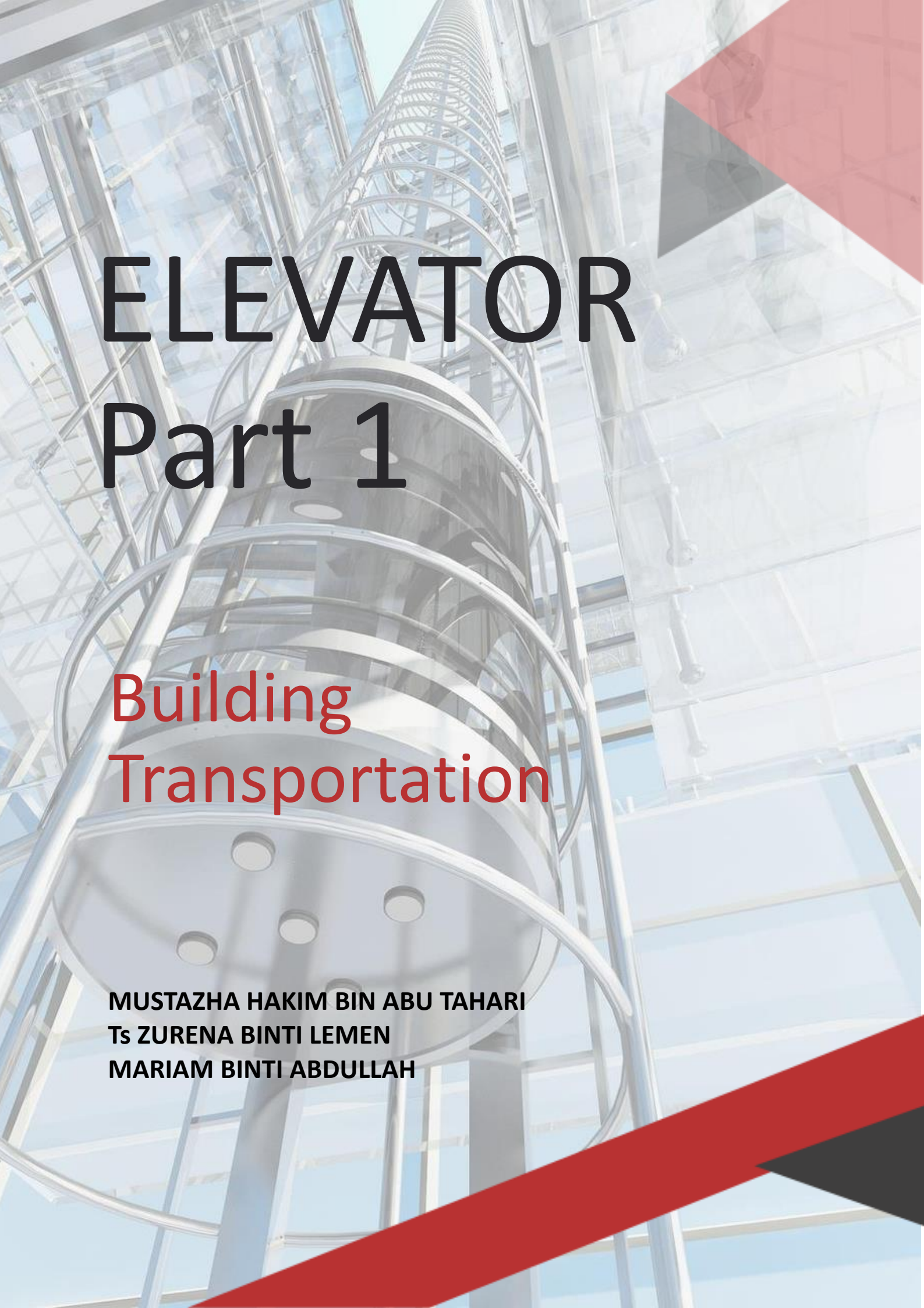

ELEVATOR Part 1

Building Transportation

MUSTAZHA HAKIM BIN ABU TAHARI
Ts ZURENA BINTI LEMEN
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ELEVATOR

Part 1

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eISBN No:

First published in 2022 by:

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PREFACE

DCB30102 - BUILDING TRANSPORTATION course provides students with knowledge on the basic concepts of internal circulation in buildings and the principles of building transportation systems. This course emphasizes the types of building transportation systems, the factors to be considered in locating lifts and escalators in a building, and the requirements in traffic analysis and system design. Students will learn the equipment functions and the operational patterns of lifts and escalators. They will understand the advantages and disadvantages of different building transportation systems. They will also understand the rules, legislations, and Acts which are related to the design and installation of building transportation systems.

This Elevator e-book is meant essentially for diploma in building services engineering students at local institutions of higher learning. We believe the approach of this book would make it a useful resource to students in Polytechnic.

MUSTAZHA HAKIM BIN ABU TAHARI
TS ZURENA BINTI LEMEN
MARIAM BINTI ABDULLAH

ACKNOWLEGDEMENT

Assalamualaikum w.b.t and peace be upon you, Grateful to Allah because with His grace we have completed this Elevator e-book as one of the sub-topics in the Building Transportation Course.

All praise belongs to Allah SWT, Alhamdulillah. We would like to express our gratitude to everyone who was directly or indirectly involved in this e-book. Thank you so much for all of the advice, guidance, kindness, and management provided throughout the preparation and completion of this project.

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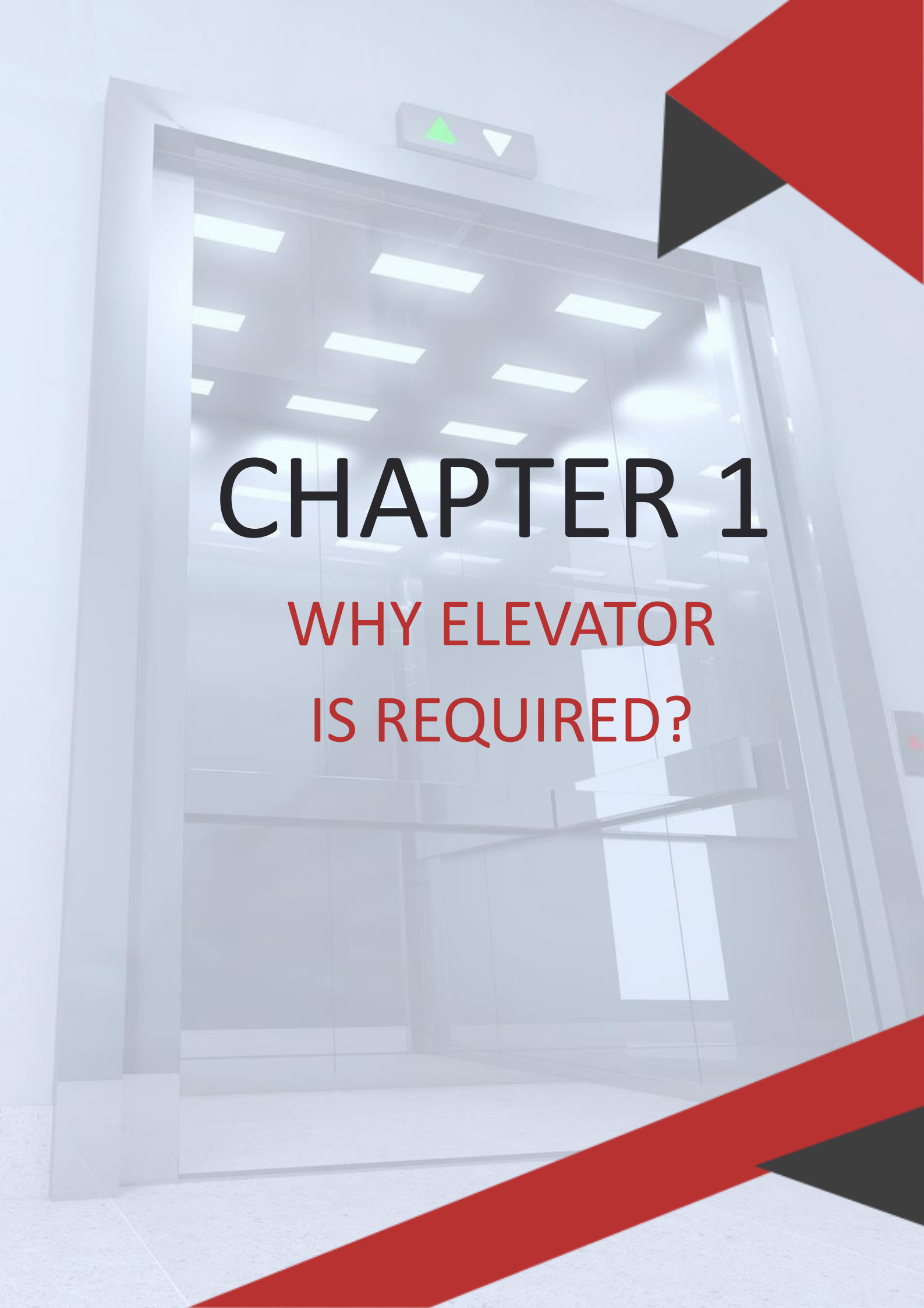


CHAPTER 1

WHY ELEVATOR IS REQUIRED?

