

## Electrical Safety and Hazards



### LEARNING OBJECTIVES

The objective of this lesson is to learn about hazards of electricity and chemicals to those who work in the electrical industry. Also to study about safety measures, first aid, fire extinguisher and its operations.



### Table of Content

- 2.1 Introduction
- 2.2 Electric shock and its causes
- 2.3 First aid for electrical emergency
- 2.4 Environmental factors
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- 2.6 Exposure to hazardous substances
- 2.7 Fire extinguisher
- 2.8 Protecting devices



### INTRODUCTION

Electrical safety is a general practice of workers followed to be to handling and maintaining electrically

powered equipments. It is a guideline used to follow to prevent accidents, electrical safety be followed while working in electricity related works.

Human body has a electrical conducting property. Without sweating the resistance of human body is approximately  $80000\ \Omega$  (ohm) and during sweating, resistance of the human body is approximately  $1000\ \Omega$ . If we touch any current carrying conductor, the current is conducted through our body to earth and we get electric shock. The nervous structure, heart, lungs, and brain affected by electric shock. If the current is heavy, even death may occur.

### 2.2.1 How shock occurs?

There are many ways of getting electric shock. Electrical shock occurs either when a person comes in contact with:

- phase and neutral wires of an electric circuit,
- one phase wire and the ground,
- a metallic part that accidentally becomes contact with an electrical conductor

If a person is within three meters of a HT power line, the energy flow can take place towards you and take a path to the ground. Never grow trees near to power line.

When assembling the components in a panel board, proper precautions have to be considered to ensure safety.

### 2.2.2 Preventive measures to avoid electric shock

Some of the methods employed to avoid electric shock are:

1. The operation of electrical equipment must be clearly known.
2. Avoid damaged wires and accessories.

3. Use proper electrical instruments.
4. The hand tools should be properly insulated.
5. Proper earthing should be provided.

When a person gets affected by an electrical shock in an unavoidable condition, first aid should be given before taking to the hospital. When a person is affected by current shock, the circuit should be disconnected first. If the main switch is nearer, put off the switch by using any wooden stick and disconnect the person from the circuit. Then immediately take him to a hospital. If the affected person loses consciousness, and breath normally, then loosen his clothes and apply cold water on his face and keep him in open air. If the person does not breathe freely, then immediately artificial method of respiration has to be made.

There are two methods of artificial breathing.

### 2.3.1 Holger Nelson method



Fig 2.1 Holger Nelson method

In this method, the casualty should be laid on the bed facing the ground. The helper sitting upon him should massage

his back using both hands. This has to be done immediately.

### 2.3.2 Mouth to mouth method

In this method, the helper pushes air by keeping his mouth on the casualty's mouth. By closing his nose, the air is filled in lungs.



Fig 2.2 Mouth to mouth method

## 2.4 ENVIRONMENTAL FACTORS

Environmental pollution causes harm to our environment and in turn to the people who exist based on the environment. Environmental pollution occurs when pollutants contaminate the surroundings which brings about changes that affect our normal lifestyles.

### 2.4.1 Types of environmental pollution

Pollution of environment is of the following types

1. Air pollution
2. Water pollution
3. Soil pollution
4. Noise pollution
5. High humidity

## 1. Air pollution

The quality of air is one of the environmental factors that play a vital role which affects the overall health of human body. Pollution of air is the major problem for living things.

## 2. Water pollution

Water pollution is nothing but the contamination of water bodies. Water pollution is caused when water bodies such as rivers, lakes, oceans, groundwater and other water resources get contaminated with industrial and agricultural effluents. The water pollution affects the entire ecosystem.

Water pollution affects aquatic life severely. Dioxin is a chemical that causes cancer due to water pollution.

## 3. Soil pollution

Soil pollution is defined as the presence of toxic chemicals (pollutants or contaminants) in soil. Naturally occurring contaminants in the soil also make soil pollution.

## 4. Noise pollution

Noise pollution or sound pollution is defined as the sound that is produced unwantedly, causes disturbance to nearby individuals. It causes distraction, hearing damage, or disrupts normal activities and affects quality of life. Workplaces are required to take those in the surrounding environment into account with regard to noise pollution, such as an industrial plant next to a residential area.

