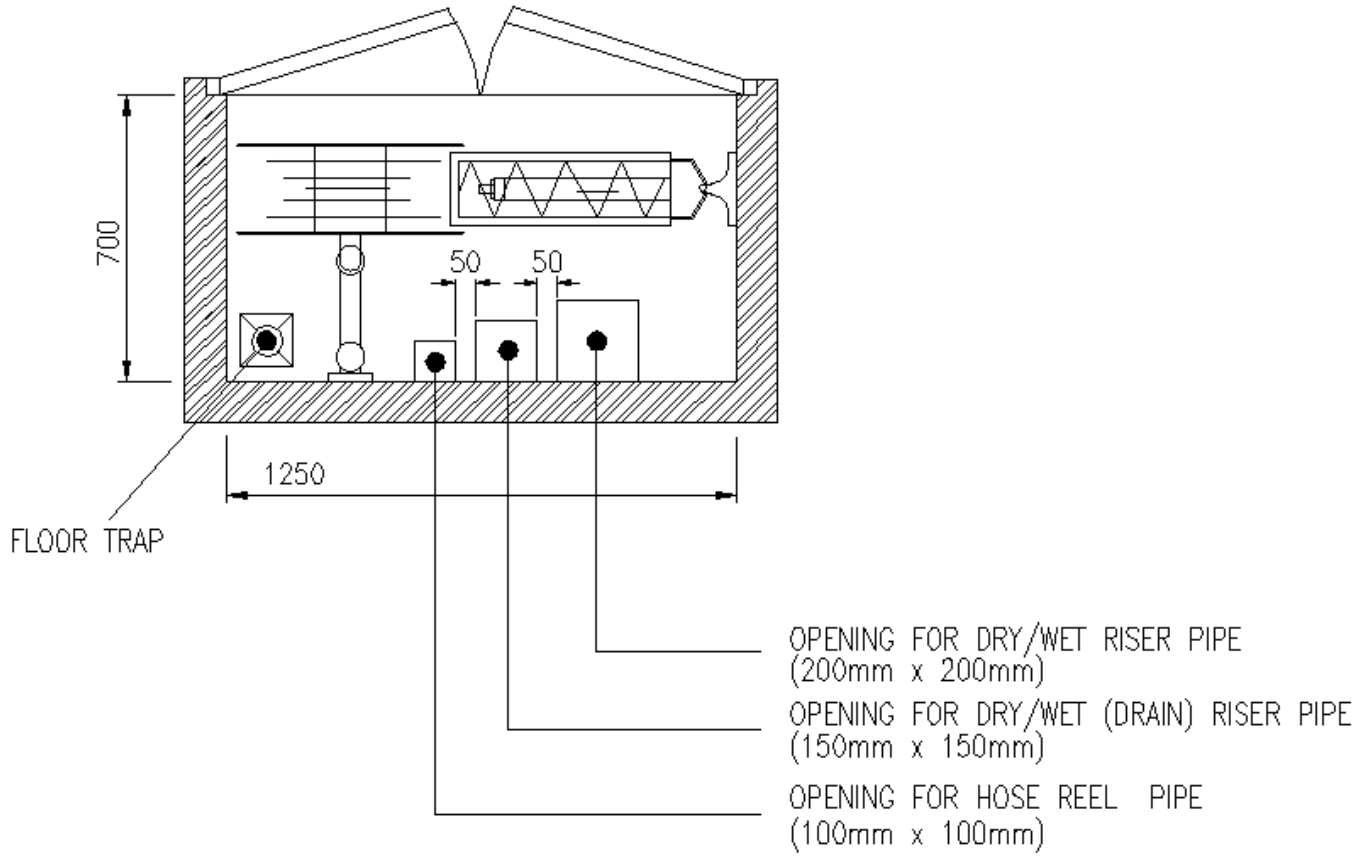


NOTES:

1. This opening is required at every floor.
2. All dimensions are in millimeter (mm).

FIGURE 2.3

DIMENSION OF RISER COMPARTMENT (HOSE REEL AND DRY/WET RISER)

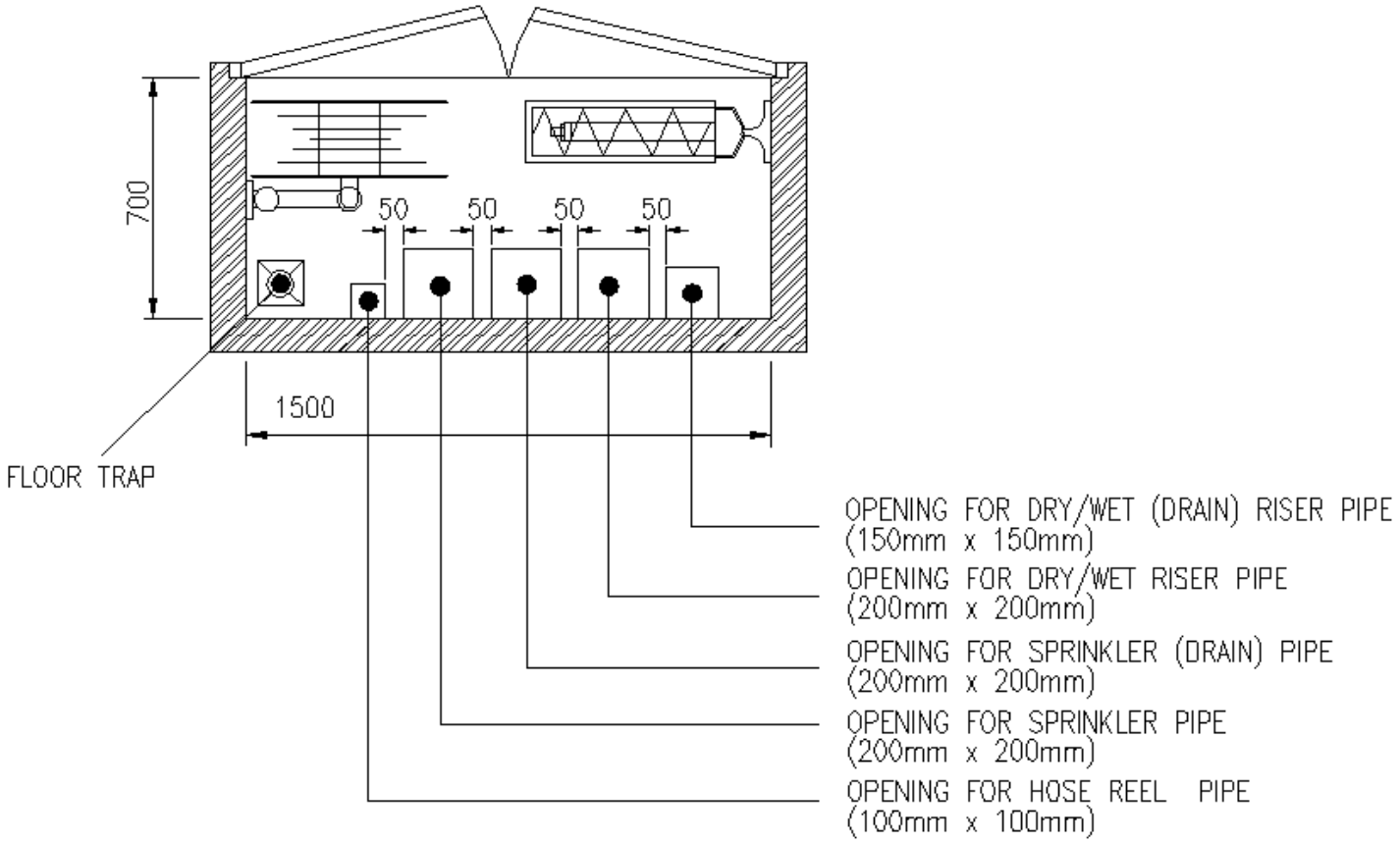


NOTES:

1. These openings are required at every floor.
2. All dimensions are in millimeter (mm).

FIGURE 2.4

DIMENSION OF RISER COMPARTMENT (HOSE REEL, DRY/WET RISER AND SPRINKLER)

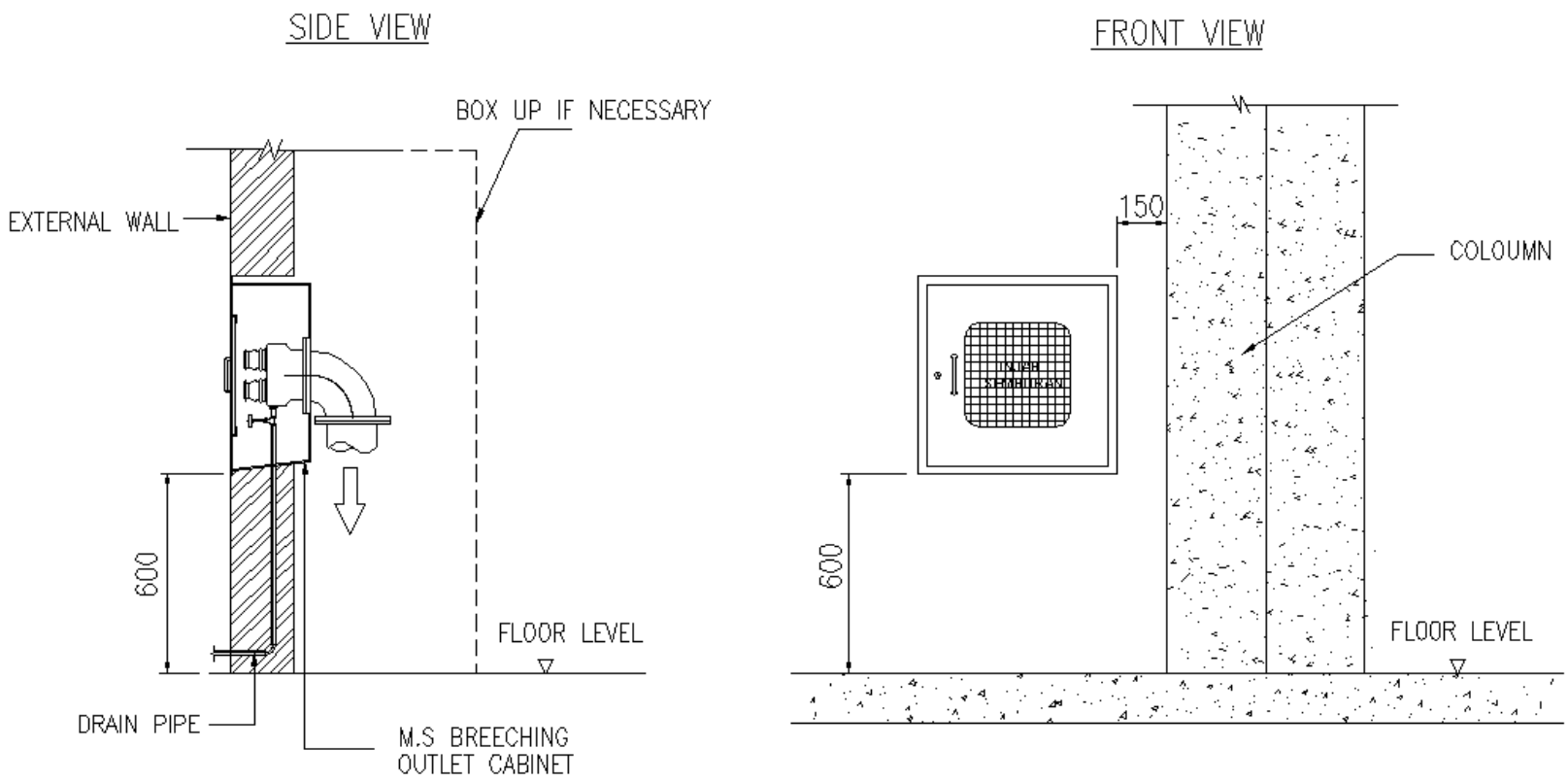


NOTES:

1. These openings are required at every floor.
2. All dimensions are in millimeter (mm).

FIGURE 2.5

DETAIL FOR BREECHING INLET CABINET



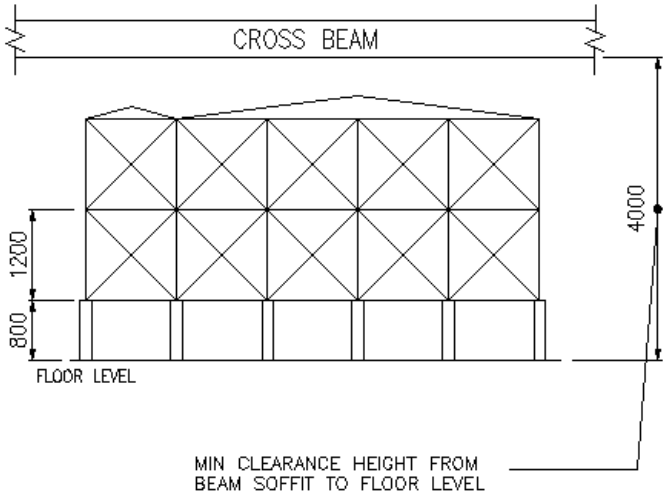
NOTES:

1. Size and location for the breeching inlet shall refer to the Mechanical Engineer.
2. All dimensions are in millimeter (mm).