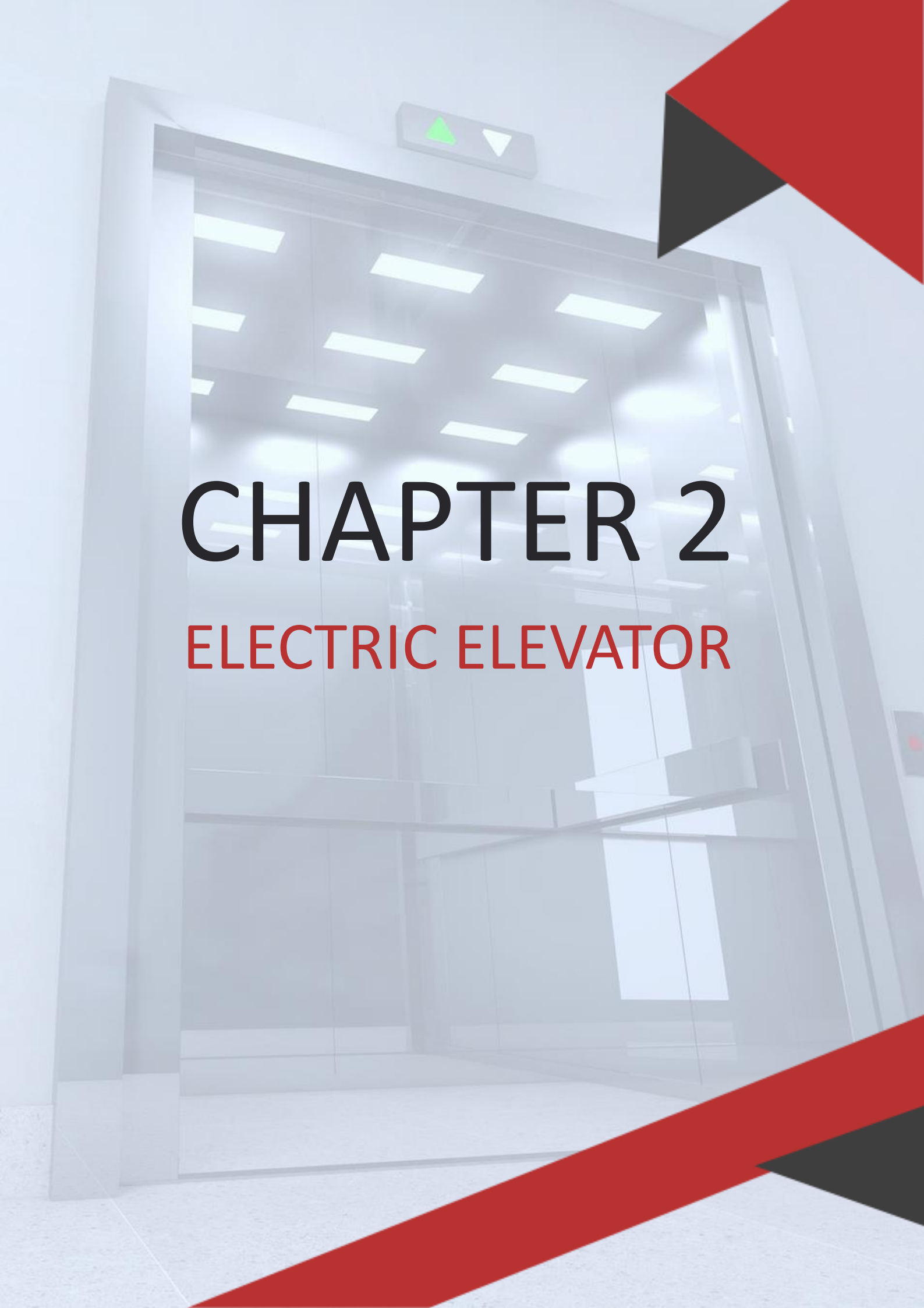
1.0 Why Elevator is Required?

Elevator services in Malaysia have resulted in numerous changes in the building transportation system. The use of elevators allowed people to get around quickly and safely. Elevators also help people with disabilities and the elderly to enjoy life cheerfully. Elevators bring convenience to our work and have a great impact on our lives. Elevators make our life and our work easier.

Elevators encourage progress and development, especially residential buildings and high-rise buildings, by allowing us to have more office space and apartments. This can contribute to a better economy for the local population.

Government and private high-rise hospitals in Malaysia mostly have lifts. It can accommodate and treat more patients. It can also help the movement of staff and patient in the hospital building.

It is an important choice for building occupants to choose a building that has the best and most comfortable elevator. The installation of an elevator has become a mandatory facility in a high-rise building to help the movement of building occupants.



CHAPTER 2

ELECTRIC ELEVATOR

2.0 Electric Elevator

An electric elevator is an electrically operated device used to lift up and down. An electrically operated elevator, is used to transport people in a fixed place. The elevator will move the load in the appropriate direction, in a high-rise building.

Electric elevators are the main choice of transportation in buildings nowadays. Although the use of stairs is still necessary, users still choose to use the elevator due to the time-saving factor.

Today's elevator manufacturers have improved the safety features of the elevator system. This is because the use of elevators has become the main choice for users of high-rise buildings. The speed limit of the elevator depends on the height of the building.

According to OSH requirements, elevators should be carefully inspected at intervals not exceeding one year. If necessary, additional monthly inspections for satisfactory operation should be carried out by a competent person.

2.0 Electric Elevator (continues)

There are 3 types of electric elevators that are commonly used in Malaysia based on the working mechanism:

i. Geared Traction

ii. Gearless Traction

iii. Machine Room-Less (MRL)

5 types of elevators based on function are:

i. Hospital elevator

ii. Passenger elevator

iii. Goods elevator

iv. Fire elevator

v. Panoramic elevator

2.1 How It Works?

The operating principle of the elevator is based on the upward thrust produced by the difference between the atmospheric pressure at the top of the car and the atmospheric pressure below the car.

The electric elevator will start moving through the signal and command coming from the control panel.

The elevator will move through a steel rope friction mechanism with traction pulleys through signals and commands from the control panel.

After receiving instructions from the control panel, the elevator car will move from top to bottom or bottom to top. The moving elevator car will be balanced using counterweights so that it is stable and safe.

2.2 Types of Electric Elevator (Mechanism)

Even if the elevator looks the same. But we have to know that the mechanism used to move each elevator is different. The selection of the elevator mechanism depends on the type of building and the owner of the building.

Machine Room-Less (MRL) also known as Electric Traction Elevators are often used in mid-rise and high-rise buildings because of its much higher travel speed. But the selection of geared and gearless elevators is also the main choice because of the appropriate function in a building.

There are 3 types of electric elevators that are commonly used based on the working mechanism:

i. Geared Traction Machine
ii. Gearless Traction Machine
iii. Machine Room-Less (MRL)

The building owner has the right to choose the type of elevator to be installed in the building. The installation of the elevator also needs to be seen in terms of maintenance and spare parts that are easy to obtain.

2.2.1 Geared Traction Elevator

Geared electrical elevators are used for mid-rise buildings up to 300 feet or 91.44 meters in height (approximately 30 floors of the building). Geared traction elevator can travel at speeds of up to 152 m per minute and at a maximum height of nearly 75 m.

Geared machines comprise a traction sheave or drum, gearbox, brake, motor and bedplate. It also includes a deflector sheave if mounted as an integral part of the bedplate assembly.

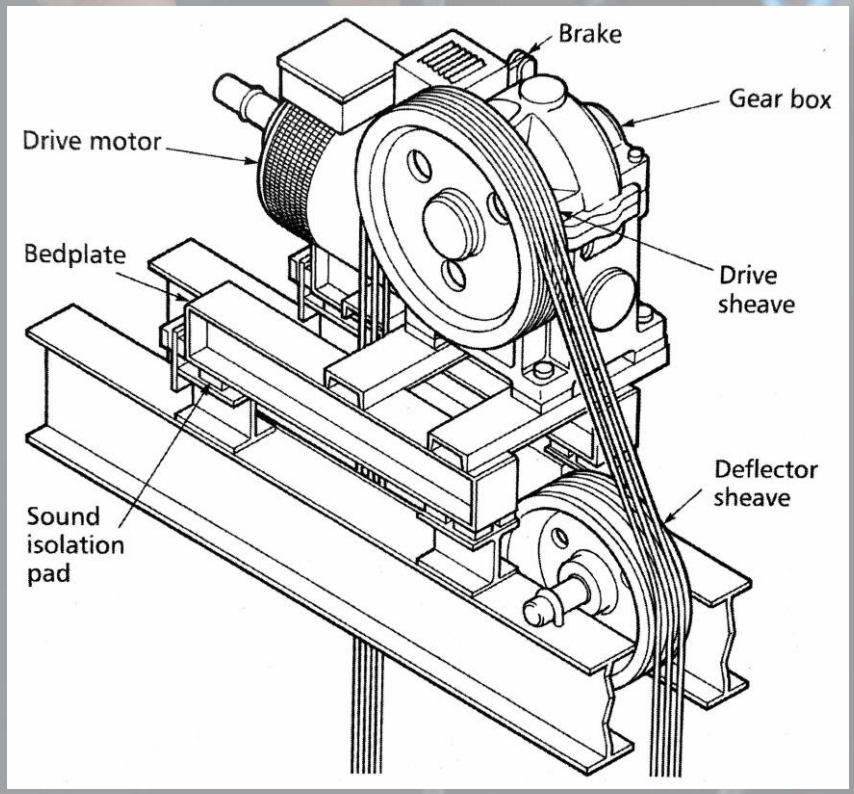
Geared machines are generally used for speeds between 0.1 m/s and 2.5 m/s. Its suitable for loads from 5 kg up to 50 000 kg or more.