## 5. High humidity

Humidity is greatly influenced by intensity of solar radiation, temperature,

altitude, wind, water status of soil etc. Low temperature causes higher relative humidity by decreasing the capacity of air moisture. Process such as transpiration, absorption of water etc. are influenced by atmospheric humidity.

## **2.5 ELECTRICAL AND CHEMICAL HAZARDS**

### **2.5.1 Electrical hazards**

Hazards from electric power causes damage to the equipment and makes serious injury to the person who operate it. Wearing of protective equipments can preserve the life of men and materials of electrical devices. Safety measures can be adopted by taking appropriate procedure of using electrical commodities.

### **2.5.2 Precautionary tips to avoid from electrical hazard**

1. Physical hazards like loosening of cords and wires can be properly insulated.
2. Wear protective equipments like gloves, safety glass, goggles etc..
3. If it is heat area use proper glass and heat resistive clothes.
4. Be careful while cleaning the electrical devices.
5. Be cautious while testing and replacing the components in the panel.
6. When doing work with electric supply the area should be away from water and moisture.
7. Don't use damaged or broken plugs.

8. Switch off the power supply while doing repair in electrical work.
9. Always use the insulated tools and materials for repairs.

## **2.6 EXPOSURES TO HAZARDOUS SUBSTANCES**

Hazardous substances are defined as any material which causes injury to people or the environment and are responsible for many immediate and long-term health conditions. But with the right control measures in place, workers can be protected from these hazards.

Some hazardous substances produce immediate effects upon exposure such as irritated eyes or skin rashes. Depending on the hazardous substance, the effects can be short-term and treatable with the right medical care, or they can be serious or even causing death.

Electrical equipment is the most typical form of potentially hazardous waste in many offices. Chemicals found in laptops, cell phones, and lighting equipment could all have a role. To avoid environmental damage, it's critical that such garbage is properly disposed off.

Almost in all business work hazardous substances must carefully examine the potential consequences for their employees, the public, animals, and the environment. These impacts can be minimized if safety laws are followed and hazardous material is properly disposed off.

### 2.6.1. Chemical hazards are caused due to:

1. Improper storage of chemicals causing a chemical leakage
2. Mishandling of chemicals due to inadequate training or negligence.

## 2.7 FIRE EXTINGUISHER

Fire extinguisher is an equipment used to extinguish or control fire at initial stage.

Fire can be divided into four types depending on the nature of the firing materials.

1. Class 'A' – Fire caused by wood, paper and clothes.
2. Class 'B' – Fire caused by oil and liquid fuels.
3. Class 'C' – Fire caused by Liquified petroleum gas (LPG).
4. Class 'D' – Fire caused by metals and electrical appliances.

### 2.7.1 Types of fire extinguishers

It is essential to know the various types of fire extinguisher. Commonly three type of fire extinguishers are used.

#### 1. Water filled extinguisher

It's classified in two types

- a. Gas cartridge type
- b. Stored pressure type

These types of fire extinguishers are used to extinguish the fire caused by trees, paper and clothes.

#### 2. Foam extinguisher

These types are compressed by air and gas. These types are used to extinguish fire caused by oil and inflammable liquid fuels.

#### 3. Dry powder extinguisher

Gas-filled or pressure type of fire extinguishers are commonly used for dry powder. These fire extinguishers are used to extinguish fire caused by metals and electrical equipments.

The steps to operate a fire extinguisher in case of an emergency has been shown in fig 2.3

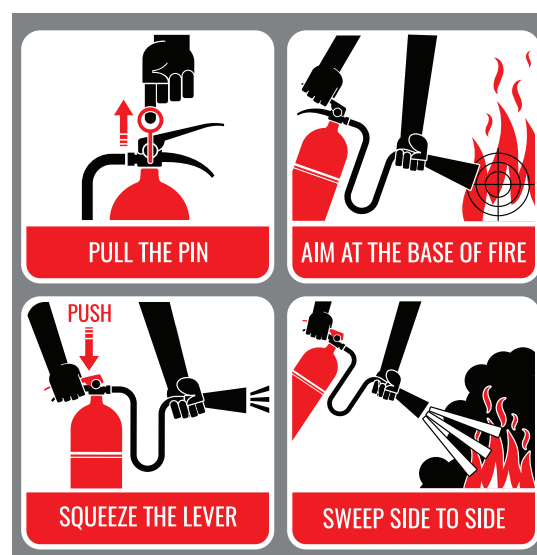


Fig 2.3 Operation of fire extinguisher

**Step 1:** Identify the safety pin of the fire extinguisher which is generally present in its handle

**Step 2:** Break the seal and pull the safety pin from the handle

**Step 3:** Use the fire extinguisher by squeezing the lever

**Step 4:** Sweep it to the flame in the proper direction.



### 2.7.2 Precautions

Usage of fire extinguisher should be known to the person who is going to operate. Some of the precautions to be followed are:

1. Observe if there is a risk of fire in or near the work area.
2. Keep the work area free from untidy things.
3. All the gates should be easily accessible in emergency situation.
4. Proper maintenance of fire extinguisher should be done regularly.
5. Ensure all safety equipments are maintained properly.

## 2.8 PROTECTING DEVICES

### 2.8.1 Relay



Fig 2.4 Relay

The relay shown in Fig 2.4 is an electrically controlled switch used to isolate or to connect the equipment in the circuit. It has a coil that can be energized and de-energized by voltage and contacts that change logic state (on/off) based on its coil (logic input) state.

### 2.8.2 Types of relay

1. Electromagnetic relay
2. Solid state relay
3. Hybrid relay
4. Thermal relay

#### 1. Electromagnetic relay

When different mechanical parts are connected on the basis of the electromagnet, contact connection is established. AC or DC power supplies can be used for electromagnetic relays.

#### 2. Solid state relay

This relay is used in semiconductor devices to make a connection to ensure the effectiveness, efficiency, and easiness of the switching speed. This is commonly used for faster-switching process and durability. This relay utilizes solid state components in order to execute a switching function without moving parts.

#### 3. Hybrid relay

Hybrid relays contain electronic components and electromagnetic relays. The electronic circuits are in the input section of the device. These circuits have several control functions available within them.

#### 4. Thermal relay

This relay allows the users to make contact connections. Thermal relays are commonly used for the purpose to protect motor. Its temperature sensors and other bimetallic elements assist in giving protection to the motor.

### 2.8.3 Electrical circuit breaker

#### 1. Description

A circuit breaker is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused due to overload of electricity or short circuit. A circuit breaker function is to detect a fault and immediately disconnect the current flow.

#### 2. Working of a circuit breakers

A circuit breaker consists of fixed and moving contacts called electrodes. Under normal operating conditions, these contacts remain closed and do not open automatically until and unless the system becomes faulty. The contacts can be opened manually or by remote control whenever desired. When a fault occurs on any part of the system, the trip coils of the breaker gets energised and the moving contacts are pulled

apart by a certain mechanism, thus opening the circuit.

When the contacts of a circuit breaker are separated under faulty conditions, an arc is struck between them. The main problem in a circuit breaker is to extinguish the arc within the shortest possible time so that heat generated by it does not reach a dangerous value.

#### 3. Methods of arc quenching

There are two methods of quenching the arc in circuit breakers.

1. High resistance method.
2. Low resistance method.

#### 4. Classification of circuit breakers

Circuit breakers are classified depending upon the medium use for arc extinction.

Sl. No.	Type	Medium used for arc extinction	Voltage range
1	Air break circuit breaker.	Air	Up to 1000 V
2	Tank type oil circuit breaker.	Transformer oil	Up to 33 KV
3.	Minimum oil circuit breaker.	Transformer oil	Up to 132 KV
4.	Air blast circuit breaker.	Compressed air	Up to 132 KV
5	Sf <sub>6</sub> circuit breaker.	Sf <sub>6</sub> gas	400 KV to 760KV
6	Vacuum circuit breaker.	Vacuum	11 KV to 33 KV
7	High voltage direct current circuit breaker.	sf <sub>6</sub> gas or vacuum	+ 500 KV DC

## 5. Miniature circuit breaker (MCB)

MCB is an electromechanical device which guards an electrical circuit from an over current that may effect from short circuit or overload. The structure of miniature circuit breaker is shown in fig 2.5.



Fig 2.5 Circuit breaker

- Normally work with currents below 100 amperes.
- Low voltage circuit breaker is typically found along with fuse box in a residential or commercial building.

## 6. Types of miniature circuit breaker

### a. Single pole miniature circuit breaker

- i. Single-pole circuit breakers are typically used for electric circuits with low power requirements used in live conductor, providing power for lamps or general purpose electric outlets.
- ii. A single-pole low voltage circuit breaker occupies only less space in a fuse box.