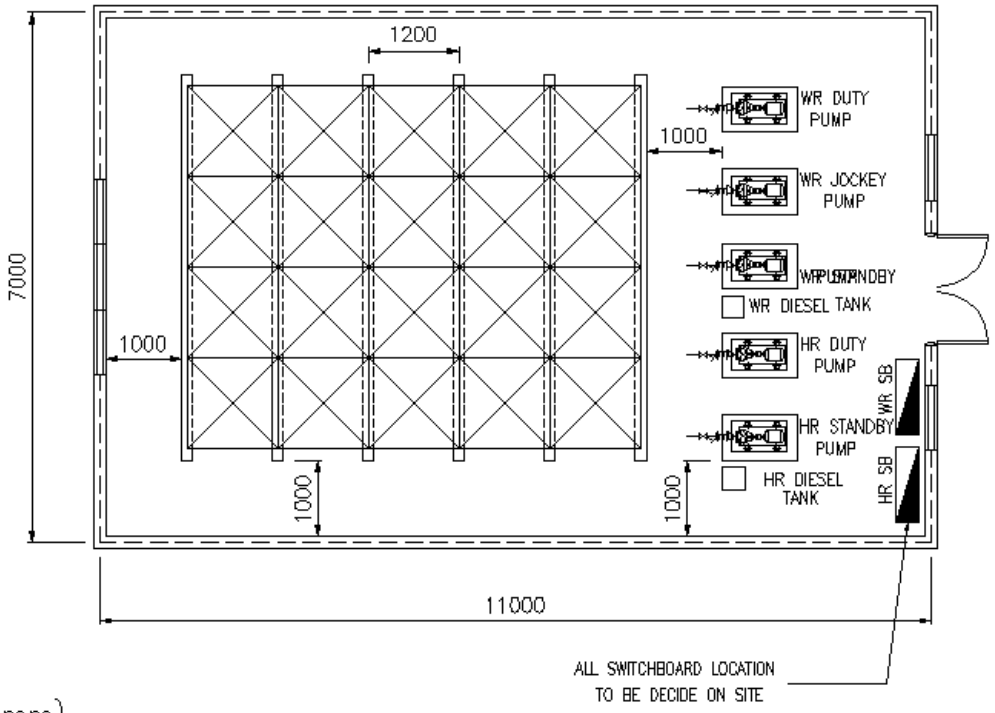
FIGURE 2.6

PLANT ROOM LAYOUT AND DIMENSIONS FOR HOSE REEL AND WET RISER SYSTEM

SIDE VIEW



PLAN VIEW

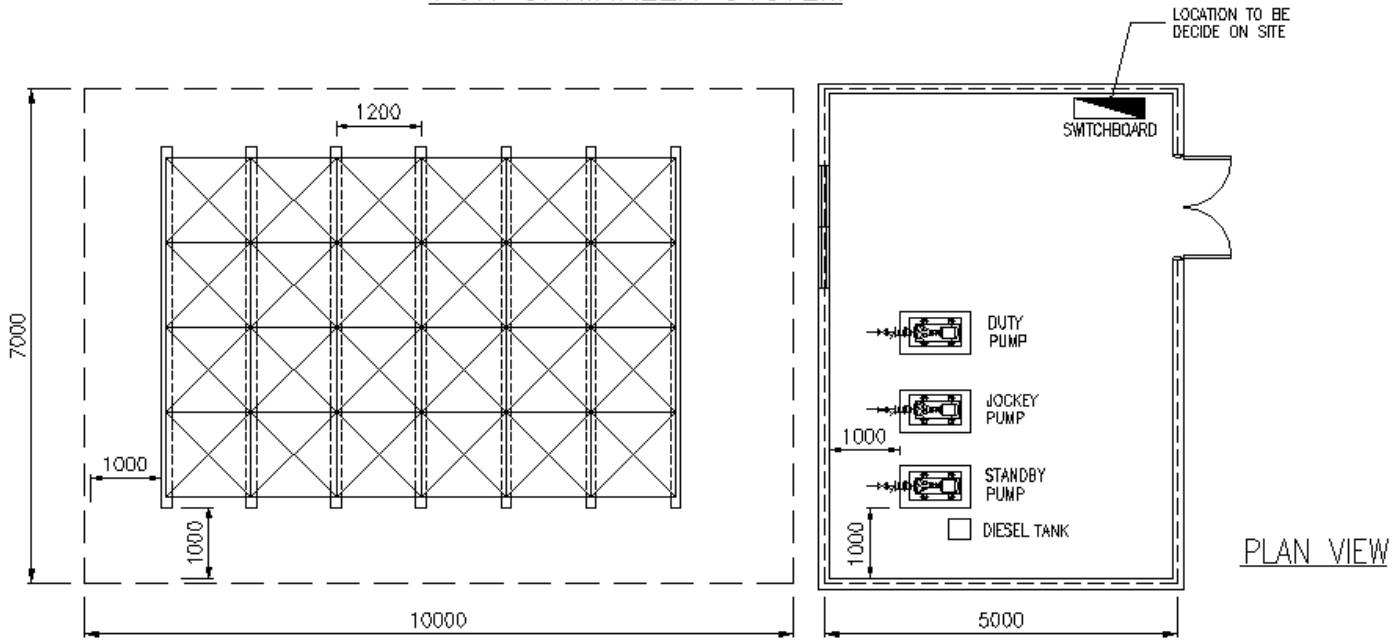


NOTE:

1. All dimensions are in millimeter (mm).

FIGURE 2.7

PLANT ROOM LAYOUT AND DIMENSIONS FOR SPRINKLER SYSTEM



NOTES :

1. Tank to be provided by Mechanical Contractor.
2. Tank may be located outdoor adjacent to pump room.
3. The discontinuous line shown above indicates room dimensions if tank is housed indoor.
4. Dimensions shown are meant for 80,000 litres tank for Sprinklers System. For other tank capacities, room should be scaled down in accordance to data in Table 2.5.
5. Each tank panel size are 1200mm x 1200mm x 1200mm. (Base on two stock)
6. Minimum distance pump to wall and plinth to wall is 1000mm.
7. All dimensions are in millimeter (mm).

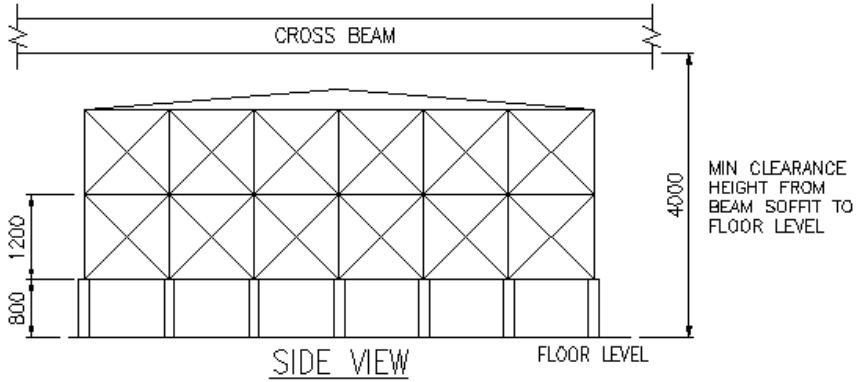
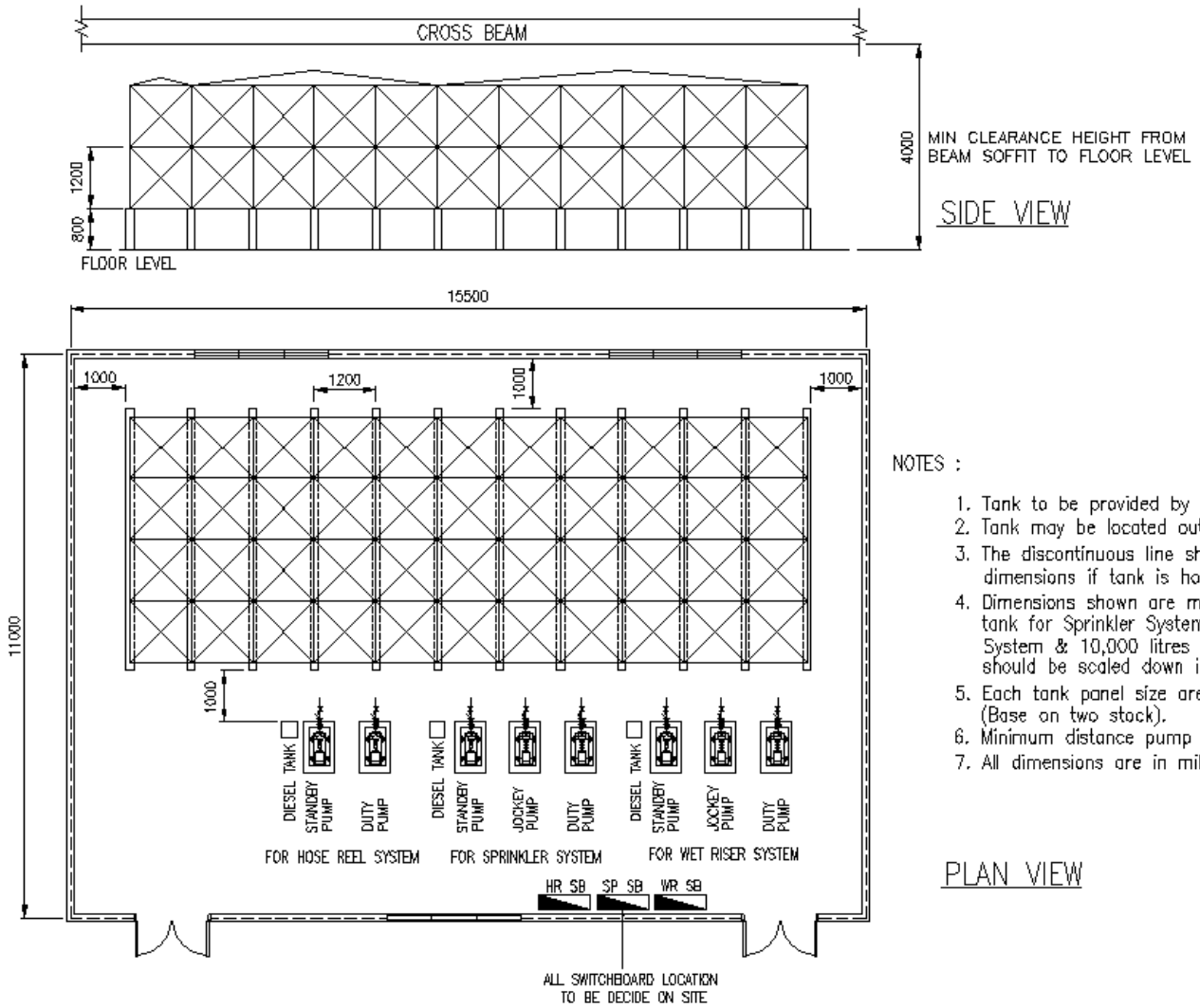


FIGURE 2.8

PLANT ROOM LAYOUT AND DIMENSIONS

HOSE REEL, WET RISER AND SPRINKLER SYSTEMS

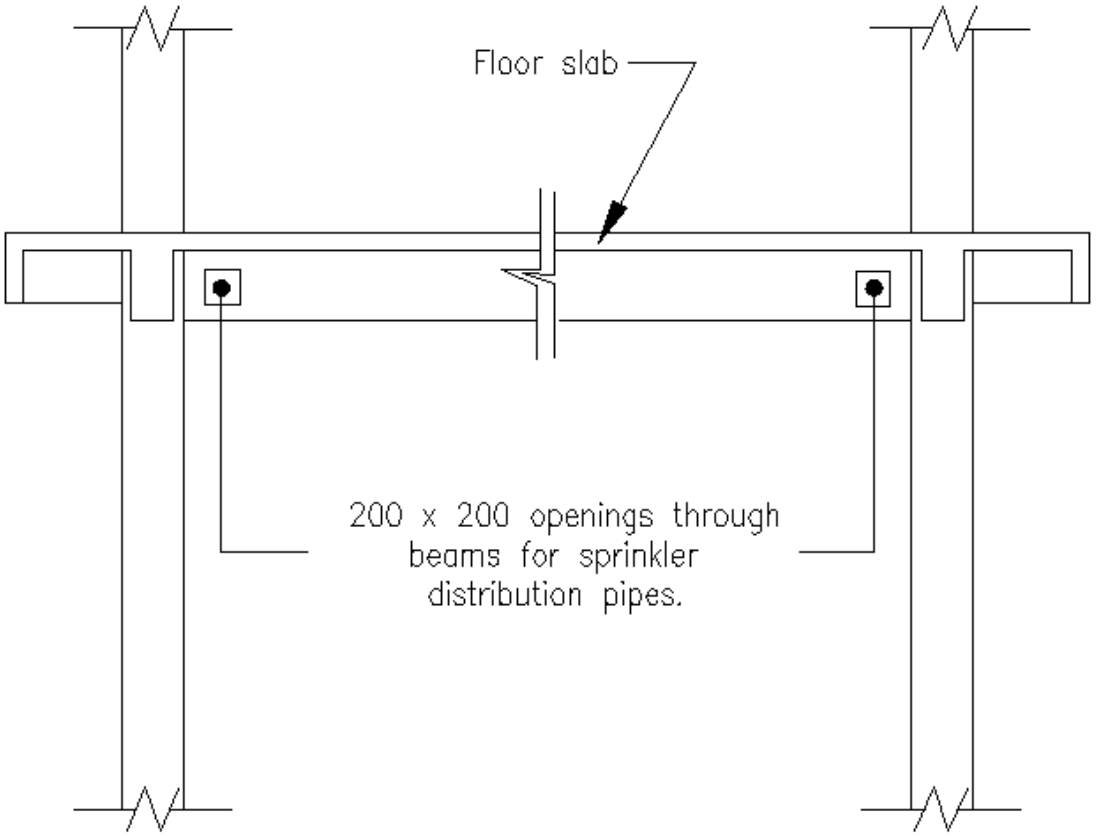


NOTES :

1. Tank to be provided by Mechanical Contractor.
2. Tank may be located outdoor adjacent to pump room.
3. The discontinuous line shown above indicates room dimensions if tank is housed indoor.
4. Dimensions shown are meant for 80,000 litres tank for Sprinkler System. 50,000 litres tank for Wet Riser System & 10,000 litres tank for Hose Reel System. Room should be scaled down in accordance to data in Table 2.5.
5. Each tank panel size are 1200mm x 1200mm x 1200mm. (Base on two stock).
6. Minimum distance pump to wall and plinth to wall is 1000mm.
7. All dimensions are in millimeter (mm).

FIGURE 2.9

POSITION OF BEAM HOLES FOR SPRINKLER PIPES



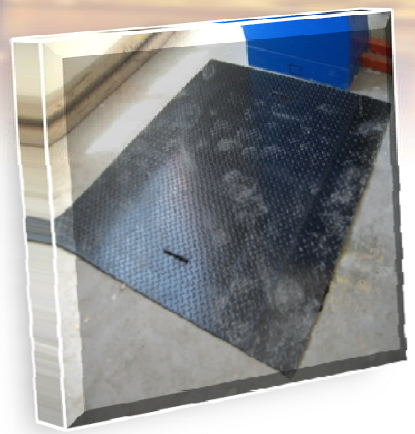
NOTE:

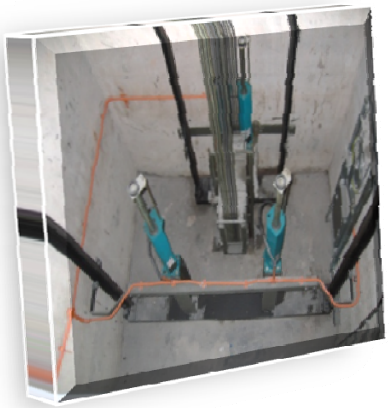
1. These openings are required at every floor.
2. All dimensions are in millimeter (mm).

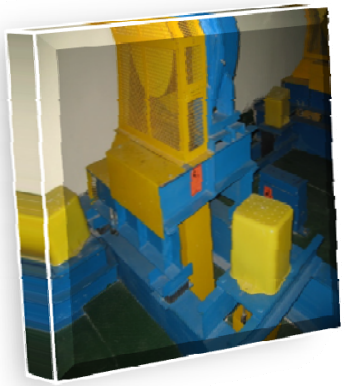
Checklist For Mechanical Requirement: Fire Fighting System

No.	Description		Yes	No	Remark
1.	**General requirement**				
2.	**Hose reel system**				
	2.1	Plant room (for pumps and water tanks)			
	2.2	Pipe riser			
	2.3	Hose reel riser compartment			
3.	**Dry riser system**				
	3.1	Pipe riser			
	3.2	Breeching inlets			
	3.3	Canvas hose riser compartment			
4.	**Wet riser system**				
	4.1	Pipe riser and landing valves			
	4.2	Canvas hose riser compartment			
	4.3	Plant room (for pump and water tank)			
5.	**Sprinkler system**				
	5.1	Water tank			
	5.2	Pump room			
	5.3	Riser pipes			
	5.4	Distribution pipes			
6.	**Main fire alarm panel room**				
	6.1	Location			
	6.2	Dimensions and construction			
	6.3	Central monitoring system. (CMS)			
7.	**Gas cylinder for total flooding fire extinguishing system.**				
	7.1	Unoccupied space-plant room (Substation TNB/JKR)			
	7.2	Occupied space-(server room, arkib, strong room and etc.)			