2.2.1 Geared Traction Elevator (continues)

Geared traction elevators contain a single gearbox mounted on an AC or DC motor. This gearbox attached to the motor will drive the wheel to rotate to move the rope.

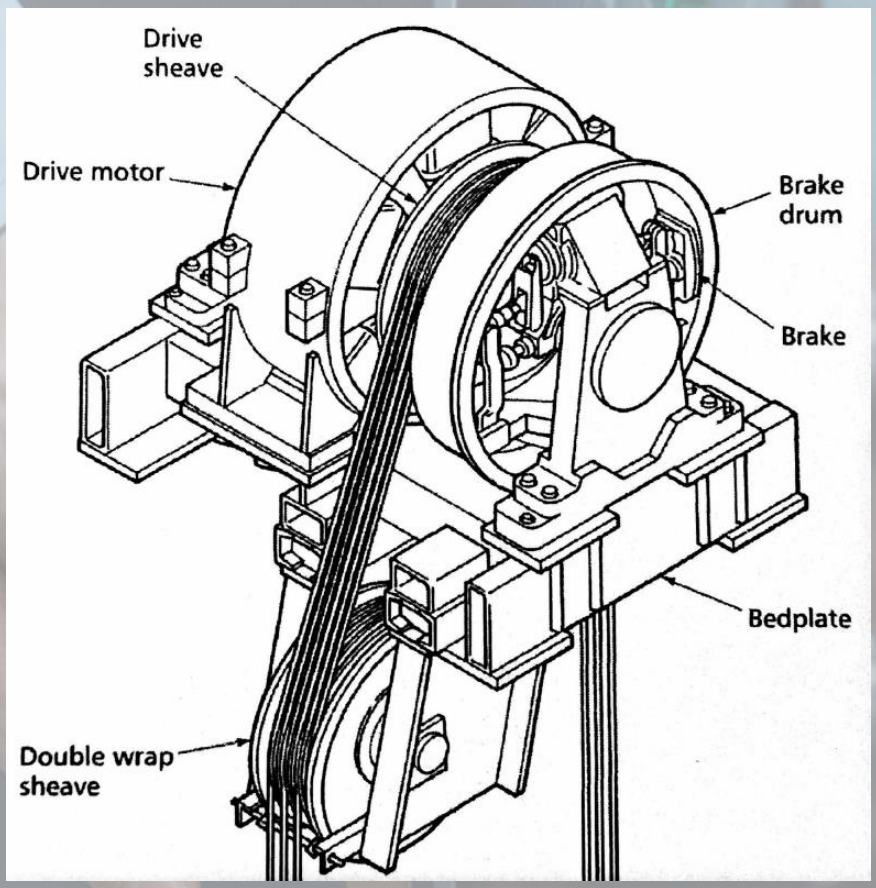
For geared elevator, the wheel and the electric motor have to place in a machine room which stays above the elevator shaft. But as the wheel will be directly attached to the motor and the cabin.

Size and shape vary considerably with load, speed and manufacturer, but the underlying principles and components are the same.



Source: CIBSE Guide D (2005)

2.2.2 Gearless Traction Elevator



Source: CIBSE Guide D (2005)

Gearless Traction Elevators are purpose-built to be the most efficient choice for high-rise buildings. This elevator has its wheels attached to an electric motor to rotate the drive shaft directly.

The assembly of geared electrical elevator consists of a drive motor, a drive sheave, a bed plate, a brake, a direct current armature or rotor in the case of an AC drive, support bearings and possibly a deflector or double winding sheave.

2.2.2 Gearless Traction Elevator (continues)

Gearless machines have generally been used for high-speed elevators, for example speeds from 2.5 m/s to 10 m/s. They are, however, now used for all speeds, including low speeds.

Gearless traction elevator can travel at rates of up to 610 m per minute over distances of up to 600 m. This means, gearless has better speed compared to geared electrical elevator.

2.2.3 Machine Room-Less (MRL) Elevator

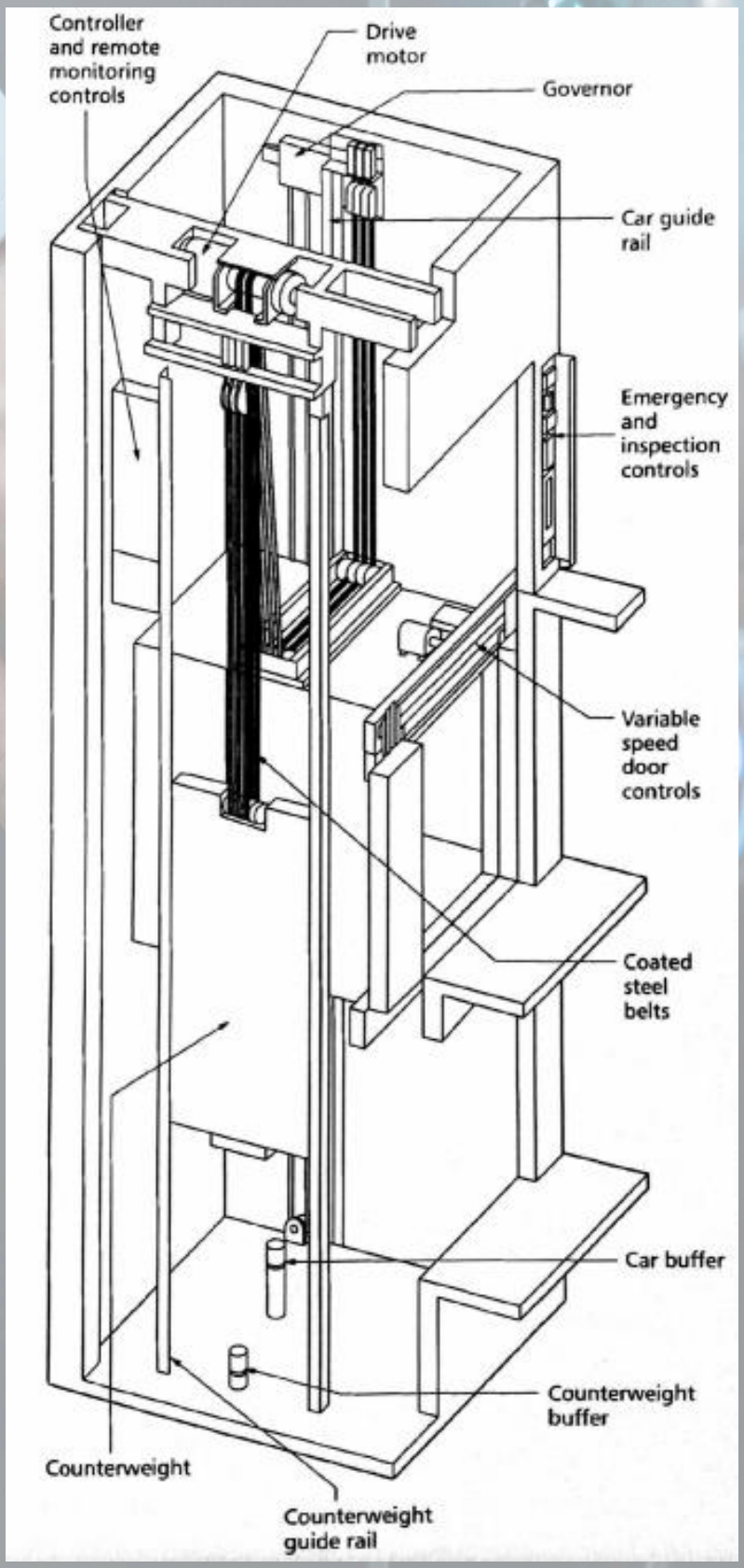
Elevators that use Machine Room-Less (MRL) mechanism can save a large amount of energy compared to hydraulic elevators (estimated 70-80%). These savings are due to the more efficient design and counterbalancing provided by the traction.

Machine Room-Less (MRL) do not have a separate space to install the motor and related systems that enable the elevator to function. Where this machine is placed depends on the type of elevator used. If the elevator has a machine room, MRL is mounted on the elevator shaft.

MRL gives us the opportunity to use the existing space in the building without having to sacrifice the extra space in the building. MRL elevators still require a secure room for the controls and associated components. This is because current regulations do not allow these to be placed in the shaft.