### b. Double pole miniature circuit breaker

- i. It is used for devices that operate with two live conductors, such as domestic air conditioner models.

- ii. When a double-pole circuit breaker is tripped, both lines are disconnected even if only less of them was involved in the electrical fault.
- iii. A double-pole low voltage circuit breaker occupies two spaces in a fuse box.

### c. Triple –pole miniature circuit breaker

- i. It is used to protect electric equipment that works with three-phase power.
- ii. It is used to protect and safeguard the appliances which runs in 3 phase supply like escalators and big cooling towers.

## 7. Moulded Case Circuit Breaker (MCCB)

This circuit breaker is an electro mechanical device which guards a circuit from short circuit and over current. They offer short circuit and over current protection for circuits ranging from 63 amps – 3000 amps. The primary functions of MCCB are to give a means to manually open a circuit, automatically open a circuit under short circuit or overload conditions.

- i. Higher current ratings when compared to miniature circuit breakers.
- ii. The breaking current ratings of a molded circuit breaker can be modified.



## 8. Earth Leakage Circuit Breaker (ELCB)

The ELCB is used to protect the circuit from the electrical leakage. When someone gets an electric shock, then this circuit breaker cuts off the power at the time of 0.1 second for protecting the personal safety and avoiding the gear from the circuit against short circuit and overload.

ELCB is a security device used in electrical system with high earth impedance to avoid shock. The main principle of earth leakage protectors is to stop injury to humans and nature due to electric shock.

In fig 2.6, the ELCB is connected between the conductor and earth. The ELCB notices fault currents from live to the ground wire inside the installation it guards. If enough voltage emerges across the sense coil in the circuit breaker, it will turn off the supply, and stay off until reset by hand.

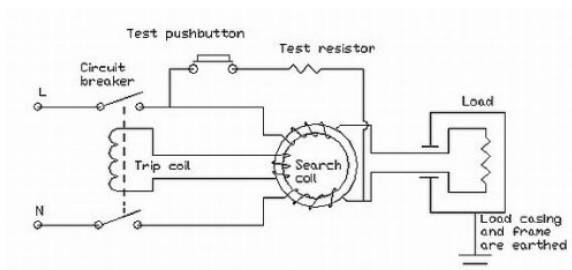


Fig 2.6 Earth Leakage Circuit Breaker

## 9. Types of Earth Leakage Circuit Breaker

1. Voltage operated Earth Leakage Circuit Breaker (Voltage – ELCB)
2. Current operated Earth Leakage Circuit Breaker (Current – ELCB)

## 10. Voltage operated Earth Leakage Circuit Breaker

One terminal of the relay coil is connected to the metal body of the equipment to be protected against earth leakage and other is connected to the earth directly. If any insulation failure occurs or live phase wire touches the metal body of the equipment, there must be a voltage difference of 50V and it produces a current to flow in the relay coil and disconnect the power supply to the equipment. In this way, the circuit is protected from earth leakage fault.

## 11. Current operated Earth Leakage Circuit Breaker

This breaker operates due to the current flow in the earth wire caused by the short circuit in electrical equipment. It also protects from earth leakage fault. When short circuit occurs, different values of current flow in three phases, which make circuit breaker to operate and protect from the fault.

### 2.8.4 Fuse

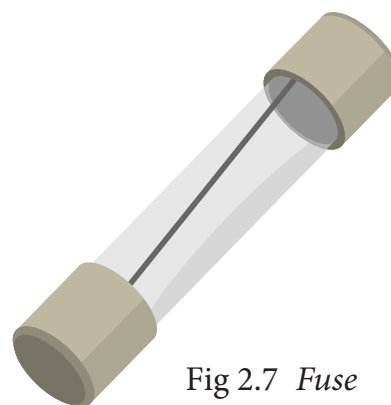


Fig 2.7 Fuse

A fuse is a short length of wire. It is designed to melt and isolate the circuit when fault occurs. Fuses are always connected in series with component(s). When a fuse blows (opens), it opens the entire circuit and stops the current through the component(s).