LIFT SYSTEM







SECTION 3

LIFT SYSTEM

No.	Item	Mechanical Requirement	Action	Remark
1.0	**Lift selection.**		Architect and Structural Engineer.	
	1.1 Office buildings.	Refer to **Table 3.1**.		Selection based on net usable building area.
	1.2 Hospitals.	Refer to **Table 3.2**.		Selection based on number of hospital beds in the block concerned.
	1.3 Residential buildings.	Refer to **Table 3.3**.		Selection based on number of unit housed in each block.
	1.4 Handicapped.	Refer to **Table 3.8**.		EPU Guidelines.
	1.5 Stretcher.	Refer to **Table 3.9**.		EPU Guidelines.
	1.6 Goods/Freight/Service.	Refer to **Table 3.10**.		
	1.7 Dumbwaiters.	Refer to **Table 3.2**.		

No.	Item	Mechanical Requirement	Action	Remark
2.0	**Layout selection based on Architect's conceptual design.**	Refer to **Figures 3.1** and **3.2** to select layout.	Architect and Structural Engineer.	
3.0	**Lobby.**			
	3.1 Dimensions.	Refer to **Figures 3.1** and **3.2**.		
	3.2 Location.	3.2.1 Firemen's lift shall be located not more than 60m from the furthermost point of the floor. Refer to **Figure 3.9**.		
		3.2.2 For other floors, fire fighting access lobbies shall be located not more than 45m from furthermost point of the floor.		
	3.3 Floor.	All lobby floors to slope away from lift well at gradient of 1: 10. Refer to **Figure 3.11**.		
	3.4 Fire protection.	3.4.1 Lobbies and stairways shall be isolated by fire-rated walls and doors.		

No.	Item	Mechanical Requirement	Action	Remark
		3.4.2 Protected lobbies. In buildings exceeding 45m above ground level, pressurization shaft shall be provided.	Architect and Structural Engineer.	Shaft size and openings to be determined by Mechanical Engineer.
	3.5 Call button and Indicator.	Provide opening at each landing. Refer to **Figure 3.10**.	Structural Engineer.	
	3.6 Firemen's switch.	Provide opening at ground floor only. Refer to **Figure 3.10**.		
4.0	**Lift pit.**			
	4.1 Dimensions.	Refer to: **Tables 3.4, 3.5, 3.6, 3.7, 3.8, 3.9** and **3.10**. **Figures 3.3**, **3.4, 3.5, 3.6, 3.7** and **3.8**.		
	4.2 Wall and floor.	4.2.1 Reinforced concrete and water proof.		
	4.3 Other facilities.	4.3.1 Sunken sump of dimension 0.5m x 0.5m x 0.3m (depth) at front corner. Refer to **Figure 3.8**.		

No.	Item	Mechanical Requirement	Action	Remark
		4.3.2 Pit floor to slope towards sump.	Architect and Structural Engineer.	To accommodate submersible pump.
		4.3.3 Cat ladder.		
		4.3.4 Lighting and 13 amp socket outlet.	Electrical Engineer.	
5.0	**Lift shaft.**	Not more than four lifts shall be provided at each of lift bank.	Architect and Structural Engineer.	
	5.1 Dimensions.	Refer to: **Tables 3.4, 3.5, 3.6, 3.7, 3.8, 3.9** and **3.10**. **Figures 3.3**, **3.4, 3.5, 3.6, 3.7** and **3.8**.		
	5.2 Construction.	5.2.1 Reinforced concrete on all sides.		
		5.2.2 Firemen's lift shaft shall be reinforced concrete on all sides. Refer **Figures 3.1** and **3.2**.		
		5.2.3 Anchoring beams at 2.4m vertical intervals in between lifts. Minimum 100mm RSJ (Rectangular Steel Joist) may be used. Refer to **Figure 3.4**.		Applicable to multiple lifts in one common hoist way.

No.	Item	Mechanical Requirement	Action	Remark
		5.2.4 Front wall shall have structural openings as depicted in **Figure 3.10**. It should also have other openings of dimensions as depicted in **Figure 3.10**.	Architect and Structural Engineer.	To provide for landing doors. These openings are for call buttons, car position indicator and firemen's switch.
	5.3 Door sill.	Refer to **Figure 3.11** for required design.		
	5.4 Partition for multiple lift shaft.	Partition shall be provided between the moving parts (car or counterweight) of multiple lifts or service lifts. The partition shall extend at least 2.5m height above the depth of the pit.		Safety (BS 5655: PART 1:1986) & (EN 81: PART 1:1985).
6.0	**Machine room (Lift motor room).**			No water pipes or other pipings should run through machine room.
	6.1 Dimensions.	Refer to **Figures 3.3, 3.4, 3.5, 3.6** and **3.7**.		
	6.2 Hoisting beam.	**6.2.1** Hoisting I-beam for each bank of lift shaft or hoisting hook for each lift shaft. Refer to **Figure 3.12**.		

No.	Item	Mechanical Requirement	Action	Remark
		6.2.2 I-beam and hoisting hook capable to take minimum 3 tonnes point load.	Architect and Structural Engineer.	
		6.2.3 I-beam to have clearance of 100mm from roof of machine room.		
	6.3 Access Door.	Double-leaf door of dimensions 1.6m x 2.1m. The doors shall be open outwards.		
	6.4 Access to machine room.	6.4.1 Reinforced concrete staircase of 1.0m wide.		Cat ladder is not acceptable.
		6.4.2 Dumbwaiters (Floor and Table type). Provide service opening 700mm x 900mm. Refer to **Figure 3.5**.		Details requirement, refer to the Mechanical Engineer.
	6.5 Access from machine room to highest landing floor.	6.5.1 Trap door(s) opening upwards and of dimensions 1.5m x 1.5m. Door material shall be of steel plate. Refer to **Figures 3.3 and 3.4**.		To enable equipment to be lowered to highest landing floor where it can be taken to the ground floor by other lifts.
		6.5.2 Trap door(s) to be located above lobby.		

No.	Item	Mechanical Requirement	Action	Remark
		6.5.3 Trap door leading to highest landing floor shall be clear of any permanent obstruction.	Architect and Structural Engineer.	
	6.6 Ventilation.	6.6.1 Provide one ventilating fan opening for a group of four lifts or less. Provide two openings for a group of six or eight lifts.		
		6.6.2 Fan opening(s) shall be of suitable aluminium frame and of clear dimensions 610mm x 610mm. Refer to **Figures 3.3** and **3.4**.		
		6.6.3 Louvered door and window shall not be allowed.		
	6.7 Floor loading.	Floor slab shall be able to take equipment weight of 3 tonnes on a base of 1500mm x 800mm.		
	6.8 Floor finishes.	Cement rendering with non slip epoxy paint.		

No.	Item	Mechanical Requirement	Action	Remark
	6.9 Electrical requirement.	6.9.1 Adequate natural lighting (i.e. skylight) to be provided i.e. by having fixed glass at high level. 6.9.2 Adequate electric lighting for lift shaft and lift motor room. 6.9.3 To provide isolator for the following equipment: a. Air-conditioning system. b. Ventilation fan. c. Lift control panel. 6.9.4 Provide 13 amp socket outlet. 6.9.5 All electrical cables shall run at high level.	Electrical Engineer.	

TABLE 3.1

LIFT SELECTION – OFFICE BUILDINGS

NO. OF FLOORS >	UP TO 5 FLOORS			6 – 10 FLOORS			11 – 15 FLOORS			16 – 20 FLOORS		
** Area per floor (m^2)	*No. of lift	Capacity (kg)	Speed (m/s)	*No. of lift	Capacity (kg)	Speed (m/s)	*No. of lift	Capacity (kg)	Speed (m/s)	*No. of lift	Capacity (kg)	Speed (m/s)
500	2	900	1.5	4	1,050	2.5	6	1,350	3.0	6	1,350	3.5
750	2	900	1.5	4	1,050	2.5	6	1,350	3.0	6	1,350	3.5
1,000	2	900	1.5	4	1,050	2.5	6	1,350	3.0			
1,250	3	900	1.5	4	1,050	2.5	6	1,600	3.0			
1,500	3	900	1.5	5	1,050	2.5						
1,750	3	900	1.5	6	1,150	2.5						

NOTES :

**1. In a building where the top occupied floor is over 18.5m above fire appliance access level, Firemen's Lift shall be provided at each of lift bank.

* 2. The numbers of lift shall include one no. of Firemen's Lift (if required).

3. Indicates the net usable building area. Normally, it is taken to be 80% of building gross area.

4. For selection within the shaded area, please consult with the Mechanical Engineer.

5. Service Lift/Goods Lift (please consult with the Mechanical Engineer) may be provided for buildings having six or eight lifts.

6. Firemen's Lift shall be provided with essential supply. The shaft shall be separated by fire rated wall.

TABLE 3.2

LIFT SELECTION – HOSPITALS

NO. OF BEDS IN BLOCK	NO. OF HOSPITAL BED LIFTS/CAPACITY/ SPEED (No. x kg x m/s)	NO. OF SERVICE/GOODS LIFTS/ CAPACITY/SPEED (No. x kg x m/s)	NO. OF DUMBWAITERS/ CAPACITY/SPEED (No. x kg x m/s)
Up to 200	2 x 1,600 x 1.0	1 x 1,600 x 1.0	Normally 2 x 150 x 0.5 (if required)
201 – 700	6 x 1,600 x 1.0	2 x 1,800 x 1.5	2 x 150 x 0.5
701 – 900	6 x 1,600 x 1.0	2 x 1,800 x 1.5	2 x 150 x 0.5
901 – 1,200	8 x 1,600 x 1.0	2 x 1,800 x 1.5	3 x 150 x 0.5
1,201 – 1,500	8 x 1,600 x 1.0	2 x 1,800 x 1.5	3 x 150 x 0.5

TABLE 3.3

LIFT SELECTION – RESIDENTIAL BUILDINGS BY FLOOR

NO. OF FLOORS >	UP TO 5 FLOORS			6 – 10 FLOORS			11 – 15 FLOORS			16 – 20 FLOORS			
** Unit per floor	*No. of lift	Capacity kg (person)	Speed (m/s)	*No. of lift.	Capacity kg (person)	Speed (m/s)	*No. of lift	Capacity kg (person)	Speed (m/s)	*No. of lift.	Capacity kg (person)	Speed (m/s)	
4	2	900 (13)	1.5	3	1,050 (15)	2.5	4	1,350 (17)	3.0	4	1,350 (20)	3.5	For Stretcher Lift requirement, refer to **Table 3.9**
6	2	900 (13)	1.5	3	1,050 (15)	2.5	4	1,350 (17)	3.0	4	1,350 (20)	3.5	
8	2	900 (13)	1.5	3	1,050 (15)	2.5	4	1,350 (17)	3.0				
10	2	900 (13)	1.5	3	1,050 (15)	2.5	4	1,350 (17)	3.0				

NOTES:

**1. In a building where the top occupied floor is over 18.5 m above fire appliance access level, Firemen's Lift shall be provided at each of lift bank.

* 2. The numbers of lift shall include one no. of Firemen's Lift (if required) and one no. of Stretcher Lift with handicapped features.

TABLE 3.4

LIFT SHAFT DIMENSION – OFFICE BUILDINGS

LIFT CAPACITY Kg (person)	SPEED (m/s)	LIFT SHAFT CLEARANCE (HOISTWAY) DIMENSIONS (mm)				STRUCTURAL OPENING FOR EACH LANDING DOOR(mm)	
		PIT DEPTH (PD)	OVER HEAD TRAVEL (OH)	WIDTH (W)	DEPTH (D)	WIDTH (SW)	HEIGHT (SH)
900 (13) and 1,050 (15)	1.5	2,100	5,100	2,200	2,400	1,400	2,300
	2.5	2,450	5,700	2,400	2,500		
	3.0	3,400	6,100	3,000	2,500		
	3.5	4,600	6,400	3,000	2,500		
1,150 (17) and 1,350 (20)	1.5	2,100	5,100	2,700	2,400	1,400	2,300
	2.5	2,450	5,700	2,700	2,600		
	3.0	3,400	6,100	3,100	2,600		
	3.5	4,600	6,400	3,100	2,600		
1,600 (23)	1.5	2,100	5,100	2,700	2,700	1,400	2,300
	2.5	2,450	5,700	2,800	2,700		
	3.0	3,400	6,100	3,200	2,800		
	3.5	4,700	6,400	3,200	2,800		

TABLE 3.5

LIFT SHAFT DIMENSION – HOSPITALS

LIFT CAPACITY Kg (person)	SPEED (m/s)	LIFT SHAFT CLEARANCE (HOISTWAY) DIMENSIONS (mm)				STRUCTURAL OPENING FOR EACH LANDING DOOR (mm)	
		PIT DEPTH (PD)	OVERHEAD TRAVEL (OH)	WIDTH (W)	DEPTH (D)	WIDTH (SW)	HEIGHT (SH)
1,600 (23) (Hospital Bed Lifts)	1.0	1,900	5,000	2,800	3,300	1,400	2,300
1,600 (23) (Hospital Bed Lifts)	1.5	2,100	5,100	2,800	3,300	1,400	2,300
1,800 **(--)** (Hospital Goods Lifts)	1.5	2,100	5,200	2,900	3,300	1,400	2,300

TABLE 3.6

LIFT SHAFT DIMENSION – RESIDENTIAL BUILDINGS

LIFT CAPACITY Kg (person)	SPEED (m/s)	LIFT SHAFT CLEARANCE (HOISTWAY) DIMENSIONS (mm)				STRUCTURAL OPENING FOR EACH LANDING DOOR(mm)	
		PIT DEPTH (PD)	OVER HEAD TRAVEL (OH)	WIDTH (W)	DEPTH (D)	WIDTH (SW)	HEIGHT (SH)
900 (13) and 1,050 (15)	1.5	2,100	5,100	2,200	2,400	1,400	2,300
	2.5	2,450	5,700	2,400	2,500		
	3.0	3,400	6,100	3,000	2,500		
	3.5	4,600	6,400	3,000	2,500		
1,150 (17) and 1,350 (20)	1.5	2,100	5,100	2,700	2,400	1,400	2,300
	2.5	2,450	5,700	2,700	2,600		
	3.0	3,400	6,100	3,100	2,600		
	3.5	4,600	6,400	3,100	2,600		
1,600 (23)	1.5	2,100	5,100	2,700	2,700	1,400	2,300
	2.5	2,450	5,700	2,800	2,700		
	3.0	3,400	6,100	3,200	2,800		
	3.5	4,700	6,400	3,200	2,800		