MRL elevators reduce the spatial requirements for elevator installation by installing the machinery in the elevator shaft or on the landing. MRL elevators can be hydraulic, or traction and they look just like traditional elevators. They just take up less space.

2.2.3 Machine Room-Less (MRL) Elevator (continues)



Source: CIBSE Guide D (2005)

2.3 Types of Electric Elevator (Function)

Elevators increase the freedom and increase the mobility of all of us. Elevators also promote a better quality of life every day. By using the elevator instead of the stairs can reduce fatigue, pain and strain on the body.

The function of each elevator depends on the type of building. Each type of elevator will serve the occupants of the building to move up and down the building vertically.

5 types of elevators based on function are:

i. Hospital elevator
ii. Passenger elevator
iii. Good elevator
iv. Fire elevator
v. Panoramic elevator

2.3.1 Hospital Elevator

Hospital elevator commonly used in hospitals, medical centers, community health care centers and nursing homes.

Hospital elevators are the ideal solution for the safe movement of patients, patient beds, medical equipment and all important medical personnel.

The hospital elevator adapts to its variable carrying capacity from 1600 kg to 2000 kg. Hospital elevator speed range is 0.5m/s to 1.0 m/s.

Hospital elevators provide easy transportation of patients and large medical equipment such as bed, wheelchairs and stretchers. Hospital elevators usually have opposite doors to facilitate patient transfer.

The dimensions of hospital elevators should be according to standards that can be used by at least one stretcher and one attendant.

2.3.2 Passenger Elevator

Passenger elevator means an elevator specially designed to carry people.

Moving in a vertical shaft to carry passengers between levels of multi-storey buildings.

The controls are designed to provide the most economical passenger distribution throughout the building

The standard dimensions for the most common elevator sizes in residential buildings are 910 mm x 1220 mm with a door width of 910 mm. However, the standard dimensions for the most common elevator sizes in office buildings are 1830 mm x 1530 mm with a door width of 1220 mm.

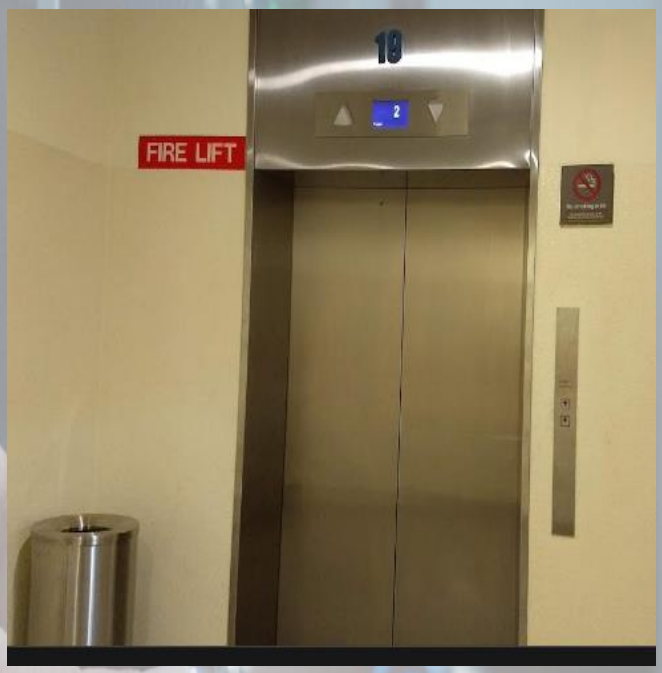
2.3.3 Goods Elevator

Goods elevator is a machine for lifting goods vertically in a safe manner. People are not allowed to ride the elevator, only for loading and unloading.

Goods elevator can be seen in warehouses, hypermarkets, and factory stores. Goods elevators are designed to move goods of every shape, size and weight between two or more floors in commercial, industrial and residential applications.

The size of the goods elevator car can range from 1100mm x 1400mm with a load of 612kg up to 4000kg with the configuration of the car size as required.

2.3.4 Fire Elevator



A fire elevator is a type of elevator that firefighters use to rescue people who may be trapped on the upper floors during a fire in a building.

Fire Service Mode (EFS) is a special mode of the elevator that is activated in the event of a fire in the building, and is used by firefighters to extinguish the fire.

It is not appropriate to use the elevator during a fire or similar building emergency. Elevators are designed to be called back to a floor, usually a lobby, during an alarm condition.

There are many reasons to avoid elevators during a fire. The main reason is that fire can short out the electrical system, causing victims to be trapped between floors. Elevator shafts act like chimneys and can quickly fill with smoke and put victims at risk of smoke inhalation.

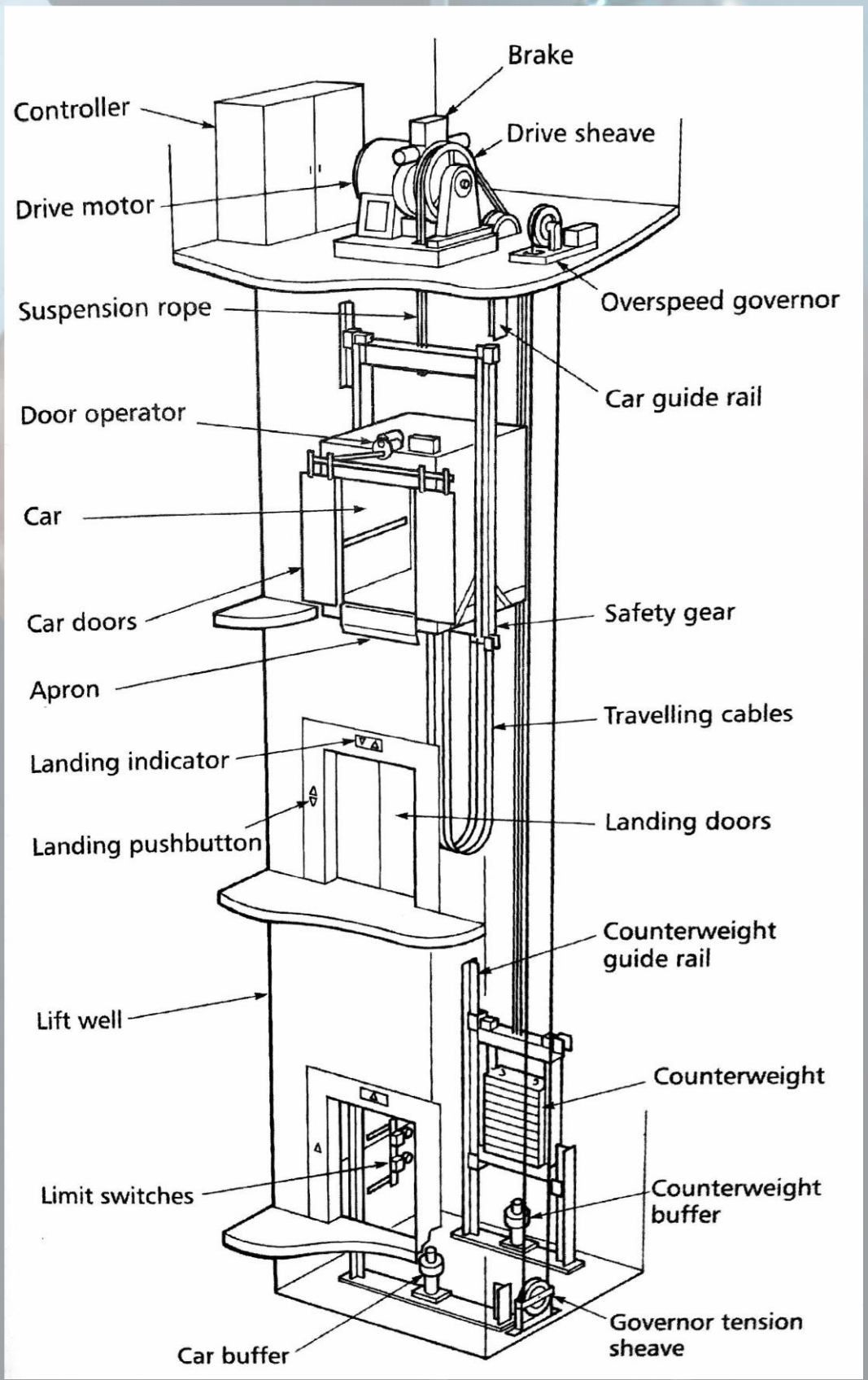
2.3.5 Panoramic Elevator

Panoramic elevators are also called sightseeing elevators or scenic elevators. Usually the building designer will determine the placement of this elevator. This will add more aesthetic value to the building.

Panoramic elevators are commonly used in commercial buildings, shopping malls, railways and underground stations.

Panoramic elevators use toughened glass, these elevators are reliable and durable, as long as proper maintenance is followed.

2.4 Electric Elevator Components & Functions



Source: CIBSE Guide D (2005)

2.4 Electric Elevator Components & Functions (continues)

1

Drive Motor

The main power source of an elevator system, to move the motor shaft and drive sheave.