## GLOSSARY

respiration	— சுவாசம்
contamination	— மாசடைதல்
hazards	— ஆபத்துகள்
humidity	— ஈரப்பதம்
effluents	— கழிவுகள்

Q

A

## PART A



Mark 1

**Choose the correct answer:**

- Without sweating of human body, the resistance is approximately
  - 80 K $\Omega$
  - 40 K $\Omega$
  - 10 K $\Omega$
  - 20 K $\Omega$
- With sweating of human body, the resistance is approximately
  - 80 K $\Omega$
  - 40 K $\Omega$
  - 1 K $\Omega$
  - 10 K $\Omega$
- ECO system is connected with which type of pollution?
  - High humidity
  - Water pollution
  - Earth
  - Noise
- Loose cords and wires can cause ----- hazard.
  - Chemical hazard
  - Mechanical hazard
  - Electrical hazard
  - Thermo hazard
- Repairing of electrical equipment with wet hand causes-----
  - Heat is produced
  - Conduction of electric current
  - Nothing will happens
  - High current will produce
- What hazard will happen when we stored chemicals improperly?
  - Thermal hazard
  - Electrical hazard
  - Chemical hazard
  - Physical hazard



Q

A

## PART A

Mark 1

7. What is the use of control relay?
  - a) To maintain static voltage
  - b) To avoid voltage drops
  - c) To turn ON/OFF
  - d) to control the supply
8. Electrical circuit breaker is like a -----
  - a) resistance
  - b) capacitance
  - c) switch
  - d) inductance
9. The ----- circuit breaker is used to protect circuit from the leakage current.
  - a) Miniature circuit breaker
  - b) Earth leakage circuit breaker
  - c) Moulded case circuit breaker
  - d) Open circuit breaker
10. The earth leakage circuit breaker breaks the circuit in ----- seconds.
  - a) 1
  - b) 0.1
  - c) 0.5
  - d) 0.7
11. The earth leakage circuit breaker connects which two parts?
  - a) Conductor – conductor
  - b) Conductor – body
  - c) Conductor – earth
  - d) Earth – earth
12. The operating voltage of voltage operated earth leakage circuit breaker is
  - a) 100 volt
  - b) 50 volt
  - c) 5 volt
  - d) 10 volt
13. Which type of device is a circuit breaker?
  - a) Mechanical switching device
  - b) Electrical device
  - c) Voltage regulating device
  - d) Current regulating device
14. Which type of circuit breaker is used for over current and short circuit?
  - a) Miniature circuit breaker
  - b) Oil circuit breaker
  - c) Air circuit breaker
  - d) Vacuum circuit breaker
15. Which type of circuit breaker is used for current leakage?
  - a) Miniature circuit breaker
  - b) Moulded circuit breaker
  - c) Earth leakage circuit breaker
  - d) Air circuit breaker
16. Due to ----- shock in ELCB is avoided.
  - a) High current value
  - b) High voltage value
  - c) High earth impedance
  - d) High power supply



17. Fuse is connected with ----- supply
- Phase
  - Neutral
  - Resistance
  - capacitance
18. How many types of fire extinguisher is commonly used?
- 4
  - 1
  - 2
  - 3
19. Which type of fire can be put out by using water filled extinguisher?
- Fire caused by oil and liquid fuels.
  - Fire caused by wood, and clothes.
  - Fire caused by Liquified petroleum gas (LPG).
  - Fire caused by metals and electrical appliances.
20. Which type of fire extinguisher is used for fire caused by metal and electric equipment?
- Water filled extinguisher
  - Gas filled extinguisher
  - Foam extinguisher
  - Dry powder extinguisher
21. Which type of fire extinguisher is used to control flammable liquid gas?
- Water filled extinguisher
  - Gas filled extinguisher
  - Foam extinguisher
  - Dry powder extinguisher

Q

A

## PART B

Mark 3

**Answer the questions in briefly**

- List out the types of environmental pollution.
- What are causes of chemical hazards?
- What is called relay?
- What is called circuit breaker.
- What are the types of fire extinguisher?
- Define fuse.
- How electrical shock occurs?



**Q** **A**

**PART C**

**Mark 5**

**Answer the questions not exceeding one page**

1. Explain the method of preventing an electric shock
2. Explain miniature circuit breaker.
3. Explain Earth leakage circuit breaker.
4. Explain moulded case circuit breaker.

**Q** **A**

**PART D**

**Mark 10**

**Answer the questions not exceeding one page**

1. Explain the type of fire extinguisher operating method and precautions.
2. Explain the types of first aid given to electric shock.
3. Write down the precautionary tips for electrical hazard.