TABLE 3.7

LIFT SHAFT DIMENSION – DUMBWAITERS

DUMBWAITER (Kg)	SPEED (m/s)	SHAFT CLEARANCE (HOISTWAY) DIMENSIONS (mm)				STRUCTURAL OPENING FOR EACH LANDING DOOR(mm)	
		PIT DEPTH (PD)	OVERHEAD TRAVEL (OH)	WIDTH (W)	DEPTH (D)	WIDTH (SW)	HEIGHT (SH)
Floor Type (200)	0.5	800	2,250	1,450	1,300	1,100	1,400
Floor Type (300)	0.5	800	2,250	1,600	1,500	1,100	1,400
Table Type (50-150)	0.5	Table Height 750	1,900	1,200	1,100	1,000	1,100

TABLE 3.8

LIFT SHAFT DIMENSION – HANDICAPPED

FLOOR HEIGHT	LIFT CAPACITY (kg)	SPEED (m/s)	CAR SIZE (mm)	LIFT SHAFT CLEARANCE (HOISTWAY) DIMENSIONS (mm)				STRUCTURAL OPENING FOR EACH LANDING DOOR(mm)	
				PIT DEPTH (PD)	OVER HEAD TRAVEL (OH)	WIDTH (W)	DEPTH (D)	WIDTH (SW)	HEIGHT (SH)
Top Most > 7.4 Metres	1450	1.5	1,800 x 1,800	2,400	5,600	2,400	2,600	1,400	2,300

NOTE:

1. Based on the latest EPU Guidelines.

TABLE 3.9

LIFT SHAFT DIMENSION – STRETCHER

LIFT CAPACITY kg (Person)	SPEED (m/s)	LIFT SHAFT CLEARANCE (HOISTWAY) DIMENSIONS (mm)				STRUCTURAL OPENING FOR EACH LANDING DOOR(mm)	
		PIT DEPTH (PD)	OVER HEAD TRAVEL (OH)	WIDTH (W)	DEPTH (D)	WIDTH (SW)	HEIGHT (SH)
1,600 (23)	1.5	2,100	5,100	2,800	3,000	1,400	2,300

NOTE:

1. For hospital, please refer to **Table 3.5**.

TABLE 3.10

LIFT SHAFT DIMENSION – GOODS/FREIGHT/SERVICE

LIFT CAPACITY Kg	SPEED (m/s)	LIFT SHAFT CLEARANCE (HOISTWAY) DIMENSIONS (mm)				STRUCTURAL OPENING FOR EACH LANDING DOOR (mm)	
		PIT DEPTH (PD)	OVERHEAD TRAVEL (OH)	WIDTH (W)	DEPTH (D)	WIDTH (SW)	HEIGHT (SH)
1,000	0.5 – 1.0	1,900	5,000	2,800	3,100	1,400	2,300
2,000	0.5 – 1.0	1,900	5,000	3,600	4,000	1,800	2,300
3,000	0.5 – 1.0	1,900	5,200	4,400	4,200	2,300	2,500

FIGURE 3.1

LIFT LAYOUTS – IN – LINE ARRANGEMENTS

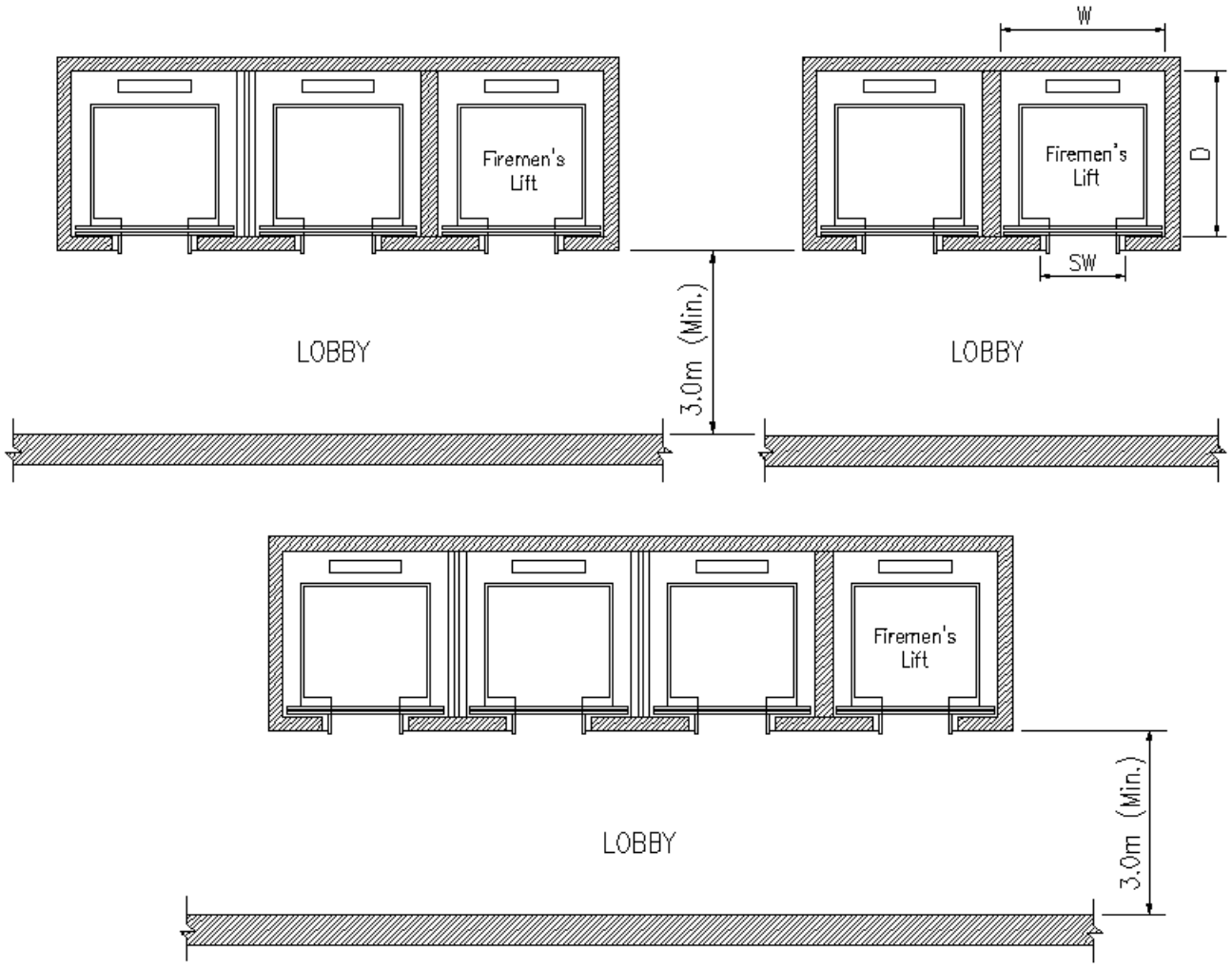


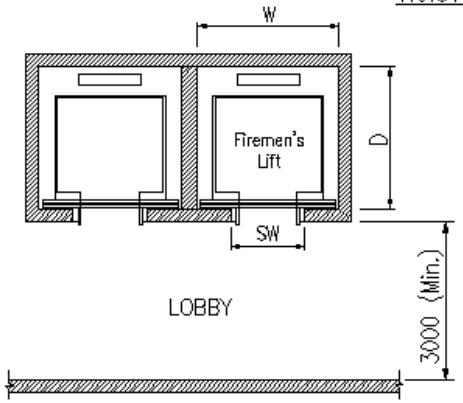
FIGURE 3.2

LIFT LAYOUTS – ALCOVE ARRANGEMENTS

GENERAL PLANT ROOM LAYOUT AND DIMENSIONS FOR IN – LINE ARRANGEMENT

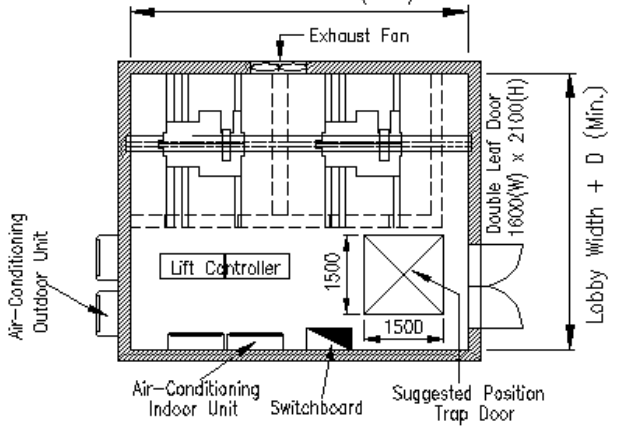
FIGURE 3.3

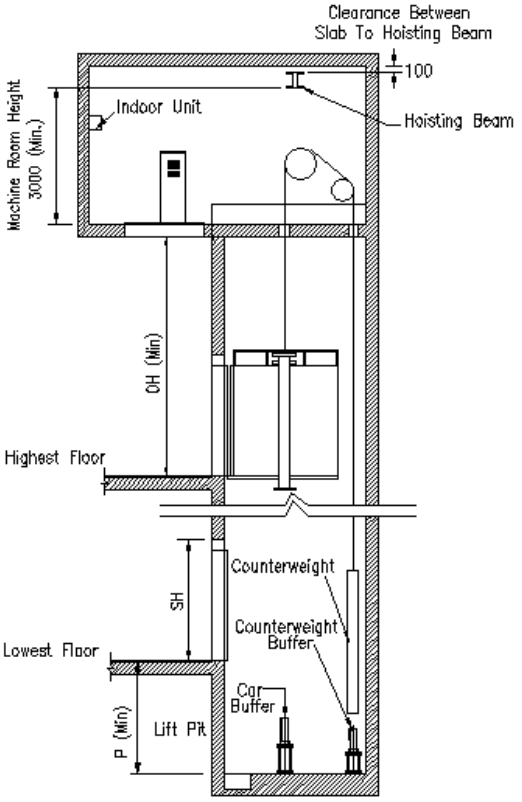
HOISTWAY PLAN



MACHINE ROOM PLAN

1000 + N x W (Min.) – Please See Note Below





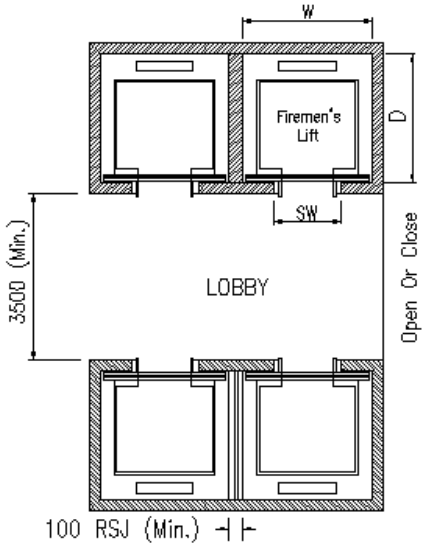
HOISTWAY SECTION

NOTES :

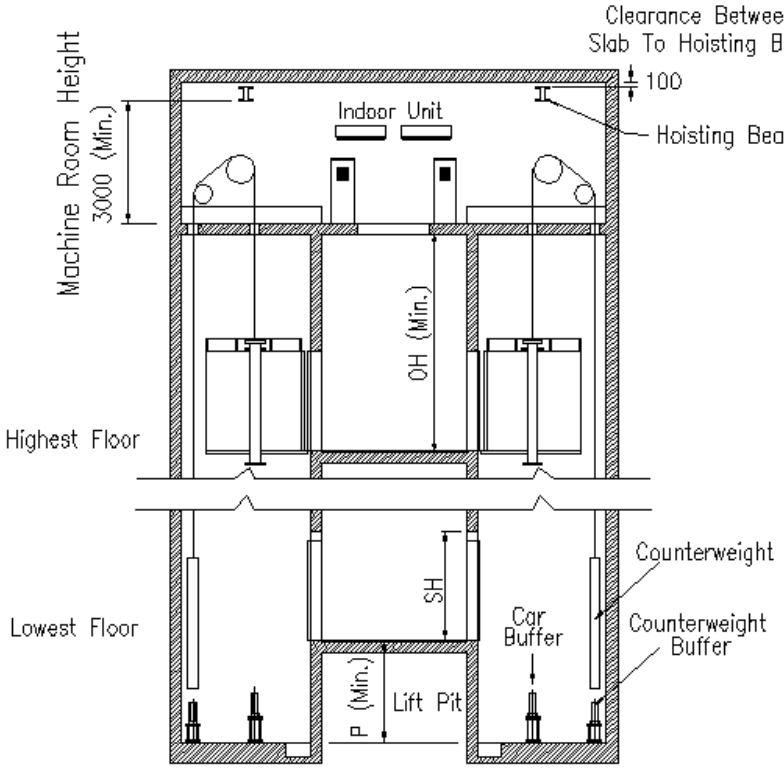
1. N in the expression equals to number of lifts in the bank.
2. Structural Opening, Refer to Tables 3.5, 3.6, 3.7, 3.9 & 3.10.
3. The exact position of outdoor & indoor unit shall be determine at site.
4. All dimensions are in millimeter (mm).