2

Drive Sheave

Attached with the suspension ropes, motor shaft and/or worm gear, to connect the drive motor and the suspension ropes.

3

Suspension Ropes

To hoist the elevator cars, and to connect the elevator car and the counterweight.

4

Elevator Car

To provide a safe place for passengers while riding an elevator.

5

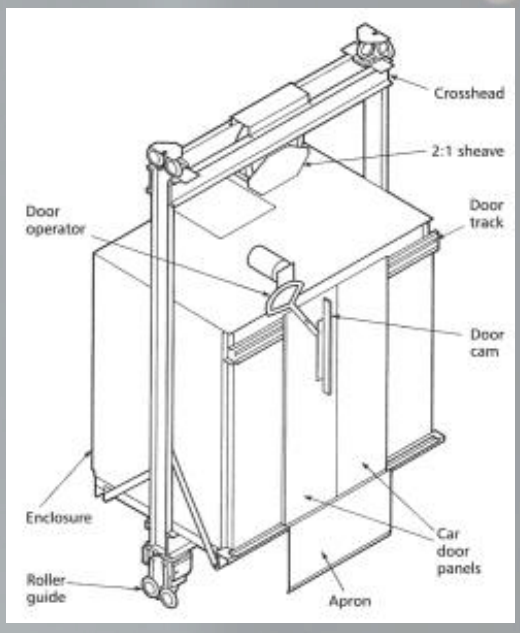
Counterweight

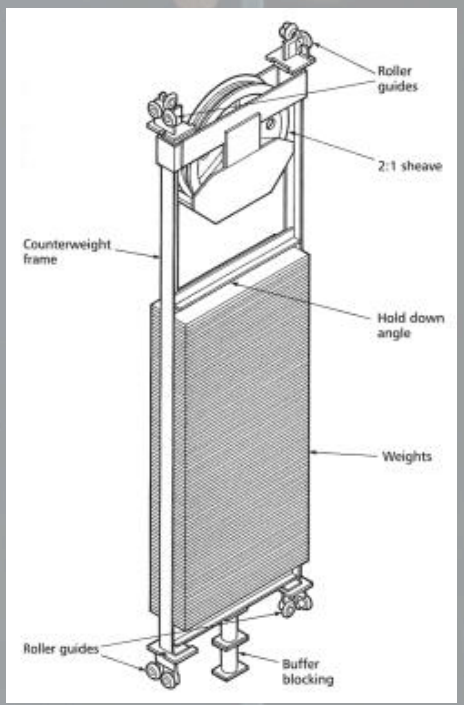
To balance the load or weight of the elevator car. Normally between 40% to 50% of the maximum elevator car load.

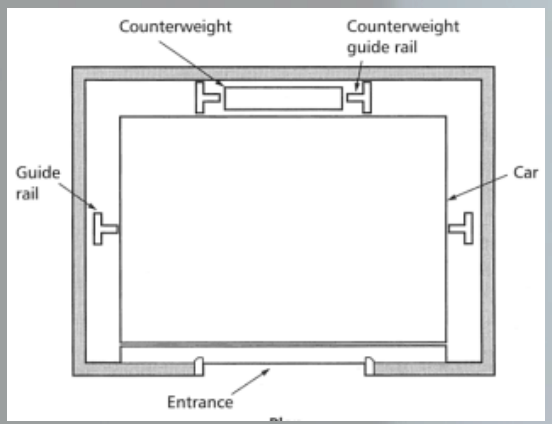
6

Guide Rails

To ensure the elevator car and counterweight travel in a uniform vertical direction.







Source: CIBSE Guide D (2005)

2.4 Electric Elevator Components & Functions (continues)

7

Elevator Doors

Consist of landing door and car door, to prevent passengers or objects from entering the elevator shaft.

8

Buffer

Located below the elevator car and counterweight, to arrest either should one or other overtravel into the pit.

9

Controller

To respond to inputs and produce outputs to control and monitor all the operation of individual elevator car.

10

Door Operator

Located above the lift doors, to open and close the landing door and car door in a safe and swift manner.

11

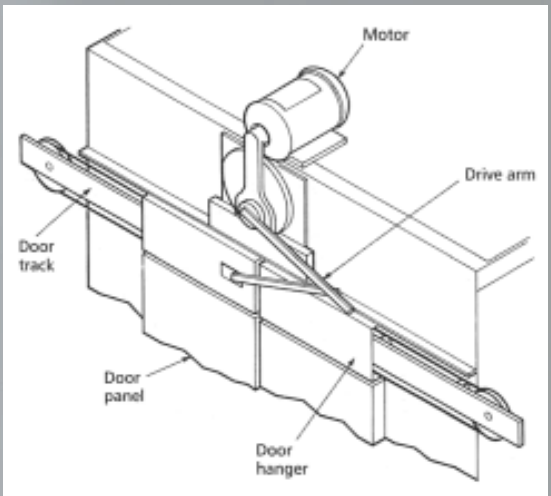
Overspeed governor

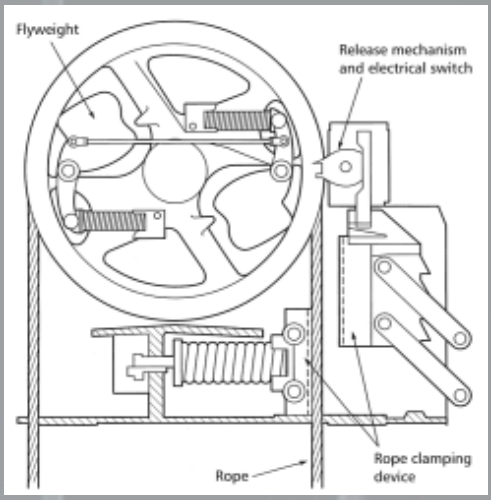
To stop and hold the governor rope with predetermined force in the event of descending car or counterweight exceeding a specified speed.

12

Elevator Shaft/Well

A space that locating the elevator system such as elevator car, guide rails, counterweight, buffer, pit etc.





Source: CIBSE Guide D (2005)

2.5 Exercise

Fill the blanks with suitable answers.

1

Most modern elevators are propelled by electric motors, with the aid of a counterweight, through a system of cables and sheaves (pulleys).

2

The assembly comprises a drive motor, drive sheave, bedplate, brake, direct current armature or rotor in the case of AC drives, supporting bearings and possibly a deflector or double wrap sheave.

3

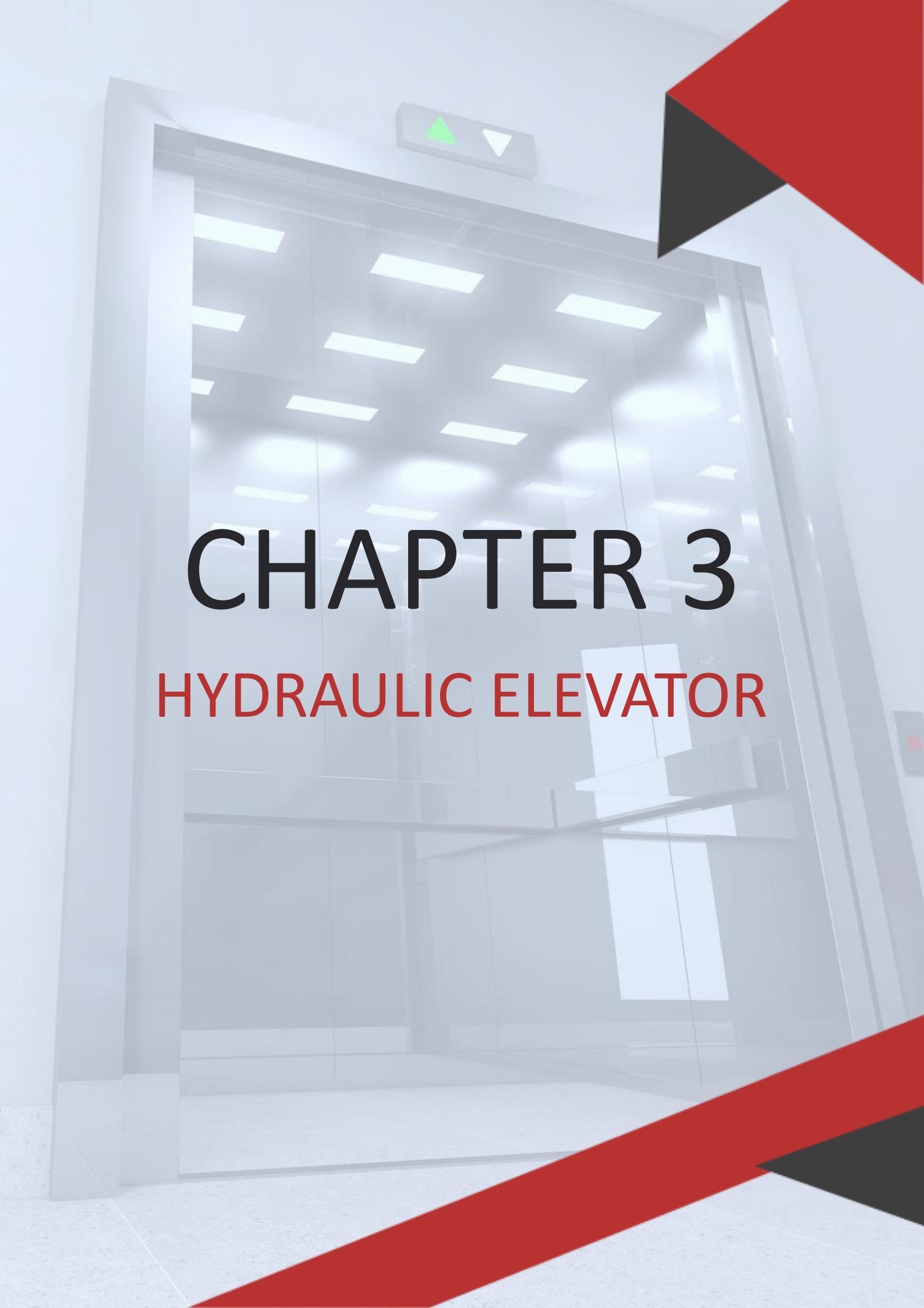
These comprise a traction sheave or drum, gearbox, brake, motor and bedplate. It may also include a deflector sheave if mounted as an integral part of the bedplate assembly.