GENERAL PLANT ROOM LAYOUT AND DIMENSIONS FOR ALCOVE ARRANGEMENT

FIGURE 3.4

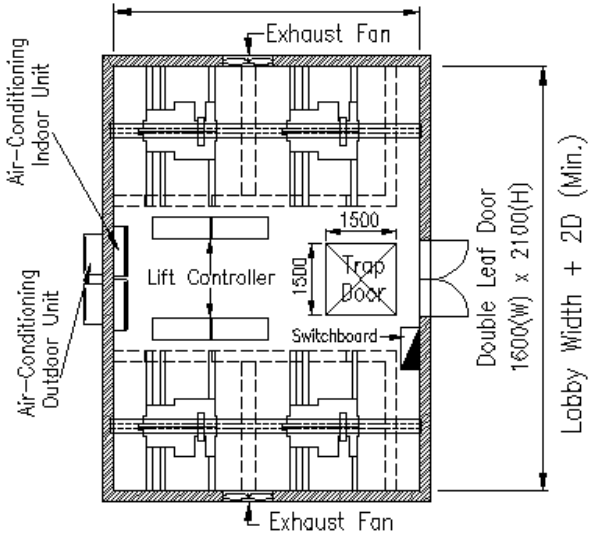


HOISTWAY PLAN



HOISTWAY SECTION

1000 + N x W (Min.) – Please See Note Below



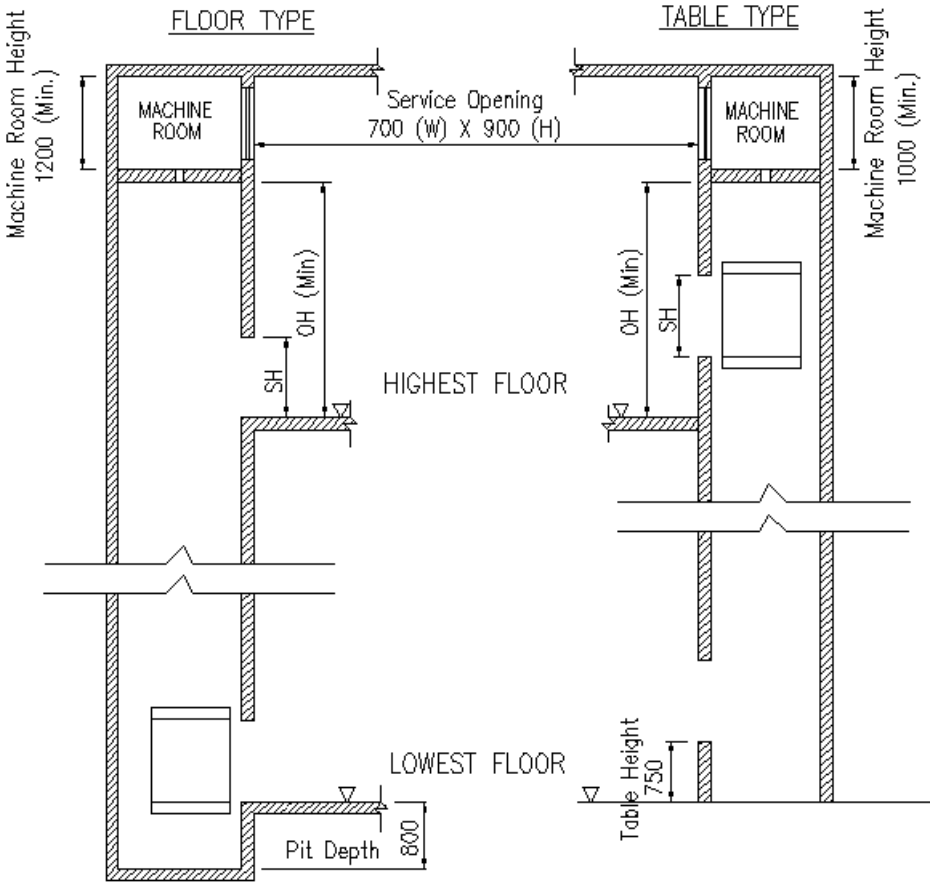
MACHINE ROOM PLAN

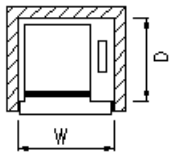
NOTES :

1. N in the expression equals to total number of lifts in group divided by 2.
   RSJ – Rectangular Steel Joist.
2. Structural Opening. Refer to Tables 3.5, 3.6, 3.7, 3.9 & 3.10.
3. The exact position of outdoor & indoor unit shall be determine at site.
4. All dimensions are in millimeter (mm).

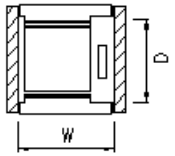
FIGURE 3.5

GENERAL PLANT ROOM LAYOUT AND DIMENSIONS FOR FLOOR AND TABLE DUMBWAITERS





TYPE 1
(OPEN ON ONE SIDE ONLY)



TYPE 2
(OPEN ON BOTH SIDES)

	Table Type	Floor Type
Rated load (kg)	50–150	200–300
Wall thickness (min)	100 mm	
Construction of hoistway	Concrete, Block or Brick	

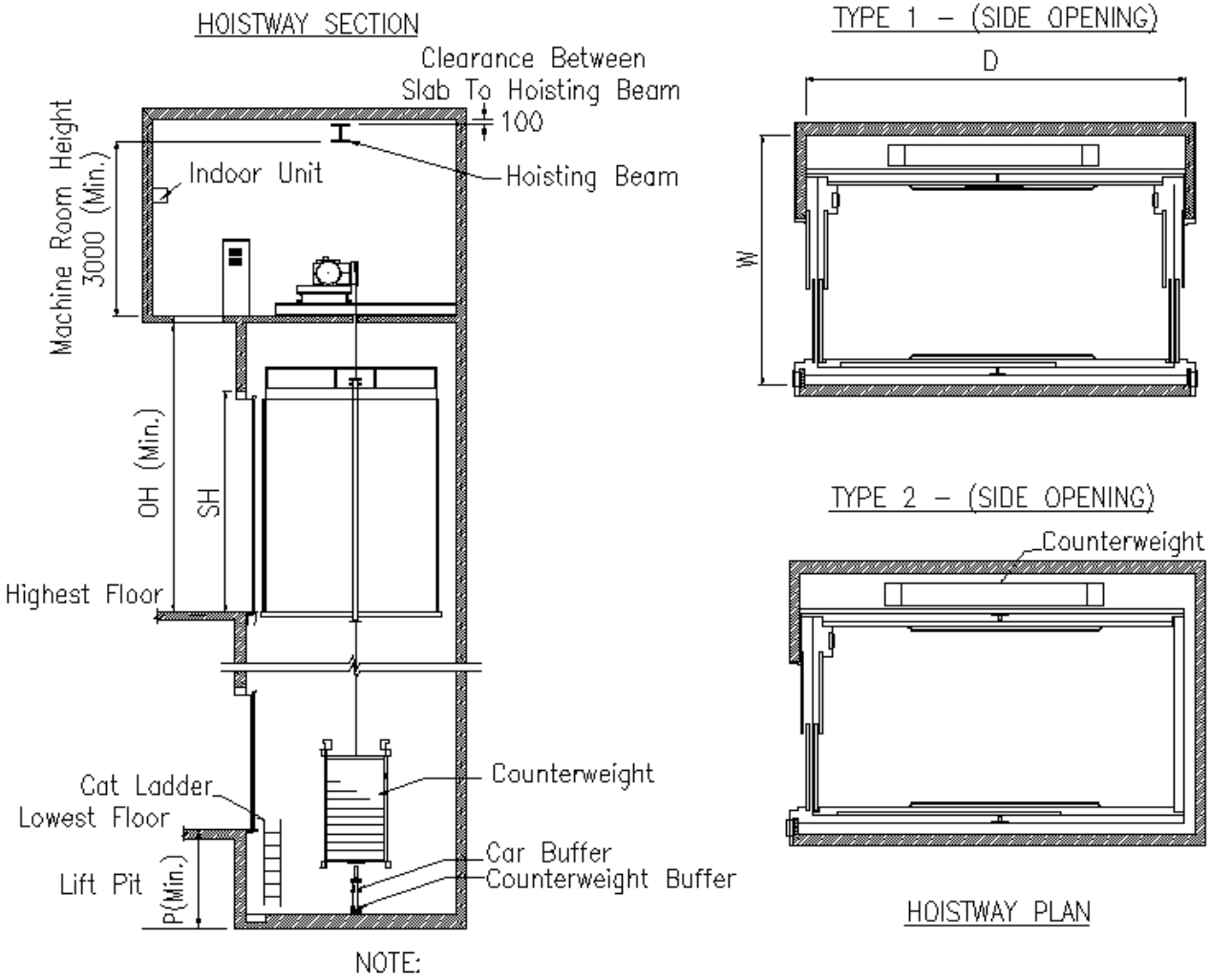
Dumbwaiter Specification

NOTES :

1. Normally, the machine room for the dumbwaiter is housed in the ceiling space.
2. All dimensions are in millimeter (mm).

FIGURE 3.6

GENERAL PLANT ROOM LAYOUT AND DIMENSIONS FOR HOSPITALS AND STRETCHER LIFT

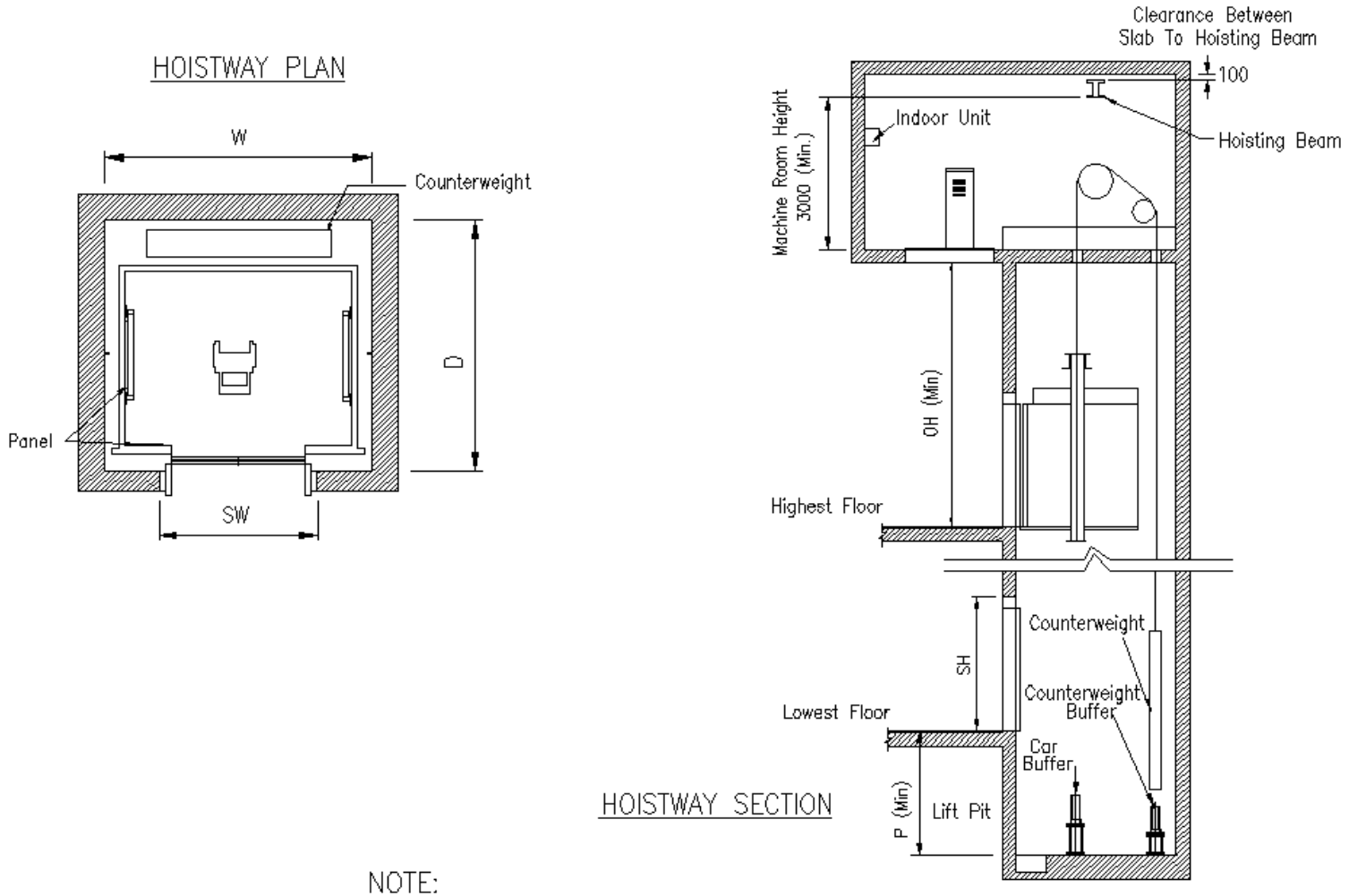


NOTE:

1. All dimensions are in millimeter (mm).

FIGURE 3.7

GENERAL PLANT ROOM LAYOUT AND DIMENSIONS FOR HANDICAPPED LIFT

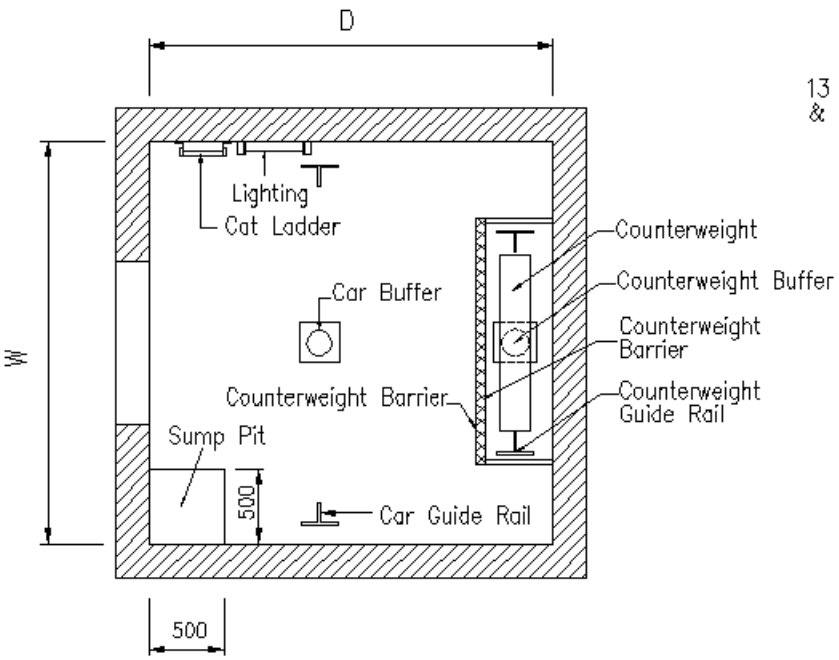


NOTE:

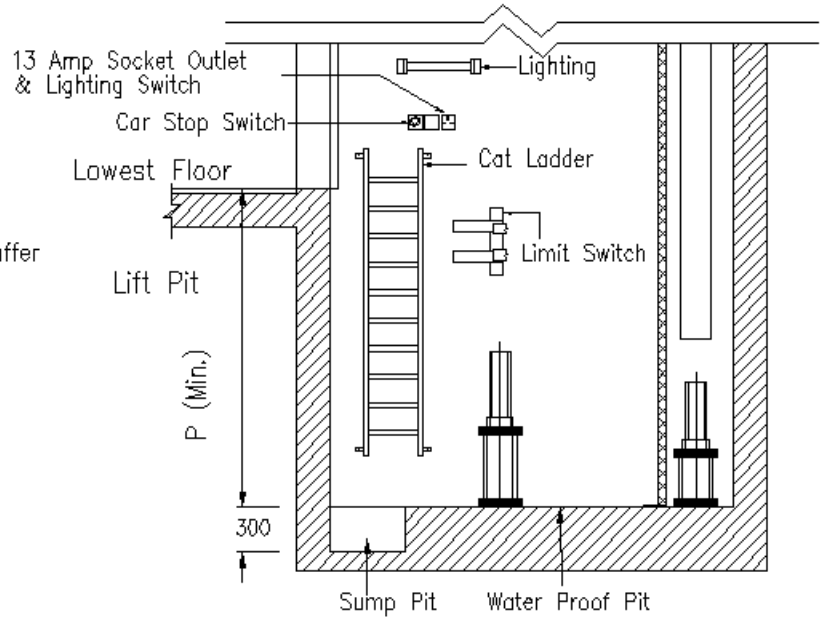
1. All dimensions are in millimeter (mm).

FIGURE 3.8

LIFT PIT DETAIL



PLAN VIEW



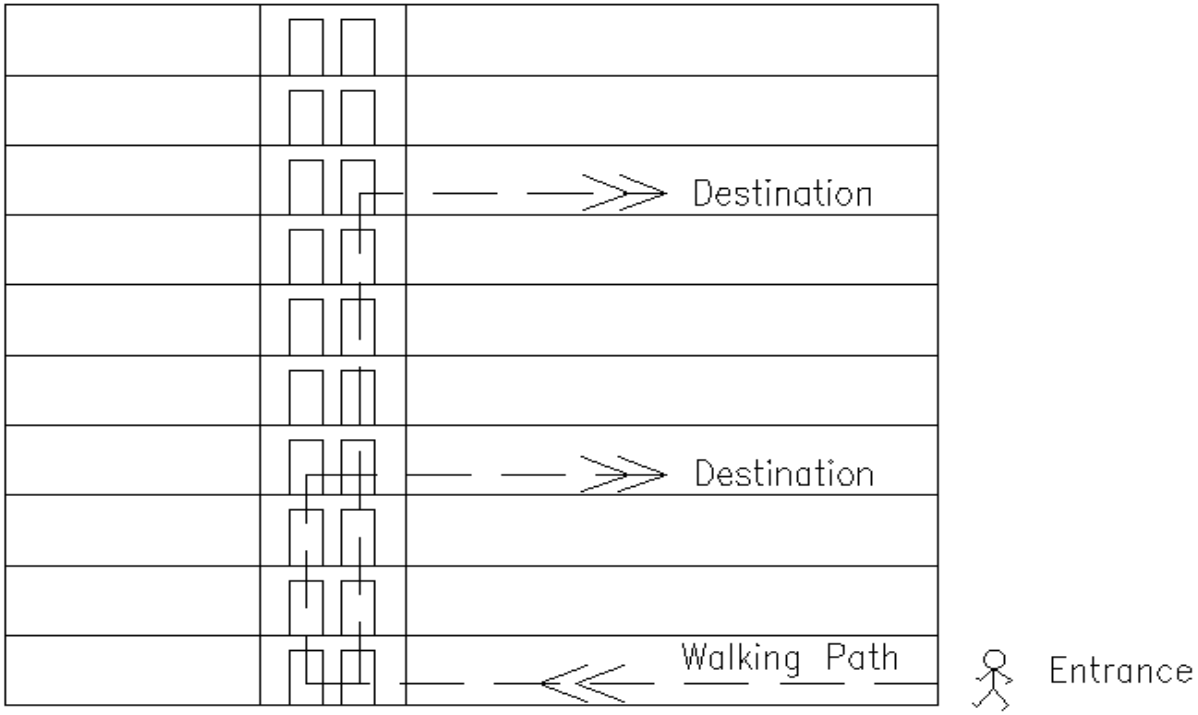
SIDE VIEW

NOTE:

1. Sump Pit dimensions shall be 500mm x 500mm x 300mm (Depth)
2. Sump to be provided at every individual lift pit.
3. Water proofing for lift pit shall be provided.
4. All dimensions are in millimeter (mm).

FIGURE 3.9

SELECTION & ARRANGEMENT OF LIFT EQUIPMENT

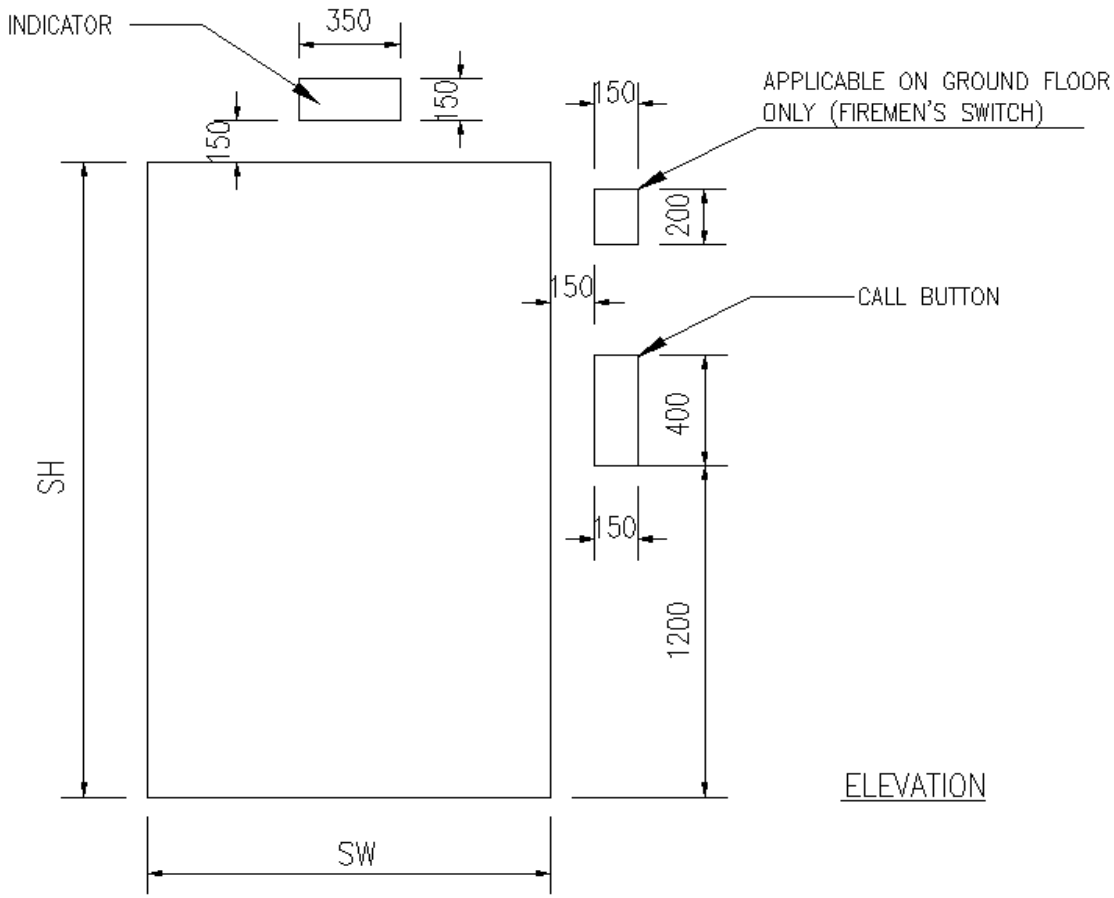


NOTE :

1. Walking distance shall be 45–60 metres (Maximum).

FIGURE 3.10

STRUCTURAL OPENING FOR DOOR AT EACH LANDING

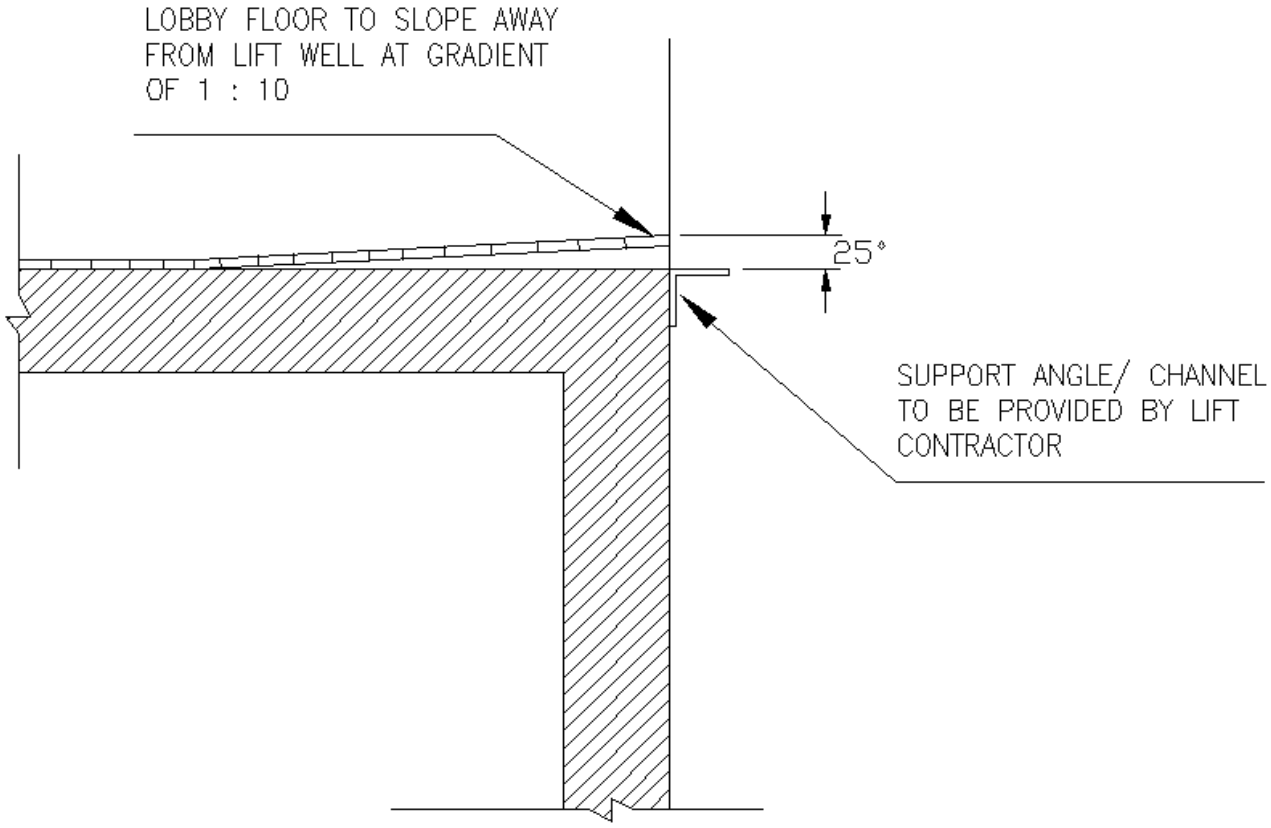


NOTES:

1. Refer to Tables 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10 for Structural Height,(SH) and Structural Width,(SW).
2. All dimensions are in millimeter (mm).

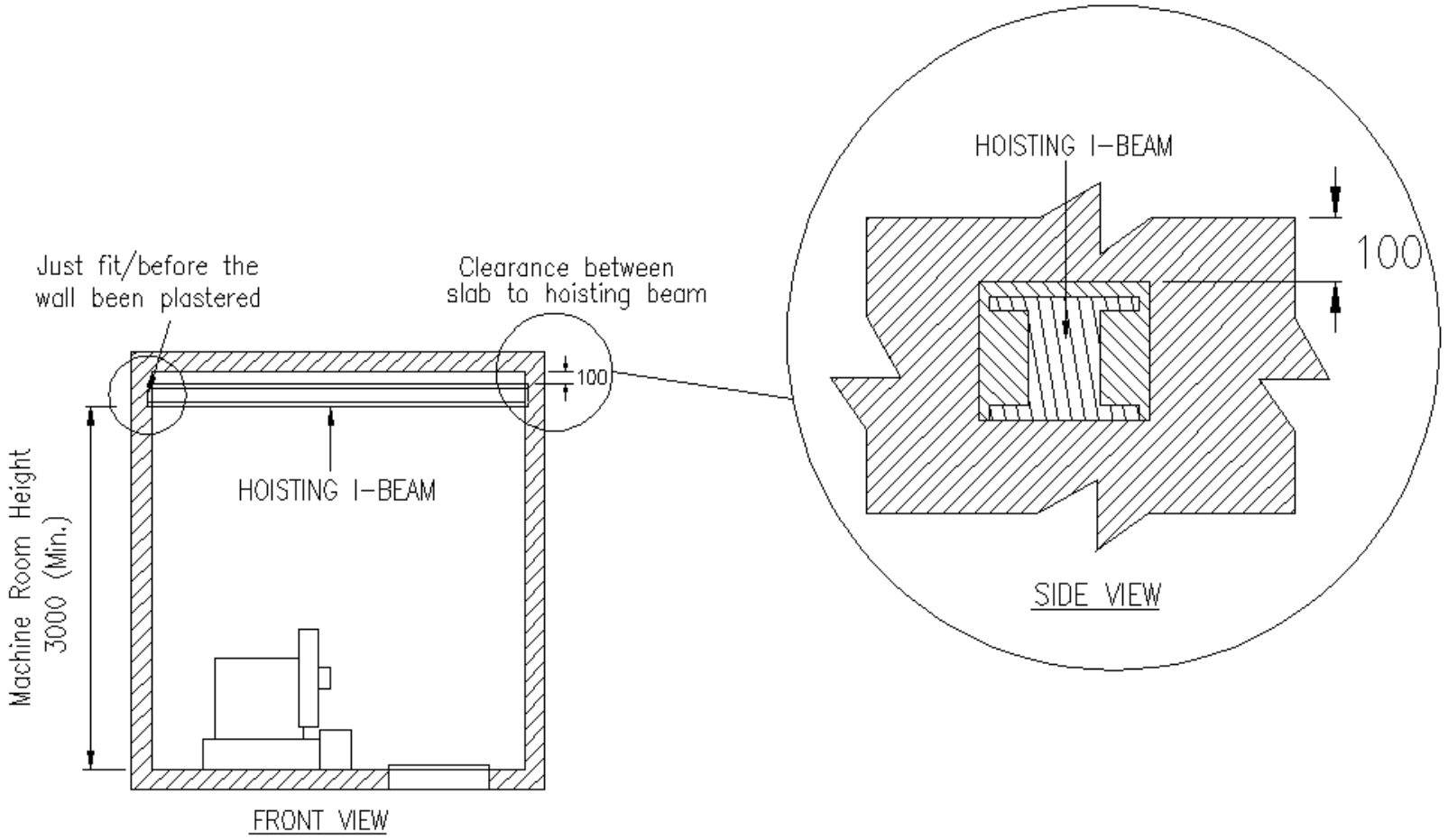
FIGURE 3.11

DOOR SILL SUPPORT AT EACH LANDING AND SLOPE AT LOBBY FLOOR



HOISTING I-BEAM AT MACHINE ROOM

FIGURE 3.12



NOTES:

1. Hoisting I-beam capable to take minimum 3 tonnes point load.
2. All dimensions are in millimeter (mm).

Checklist For Mechanical Requirement: Lift System

No.	Description		Yes	No	Remark
1.	**Lift selection**				
	1.1	Office buildings			
	1.2	Hospitals			
	1.3	Residential buildings			
	1.4	Handicapped			
	1.5	Stretcher			
	1.6	Goods/Freight/Service			
	1.7	Dumbwaiters			
2.	**Layout selection based on Architect's conceptual design**				
3.	**Lobby**				
	3.1	Dimensions			
	3.2	Location			
	3.3	Floor			
	3.4	Fire protection			
	3.5	Call button and indicator			
	3.6	Firemen's switch			
4.	**Lift pit**				
	4.1	Dimensions			
	4.2	Wall and floor			
	4.3	Other facilities:			

Checklist For Mechanical Requirement: Lift System (Cont'd.)