4

State 2 types of electrical elevator based on function.

5

For lifts without machine rooms, the equipment should be located away from the pit area to avoid problems associated with water in the pit.

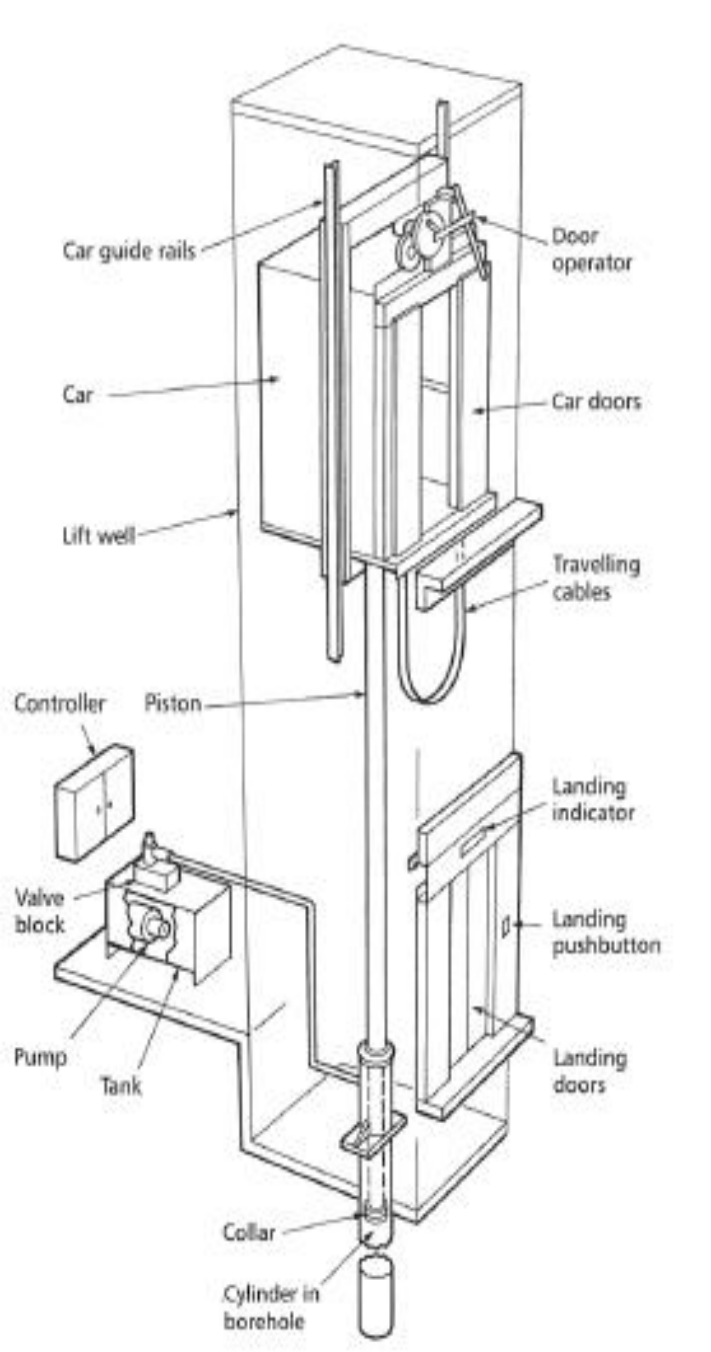


CHAPTER 3

HYDRAULIC ELEVATOR

3.0 Hydraulic Elevator

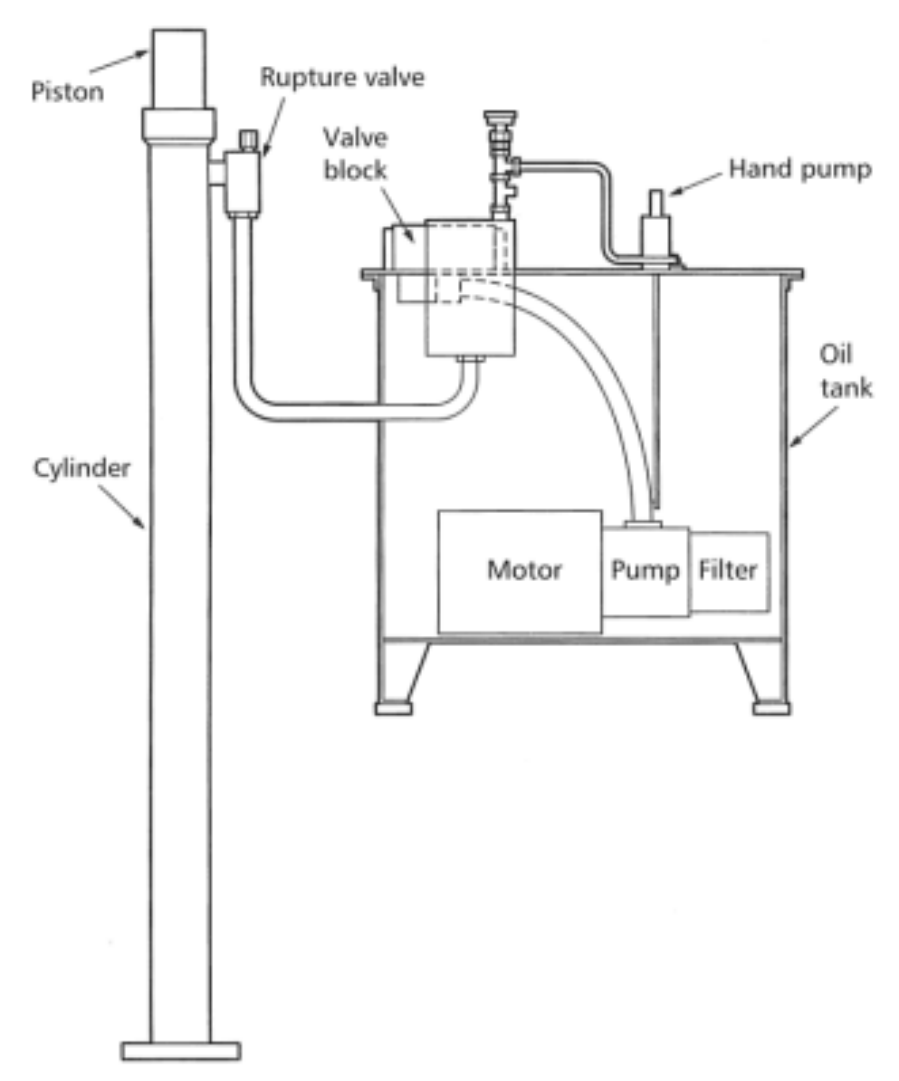
A hydraulic elevator is a type of machine that uses a hydraulic apparatus to lift or move objects using the force created when pressure is exerted on liquid in a piston. Force then produces "lift" and "work."



Source: CIBSE Guide D (2000)

3.1 How It Works?

Hydraulic elevators work on a basic principle: to go up, a pump pushes oil into the cylinder, pushing the piston (which pushes the elevator car) up. To go down, the valve opens and oil is allowed to flow back into the reservoir, and is pushed back using the gravitational force of the elevator car.



Source: CIBSE Guide D (2000)

3.2 Hydraulic Elevator Components & Functions

1

Controller

To respond to inputs and procedure outputs in order to control and monitor all the operations of an individual elevator car.

2

Pump

To produce pressure to the hydraulic oil in the oil tank.

3

Hydraulic oil tank

To reserve the hydraulic oil for hydraulic elevator.

4

Piston

To transmit the power to the elevator car directly or indirectly

5

Cylinder

To connect the pressurised hydraulic oil and the piston.

6

Elevator Car

To provide a safe place for passengers while riding an elevator.

7

Elevator Doors

To prevent people or objects from entering the path of the elevator.