No.	Description		Yes	No	Remark
5.	**Lift shaft**				
	5.1	Dimensions			
	5.2	Construction			
	5.3	Door sill			
	5.3	Partition for multiple lift shaft			
6.	**Machine room (Lift motor room)**				
	6.1	Dimensions			
	6.2	Hoisting beam			
	6.3	Access Door			
	6.4	Access to machine room			
	6.5	Access from machine room to highest landing floor			
	6.6	Ventilation			
	6.7	Floor loading			
	6.8	Floor finishes			
	6.9	Electrical requirement			

INTERNAL COLD WATER AND SANITARY SYSTEM





SECTION 4

INTERNAL COLD WATER AND SANITARY SYSTEM

No.	Item	Mechanical Requirement	Action	Remark
1.0	**General requirement**	Any equipment of cold water and sanitary system located outdoor shall be provided with decorative enclosure.	Architect and Structural Engineer.	
2.0	**Internal cold water and sanitary system.**			
	2.1 Pipe riser.	2.1.1 Provide pipe riser with opening at every floor for the riser pipe complete with access door and adjacent to cubical toilet.		Refer to the Mechanical Engineer for riser size.
		2.1.2 Provide floor trap at the ground floor riser.		
	2.2 Domestic tank.	2.2.1 For the domestic tank in the ceiling space, the minimum clearance within roof top for maintenance purposes shall refer to **Figure 4.1**.		Refer to the Mechanical Engineer for tank capacity and size.
		2.2.2 Provide 600mm x 600mm opening for domestic tank in the ceiling. Refer to **Figure 4.1**.		

No.	Item	Mechanical Requirement	Action	Remark
		2.2.3 Staircase shall be provided to the domestic tank located on the rooftop.	Architect and Structural Engineer.	Based on capacity. Requirement of staircase to be decided by Mechanical Engineer.
		2.2.4 Provide plinth for the water tank.		Refer to the Mechanical Engineer to determine types and sizes of plinth for water tank.
	2.3 Break tank. (if required)	2.3.1 The minimum clearance within roof top for maintenance purposes shall refer to **Figure 4.1**.		Refer to the Mechanical Engineer for tank capacity and size.
		2.3.2 Provide 600mm x 600mm opening for break tank in the ceiling. Refer to **Figure 4.1**.		
		2.3.3 Provide plinths for the water tank.		Refer to the Mechanical Engineer to determine types and sizes of plinth for the water tank.
		2.3.4 Buildings of height greater than 30m shall be provided with a break tank at every five storey intervals.		

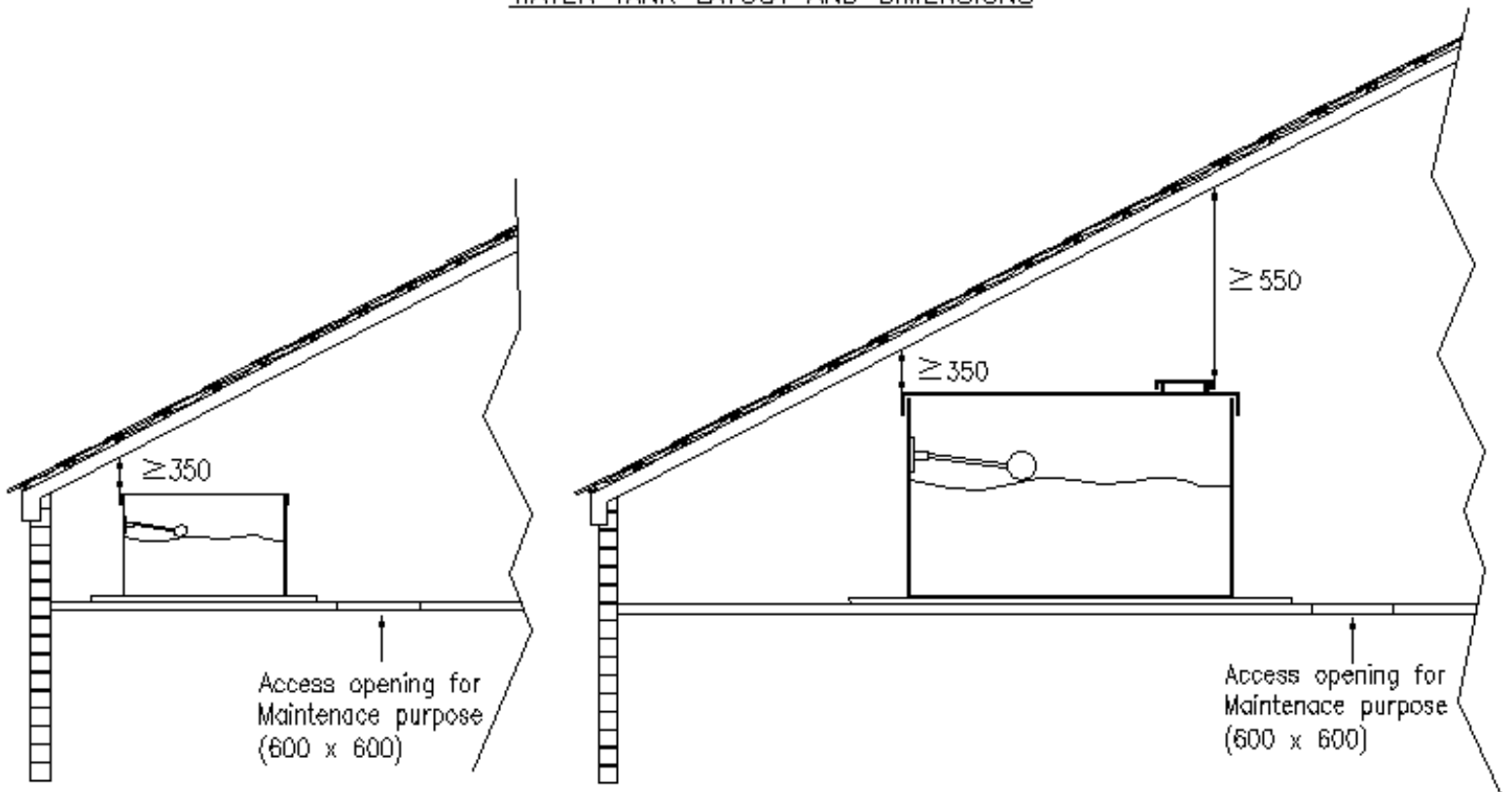
No.	Item	Mechanical Requirement	Action	Remark
3.0	**Rain water harvesting.**		Architect and Structural Engineer.	
	3.1 Storage tank.	3.1.1 Location, space and height to be decide during coordination.		
		3.1.2 Provide plinths for the storage tank.		
	3.2 Pump. (if required)	3.2.1 Provide pump room size dimension of 3m x 3m.		
		3.2.2 Provide plinths for the pump.		
	3.3 Pipe riser.	Provide pipe riser with opening.		
	3.4 Water treatment. (if required)	Provide plant room. Location, space and height to be decide during coordination.		For portable used.
4.0	**Plant room for booster pump.**	4.1.1 Provide plant room size dimension of 3m x 3m for water tank located outdoor.		If combine with other mechanical services, the size of plant room shall refer to the Mechanical Engineer.

No.	Item	Mechanical Requirement	Action	Remark
		4.1.2 For water tank inside the plant room. Refer to the Mechanical Engineer to determine the actual size of plant room.	Architect and Structural Engineer.	Clearance between water tank and wall not less than 1000mm.
		4.1.3 Provide louvered double-leaf doors. Door shall open outwards.		
		4.1.4 Provide high-level louvered glass.		For adequate ventilation.
		4.1.5 Provide concrete plinths 800mm height for tank.		Actual size and location shall be determined by Mechanical Engineer.
		4.1.6 Provide concrete plinth of 150mm height for pump.		Actual size and location shall be determined by Mechanical Engineer.
		4.1.7 Provide floor trap adjacent to each other. Floor level shall slope gently towards drainage outlet. The floor trap shall be located in a 600mm x 600mm x 50 mm sunken floor areas.		

No.	Item	Mechanical Requirement	Action	Remark
		4.1.8 Provide non-slip epoxy paint for floor.	Architect and Structural Engineer.	
		4.1.9 Provide adequate lighting and 13 amp socket outlet.	Electrical Engineer.	
5.0	**Flush valve system. (sanitary system)**			
	5.1 Pump.	Provide Reinforced Concrete (RC) plinth of 150mm height.		Actual size and location shall be determined by Mechanical Engineer.
6.0	**Water meter.**	Provide water meter compartment.		Location of water meter compartment shall be decided during the coordination.

FIGURE 4.1

WATER TANK LAYOUT AND DIMENSIONS



a. Capacity up to 1000 litres.

b. Capacity more than 1000 litres.

NOTES:

1. Refer to the Mechanical Engineer to determine types and sizes of plinth for water tank.
2. Source BS67000:2006.
3. All dimensions are in millimeter (mm).

Checklist For Mechanical Requirement: Internal Cold Water And Sanitary System

No.	Description		Yes	No	Remark
1.	**General requirement**				
2.	**Internal cold water and sanitary system**				
	2.1	Pipe riser			
	2.2	Domestic tank			
	2.3	Break tank (if applicable)			
3.	**Rain water harvesting**				
	3.1	Storage tank			
	3.2	Pump (if required)			
	3.3	Pipe riser			
	3.4	Water treatment (if required)			
4.	**Plant room for booster pump**				
5.	**Flush valve system (sanitary system)**				
	5.1	Pump			
6.	**Water meter**				

SECTION 5

IBS SYSTEM

No.	Item	Mechanical Requirement	Action	Remark
1.0	**General requirement.**		Architect and Structural Engineer.	
	1.1 Coordination	M&E Coordinator should be involved at initial period of construction planning.		
2.0	**Air-conditioning system.**			
	2.1 Chiller plant room.	Provide: a. Floor slab - cast in-situ. b. Wall - conventional brick.		
	2.2 AHU room.	Provide: a. Floor slab - cast in-situ. b. Wall - conventional brick.		
	2.3 Pipe riser.	Opening at floor slab (i.e. refrigerant pipe, chilled water and condenser water pipe).		
	2.4 Ducting path.	Provide opening at pre cast wall.		

No.	Item	Mechanical Requirement	Action	Remark
	2.5 Hanger.	2.5.1 Supplier has to mark location that prohibited from drilling (wire strand location) for hollow core slab. The maximum anchoring depth for duct/pipe hanger is 40mm.	Architect and Structural Engineer.	
		2.5.2 The hollow core slab must be able to support the load of Fan Coil Unit (FCU) at minimum load of 50kg.		Actual load of FCU shall refer to the Mechanical Engineer.
	2.6 Split unit support. (Indoor and outdoor unit)	2.6.1 Provide wall capable of taking 20kg minimum load (indoor) and 50 kg (outdoor).		Actual load of FCU shall refer to the Mechanical Engineer.
		2.6.2 Provide opening/groove for piping.		
	2.7 24-hours air-conditioning room.	Provide wall with suitable material and thickness.		
	2.8 Exhaust fan.	Provide opening at pre cast wall.		

No.	Item	Mechanical Requirement	Action	Remark
3.0	**Fire fighting system.**		Architect and Structural Engineer.	
	3.1 Plant / pump room.	Provide: a. Floor slab - cast in-situ. b. Wall – conventional brick.		
	3.2 Pipe path.	Provide opening at floor slab.		
	3.3 Hanger.	Supplier has to mark location that prohibited from drilling (wire strand location) for hollow core slab. The maximum anchoring depth for pipe hanger is 40mm.		
	3.4 Riser compartment. (Hose Reel, Dry/ Wet Riser & Sprinkler)	Provide: a. Floor slab - cast in-situ. b. Wall – conventional brick.		
	3.5 Breeching inlet compartment.	Provide opening of compartment (flush type).		

No.	Item	Mechanical Requirement	Action	Remark
4.0	**Lift system.**		Architect and Structural Engineer.	
	4.1 Lift shaft.	Provide lift shaft- cast in-situ.		
	4.2 Lift motor room.	Provide floor slab - cast in-situ.		
	4.3 Trap door.	Provide floor slab opening.		
	4.4 Lift lobby.	Provide floor slab - cast in-situ.		
	4.5 Air-conditioning.	Refer to air-conditioning requirement above.		
	4.6 Exhaust fan.	Provide opening at lift motor room wall.		
5.0	**Internal cold water and sanitary system.**			
	5.1 Pump room.	Provide: a. Floor slab - cast in-situ. b. Wall – conventional brick.		

No.	Item	Mechanical Requirement	Action	Remark
	5.2 Toilet (Non modular).	Provide slab - cast in-situ.	Architect and Structural Engineer.	
	5.3 Pipe path.	5.3.1 Provide opening/groove for piping.		
		5.3.2 Topping of floor slab has to consider. pipe size.(Quarters)		
	5.4 Service shaft/ sub meter/ pipe riser.	Provide slab - cast in-situ.		
	5.5 Exhaust fan.	Provide opening on toilet wall.		
6.0	**Others.**			
	6.1 Column.	Avoid column with corbel usage where pipe/duct path lies.		

Checklist For Mechanical Requirement: IBS System

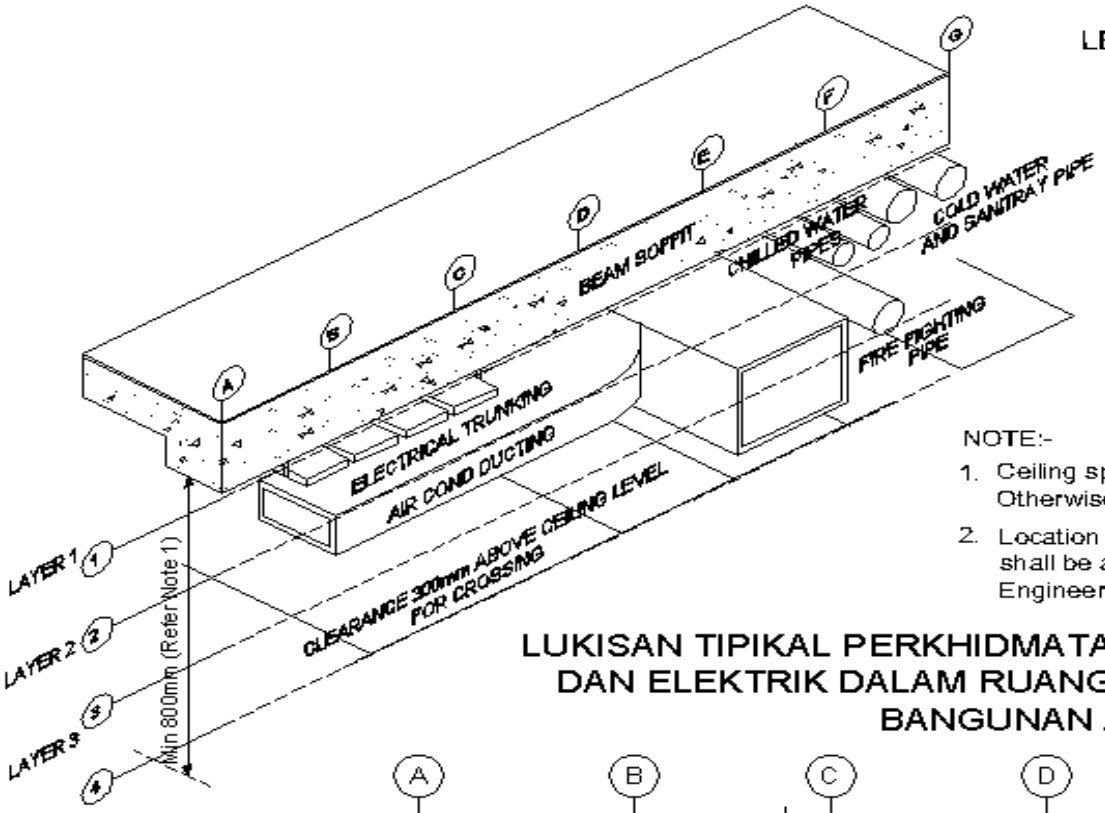
No.	Description		Yes	No	Remark
1.	**General requirement**				
	1.1	Coordination			
2.	**Air-conditioning system**				
	2.1	Chiller plant room			
	2.2	AHU room			
	2.3	Pipe riser			
	2.4	Ducting path			
	2.5	Hanger			
	2.6	Split unit support. (Indoor and outdoor unit)			
	2.7	24-hours air-conditioning room			
	2.8	Exhaust fan			
3.	**Fire fighting system**				
	3.1	Plant / pump room			
	3.2	Pipe path			
	3.3	Hanger			
	3.4	Riser compartment. (Hose Reel, Dry/ Wet Riser & Sprinkler)			
	3.5	Breeching inlet compartment			
4.	**Lift system**				
	4.1	Lift shaft			
	4.2	Lift motor room			
	4.3	Trap door			
	4.4	Lift lobby			
	4.5	Air conditioning			
	4.6	Exhaust fan			

Checklist For Mechanical Requirement: IBS System (Cont'd.)