8

Door operator

To open and close the doors in a safe and swift manner.

3.3 Hydraulic Drives

For certain applications, hydraulic drive has many advantages over electric traction. However, misapplied hydraulic drives can cause major problems for building owners and users.

Low traffic

Suitable for low-traffic passenger, goods, vehicle and bullion elevators are all suitable applications for hydraulic drive. For applications which involve very large loads, hydraulic drive often provides the best solution because the floor of the well carries the load of the elevator. Hydraulic drive, with the cylinder in a borehole, is often specified for observation elevators in commercial buildings.

Smooth & comfortable ride

Hydraulic drive systems also offer smooth and comfortable ride conditions with accurate floor levelling along with the ability to incorporate a remote machine pump room. They are, however, incapable of the flight times and intensity of service achieved by electric traction drives and their travel is usually limited to a maximum of 18m.

Cylinder

Hydraulic drives in which the cylinder is installed in a borehole cylinder can make an attractive architectural feature. There are no problems with hiding ropes and pulley as with suspended elevator cars and the control equipment and pump unit can be located remote from the elevator. However the ‘wall climbing’ illusion is lost due to the visibility of the piston.

Practical

The practical maximum travel is about 18m. This is due to the strength and length of the hydraulic jacks. As travel increases, larger diameter pistons have to be used to resist the larger buckling forces. This increases equipment costs and makes the use of the hydraulic drive less attractive when an alternative drive is available. The contract speed is normally limited to 0.63 m/s.

3.4 Location

Hydraulic lift suitable in this location:

Older building

In many older buildings that are not originally designed to include an elevator, hydraulic elevators are often the most suitable type due to restricted building height and building structural strength.

Commercial buildings

Caution should be applied in considering hydraulic elevators for commercial buildings where continuous heavy traffic is expected since this may require elevator speeds of 1 m/s or greater. Cooling is essential under these circumstances since 0.63 m/s is generally accepted as the maximum for hydraulic elevators without cooling. This cooling requirement is often neglected in the design of the building.

Private

Suitable for private residential buildings of up to eight stories, hydraulic elevators may be used due to the low traffic levels in such buildings.

3.5 Exercise

Fill the blanks with suitable answers.

1

car only configuration, while the other is a fully fledged car/passenger elevator.

2

high tensile steel ropes driver through traction sheaves attached to the motor shaft, a system of pulleys and a counterweight.

3

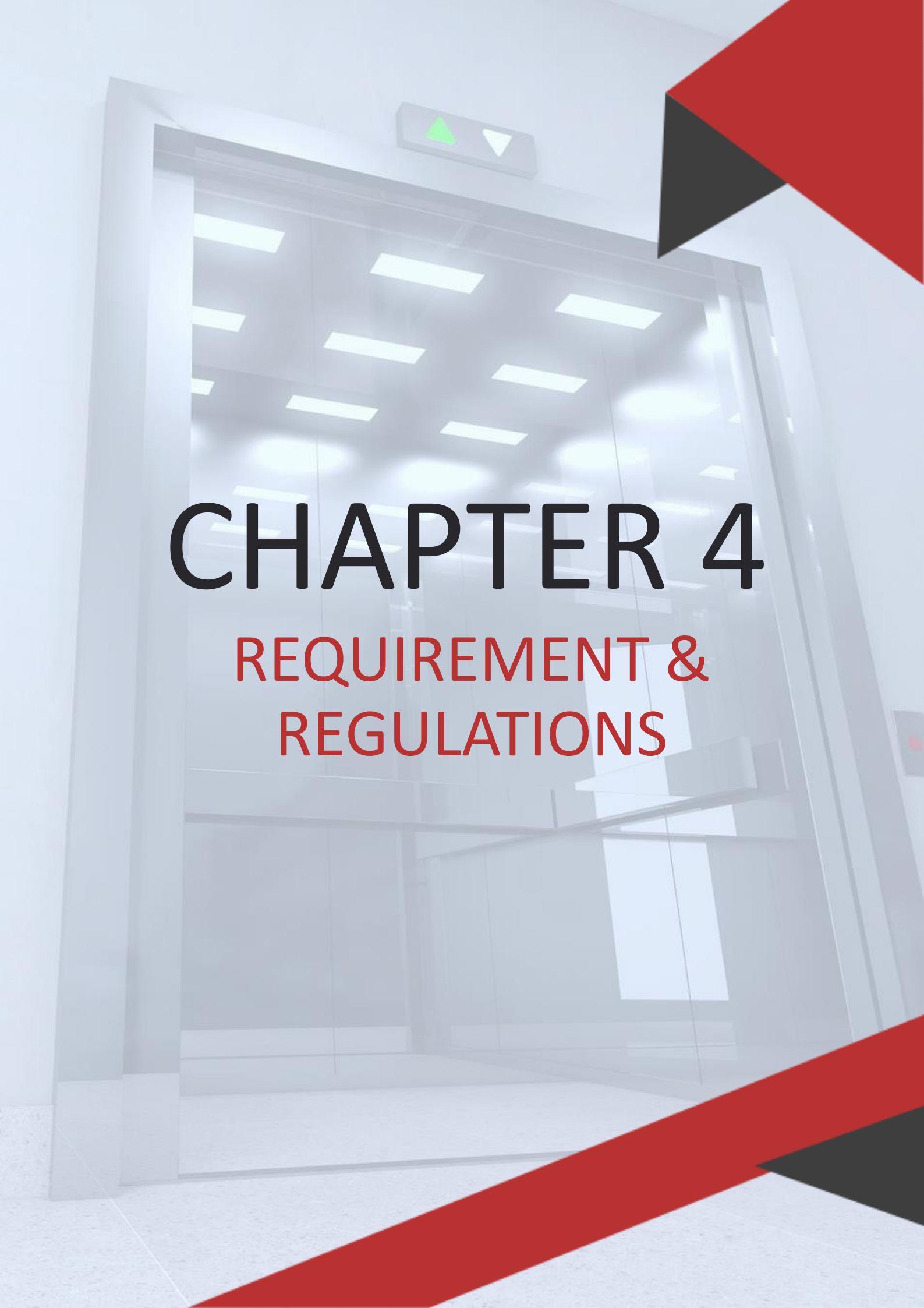
travel is usually limited to a maximum of 18m.

4

Highly efficient permanent magnet (PM) motors for high-speed and super high-speed elevators.

5

Suitable for buildings of up to eight stories, hydraulic elevators may be used due to the low traffic levels in such buildings.

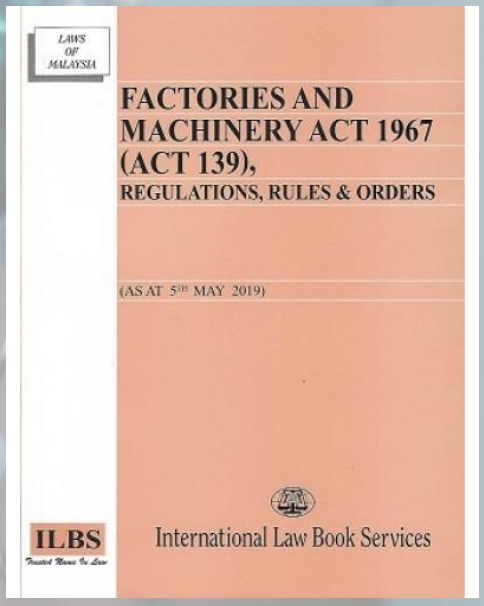


CHAPTER 4

REQUIREMENT & REGULATIONS

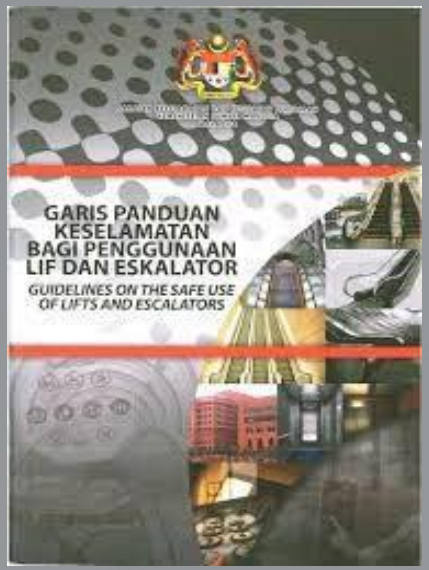
4.0 Requirements and Regulations

Several requirements or regulations should be considered during elevator system installation, to ensure that the elevator system meets the standards. The regulations should be taken into consideration by the manufacturers, elevator installers, elevator technicians, and elevator inspectors. Meanwhile, there is also a guideline for reference for building owners and elevator users.