No.	Description		Yes	No	Remark
5.	**Internal cold water and sanitary system**				
	5.1	Pump room			
	5.2	Toilet (Non modular)			
	5.3	Pipe path			
	5.4	Service shaft/ sub meter/ pipe riser			
	5.5	Exhaust fan			
6.	**Others**				
	6.1	Column			

COORDINATION DRAWING

Page



LEGEND

LAYER (1) SERVICE MECHANICAL
- CHILLER WATER PIPES
- COLD WATER AND SANITARY
- AIR COND DUCTING

SERVICE ELECTRICAL
- ELECTRICAL TRUNKING, TEL/IT TRUNKING, ELV TRUNKING

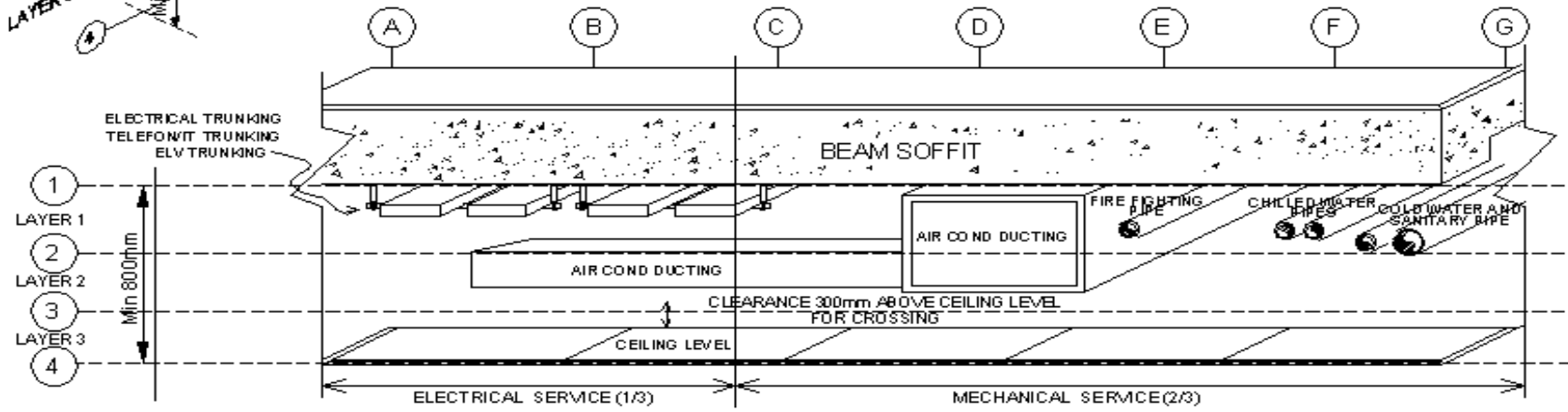
LAYER (2) SERVICE MECHANICAL
- AIR COND DUCTING
- FIRE FIGHTING PIPE

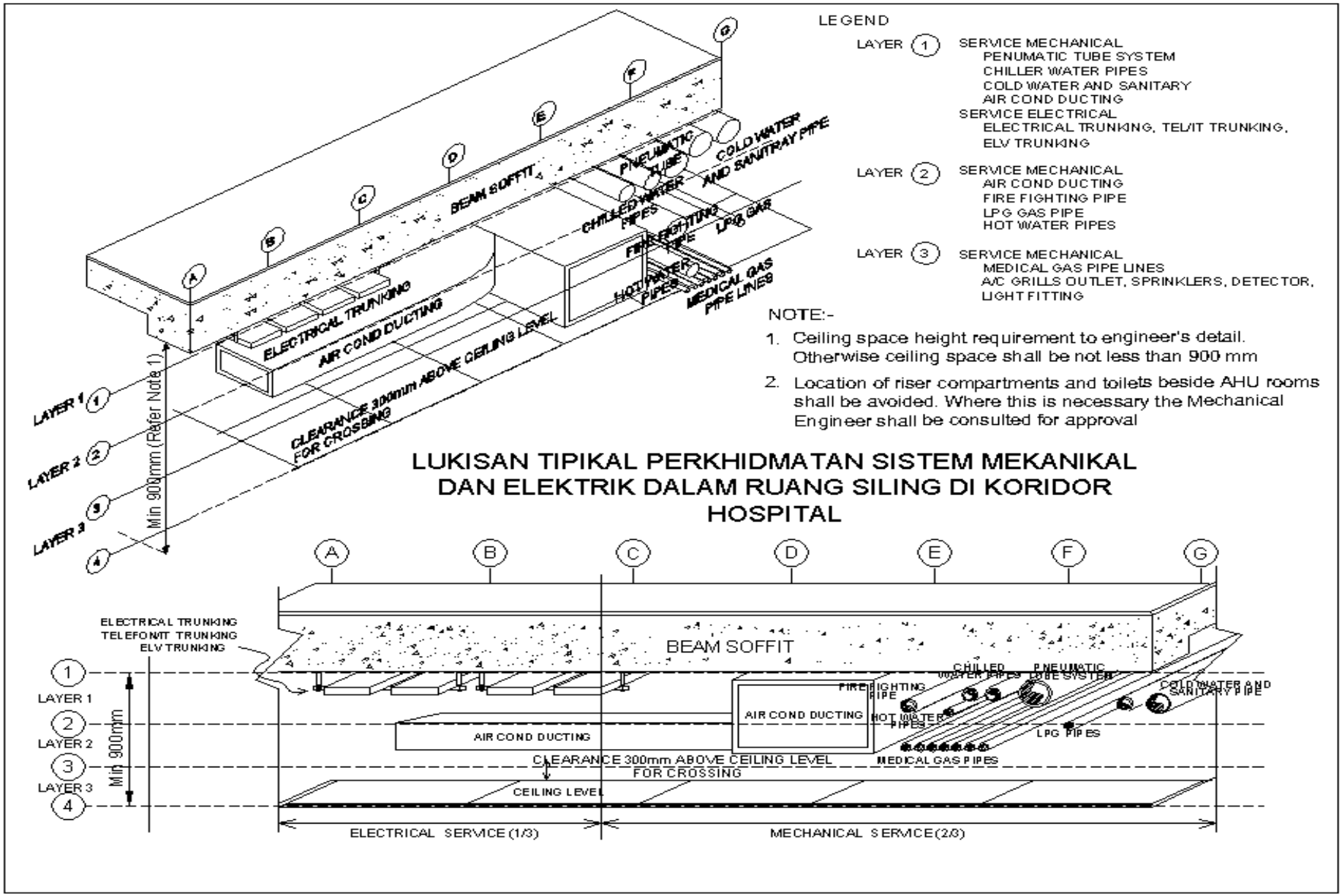
LAYER (3) A/C GRILLS OUTLET, SPRINKLERS, DETECTOR, LIGHT FITTING

NOTE:-

1. Ceiling space height requirement to engineer's detail. Otherwise ceiling space shall be not less than 800 mm
2. Location of riser compartments and toilets beside AHU rooms shall be avoided. Where this is necessary the Mechanical Engineer shall be consulted for approval

LUKISAN TIPIKAL PERKHIDMATAN SISTEM MEKANIKAL DAN ELEKTRIK DALAM RUANG SILING DI KORIDOR BANGUNAN AM




LEGEND
LAYER 1
SERVICE MECHANICAL
PENUMATIC TUBE SYSTEM
CHILLER WATER PIPES
COLD WATER AND SANITARY
AIR COND DUCTING
SERVICE ELECTRICAL
ELECTRICAL TRUNKING, TEL/IT TRUNKING,
ELV TRUNKING
LAYER 2
SERVICE MECHANICAL
AIR COND DUCTING
FIRE FIGHTING PIPE
LPG GAS PIPE
HOT WATER PIPES
LAYER 3
SERVICE MECHANICAL
MEDICAL GAS PIPE LINES
A/C GRILLS OUTLET, SPRINKLERS, DETECTOR,
LIGHT FITTING
NOTE:-
1. Ceiling space height requirement to engineer's detail. Otherwise ceiling space shall be not less than 900 mm
2. Location of riser compartments and toilets beside AHU rooms shall be avoided. Where this is necessary the Mechanical Engineer shall be consulted for approval
BEAM SOFFIT
ELECTRICAL TRUNKING
AIR COND DUCTING
CLEARANCE 300mm ABOVE CEILING LEVEL FOR CROSSING
PNEUMATIC TUBE
COLD WATER AND SANITRAY PIPE
CHILLED WATER PIPES
FIRE FIGHTING PIPE
LPG GAS
HOT WATER PIPES
MEDICAL GAS PIPE LINES
LAYER 1
LAYER 2
LAYER 3
Min 900mm (Refer Note 1)
LUKISAN TIPIKAL PERKHIDMATAN SISTEM MEKANIKAL
DAN ELEKTRIK DALAM RUANG SILING DI KORIDOR
HOSPITAL
ELECTRICAL TRUNKING
TELEFON/IT TRUNKING
ELV TRUNKING
BEAM SOFFIT
AIR COND DUCTING
AIR COND DUCTING
CHILLED WATER PIPES
PNEUMATIC TUBE SYSTEM
FIRE FIGHTING PIPE
HOT WATER PIPES
COLD WATER AND SANITARY PIPE
LPG PIPES
MEDICAL GAS PIPES
CLEARANCE 300mm ABOVE CEILING LEVEL FOR CROSSING
CEILING LEVEL
LAYER 1
LAYER 2
LAYER 3
Min 900mm
ELECTRICAL SERVICE (1/3)
MECHANICAL SERVICE(2/3)

REFERENCE AND ACKNOWLEDGEMENT

REFERENCE

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5. Factories And Machinery Act with Regulations, 2007.

6. British Standard.

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9. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

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Rosmawati Binti Zahari
Anisah Binti Idris
Umar Bin Abdul Manap
Mohd Khalil Bin Mohd Daud
Jefri Bin Amir
Sophian Bin Abdul Majid
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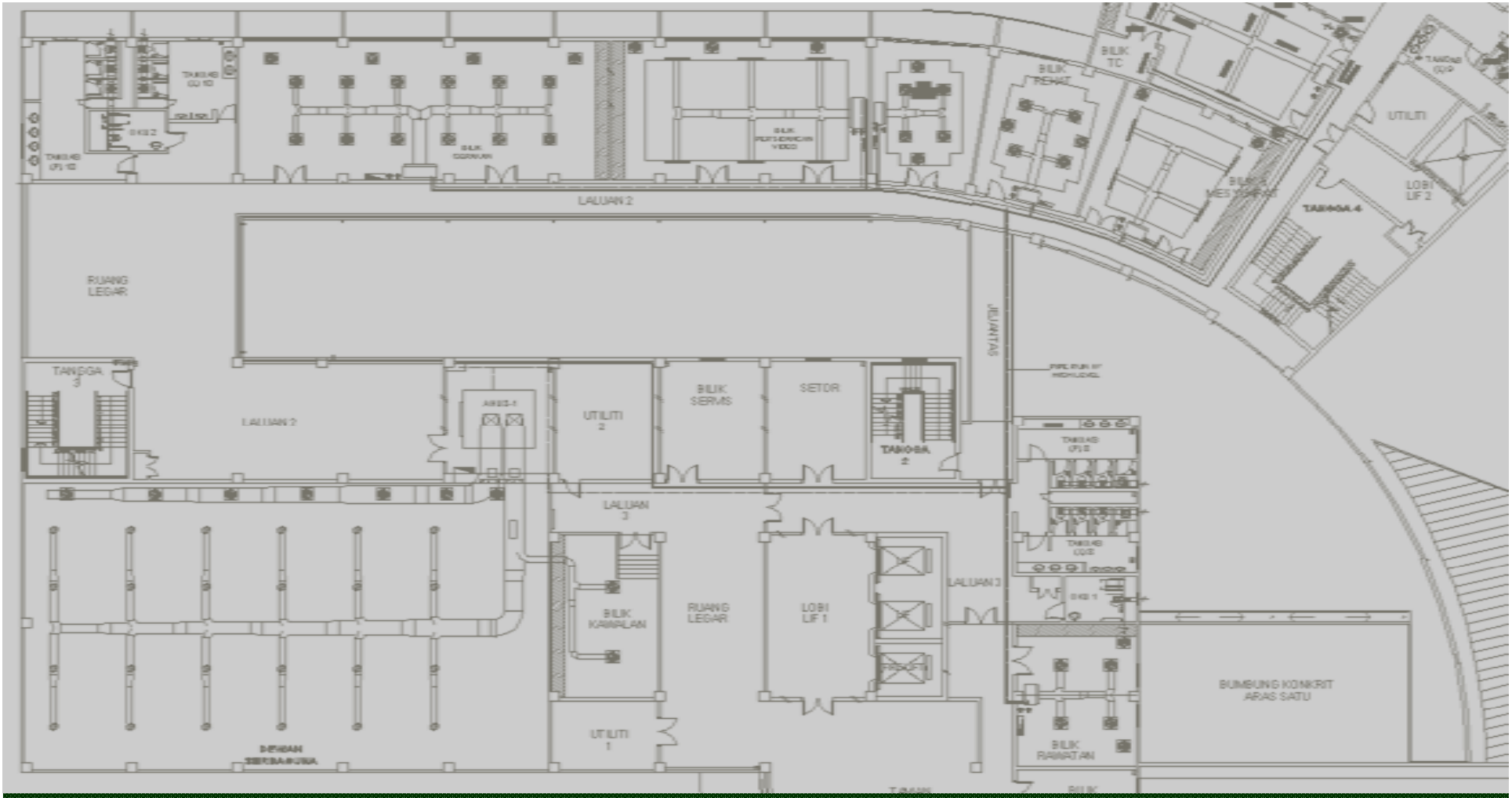

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