Regulations on elevator systems in this chapter:

- Factories and Machinery (Electric Passenger and Goods Lift) Regulations 1970
- Uniform Building By-Law (UBBL) 1984
- Guidelines for The Safe Use of Lift and Escalator 2010



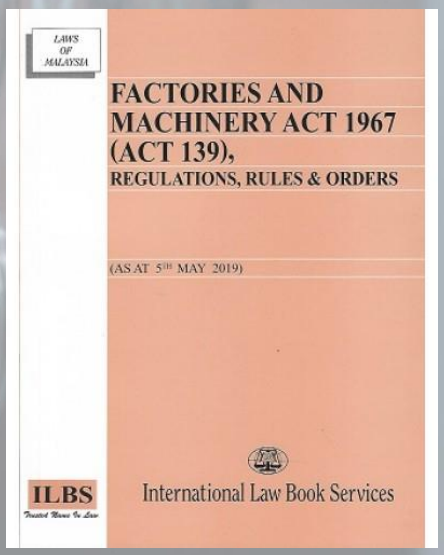
DID YOU KNOW?

Children should be accompanied by their parents while using elevators to avoid accident.

4.1 Factory and Machinery (Electric Passenger and Goods Lift) Regulations, 1970

This regulation covers most of the process from design, construction, installation and test of each elevator component, to the duties of the owner and the implemented penalties.

Content:



4.1 Factory and Machinery (Electric Passenger and Goods Lift) Regulations, 1970 (continues)

Content:

Part II – Design, Construction, Installation and Tests

Regulation 13. Landing door locking devices Regulation 14. Lift car construction

Regulation 14. Lift car construction

Regulation 15. Car doors and gates

Regulation 16. Hatches

Regulation 17. Ventilation

Regulation 18. Lighting

Regulation 19. General

Regulation 20. Counterweight

Regulation 21. Guides

Regulation 22. Safety gear

Regulation 23. Governors

Regulation 24. Buffers

Regulation 25. Clearances and overtravels for lift cars and counterweights

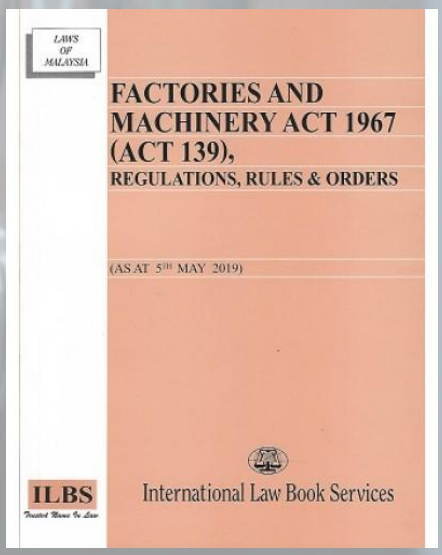
Regulation 26. Terminal stopping ropes

Regulation 27. Suspension ropes

Regulation 28. Operation and control

Regulation 29. Clearances between cars and counterweights, etc.

Regulation 30. Tests

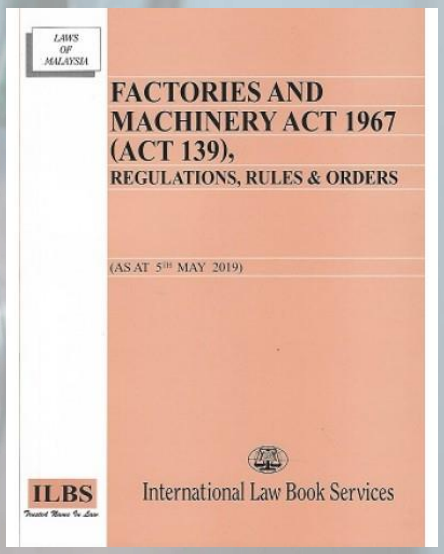


4.1 Factory and Machinery (Electric Passenger and Goods Lift) Regulations, 1970 (continues)

Content:

Part III – Maintenance

Regulation 31. Duties of the owner



Part IV – Miscellaneous

Regulation 32. Notices

Regulation 33. Attendants

Regulation 34. Penalties

For more details, this regulation can be downloaded at DOSH Malaysia website:

https://www.dosh.gov.my/index.php/list-of-documents/regulation/regulations/regulations-under-factories-and-machinery-act-1967-act-139/537-13-factories-and-machinery-electric-passenger-and-goods-lift-regulations-1970/file

DID YOU KNOW?

The minimum illumination at the landing edge of a car platform when the car and landing doors are open shall not be less than 5 foot candles or 53.82 lux.

4.2 Uniform Building By-Law 1984 Amendment 2021

1. Part VI – Constructional Requirements
2. Part VIII – Fire Alarms System and Fire Extinguishment System

Part VI, By-Law 124 Lift

For all non-residential buildings exceeding 4 storeys above or below the main access level at least one lift shall be provided.

Part VIII, By-Law 243 Fire Lift

(1) In a building where the topmost occupied floor is over 18 metres above of a basement storey is more than 9 metres below the fire appliance access level, a fire lift shall be provided.

Part VIII, By-Law 243 Fire Lift

(2) A penthouse occupying not more than 50 percent of the area of the floor immediately below shall be exempted from this measurement to provide the fire lift.

Part VIII, By-Law 243 Fire Lift

(3) The fire lift shall be located within a separate protected shaft if it opens into a separate lobby.

Part VIII, By-Law 243 Fire Lift

(4) The fire lift shall be provided at the rate of one lift in every group of lifts which discharge into the fire fighting access lobby.

4.2 Uniform Building By-Law 1984 Amendment 2021 (continues)

1. Part VI – Constructional Requirements
2. Part VIII – Fire Alarms System and Fire Extinguishment System

Part VIII, By-Law 243_A Emergency mode of operation in the event of mains power failure

(1) On failure of mains power, all lifts shall return in sequence directly to the designated floor, commencing with a fire lift, without answering any car call or landing call and park with its door open.

Part VIII, By-Law 243_A Emergency mode of operation in the event of mains power failure

(2) After all lifts are parked, all lifts on emergency power shall resume the normal operation: provided that sufficient emergency power is available for operation of all lifts, this mode of operation is not applicable.

4.2 Uniform Building By-Law 1984 Amendment 2021 (continues)

1. Part VI – Constructional Requirements
2. Part VIII – Fire Alarms System and Fire Extinguishment System

Part VIII, By-Law 243_B Fire mode of operation

(1) A fire mode of operation shall be initiated by a single from the fire alarm panel which is activated automatically by one of the alarm devices in the building or manually.

Part VIII, By-Law 243_B Fire mode of operation

(2) If mains power is available in this mode of operation, all lifts shall return in sequence directly to the designated floor, commencing with a fire lift, without answering any car call or landing call, overriding the emergency stop button inside the car, but not overriding any other emergency device or safety device, and park with its door open.

Part VIII, By-Law 243_B Fire mode of operation

(3) The fire lift shall then be available for use by the fire brigade on operation of the fireman's switch.

4.2 Uniform Building By-Law 1984 Amendment 2021 (continues)

1. Part VI – Constructional Requirements
2. Part VIII – Fire Alarms System and Fire Extinguishment System

Part VIII, By-Law 243_B Fire mode of operation

(4) Under this mode of operation, the fire lift shall only operate in response to the car call but not to the landing call in the emergency mode of operation in accordance with by-law 243_A.

Part VIII, By-Law 243_B Fire mode of operation

(5) On failure of mains power, all lifts shall return in sequence directly to the designated floor and operate under emergency power as described under paragraphs (2) to (4).

Part VIII, By-Law 243_B Fire mode of operation

(6) A fireman intercom system shall be provided in a lift car for the communication between a lift operator at each lift landing and a fire command centre.

4.3 Guidelines on The Safe Use of Lift & Escalator 2010

DO'S

1. Press button for the required floor only.
2. Obey the maximum number of passengers or load.
3. Entering or exiting the elevator doors carefully if the elevator floor is not level with the landing floor.
4. Stay clear of opening and closing elevator doors.
5. Stay inside if you are trapped in an elevator car.
6. Use the stairs in case of fire.

DON'TS

1. Exceeding the permitted load or weight.
2. Obstruct the movement of elevator doors.
3. Jumping or playing in the elevator car.
4. Touch or lean against the doors.
5. Press buttons mischievously or using sharp objects.
6. Forcing the doors to open in your attempt to escape from the elevator car.
7. Play with the emergency button.
8. Smoke in the elevator car.

4.3 Guidelines on The Safe Use of Lift & Escalator 2010 (continues)

If you are trapped in a elevator car…

1. Stay inside the elevator car.
2. Keep calm.
3. Summon for help using the alarm bell and intercom.
4. Do not attempt to leave the elevator car.
5. Do not force open the elevator doors.
6. Contact the building management for assistance.

4.4 Exercise

Please choose and tick (/) the correct answers.

1. Select the **CORRECT** regulation for elevator system:
   - ☐ Factories and Machinery Acts 1967
   - ☐ Uniform Piling By Law 1983
   - ☐ International Law Book Services

2. What is the minimum number of storey for a non-residential building to require an elevator system?
   - ☐ 4 storey
   - ☐ 5 storey
   - ☐ 6 storey

3. The minimum lighting requirement for elevator landing area is:
   - ☐ 48.84 lux
   - ☐ 50.62 lux
   - ☐ 53.82 lux

4.5 References

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Published by:
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e ISBN 978-967-0032-40-5
9 7 8 9 6 7 0 0 3 2 4 0 5