



# Participant Handbook

Sector  
**Electronics**

Sub-Sector  
**Industrial Electronics**

Occupation  
**Sales and After Sales Service**

Reference ID - **ELE/Q7201, Version 3.0**  
**NSQF Level 4**



**Field Technician -  
UPS and Inverter**





**Shri Narendra Modi**  
Prime Minister of India

“ Skilling is building a better India.  
If we have to move India towards  
development then Skill Development  
should be our mission. ”



## Certificate

**COMPLIANCE TO  
QUALIFICATION PACK – NATIONAL OCCUPATIONAL  
STANDARDS**

is hereby issued by the

**ELECTRONICS SECTOR SKILLS COUNCIL OF INDIA**

for

**SKILLING CONTENT : PARTICIPANT HANDBOOK**

Complying to National Occupational Standards of

Job Role/Qualification Pack **"Field Technician - UPS And Inverter"** QP No. **"ELE/Q7201,  
NSQF Level 4"**

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'Valid up to' date mentioned above (whichever is earlier)

Authorized Signatory  
Electronics Sector Skills Council of India

## Acknowledgments

The need for having a standard curriculum for the Job Role based Qualification Packs under the National Skills Qualification Framework was felt necessary for achieving a uniform skill based training manual in the form of a Participant Handbook.

I would like to take the opportunity to thank everyone who contributed in developing this Handbook for the QP Field Technician – UPS and Inverter.

The Handbook is the result of tireless pursuit to develop an effective tool for imparting the Skill Based training in the most effective manner.

I would like to thank the team for their support to develop the content, the SME and the team at the ESSCI along with the industry partners for the tireless effort in bringing the Handbook in the current format.

CEO

Electronics Sector Skills Council of India

## About this Book

This Participant Handbook is designed to enable training for the specific Qualification Pack (QP). Each National Occupational (NOS) is covered across Unit/s.

Key Learning Objectives for the specific NOS mark the beginning of the Unit/s for that NOS.

- Explain the basics of electronics
- Identify the electronic components
- Explain fundamentals of electricity
- Describe UPS and Inverter
- List tools and equipment used for installing and repairing UPS/Inverter
- Determine the responsibilities of a field technician
- Analyse the customer requirements
- Adhere to the reporting and documentation process
- Follow the health and safety norms
- Identify ways to improve the work process
- Identify the installation process of UPS/Inverter
- Identify the faults and repair the faulty modules of UPS/Inverter
- Identify the correct way of interacting with supervisors and colleagues
- Identify soft skills required for doing the job of a technician

The symbols used in this book are described below.

## Symbols Used



Key Learning  
Outcomes



Steps



Role Play



Tips



Notes



Unit  
Objectives



Practical



e-Resources



Activity

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# 1. Basics of Uninterrupted Power Supply (UPS) and Inverter



Unit 1.1 – Basics of Electronics and Electronic Components

Unit 1.2 – Fundamentals of Electricity

Unit 1.3 – Introduction to UPS and Inverters

Unit 1.4 – Tools and Equipment



## Key Learning Outcomes



**At the end of this unit, you will be able to:**

1. Explain the basics of electronics
2. Identify the electronic components
3. Explain fundamentals of electricity
4. Describe UPS and Inverter
5. List tools and equipment used for installing and repairing UPS/Inverter

## UNIT 1.1: Basics of Electronics and Electronic Components

### Unit Objectives

At the end of this unit, you will be able to:

1. Define basic electronics
2. List electronic components

### 1.1.1 Understanding Basics of Electronics

Electronics is the branch of science where electrical energy is controlled electrically, through the flow of electrons. The study of this branch deals with electrical circuits involving active electronic components such as vacuum tubes, transistors, diodes and integrated circuits and passive electronic components such as resistors, capacitors and inductors, along with its interconnection technologies.

The following figure shows concepts covered in basics of electronics:

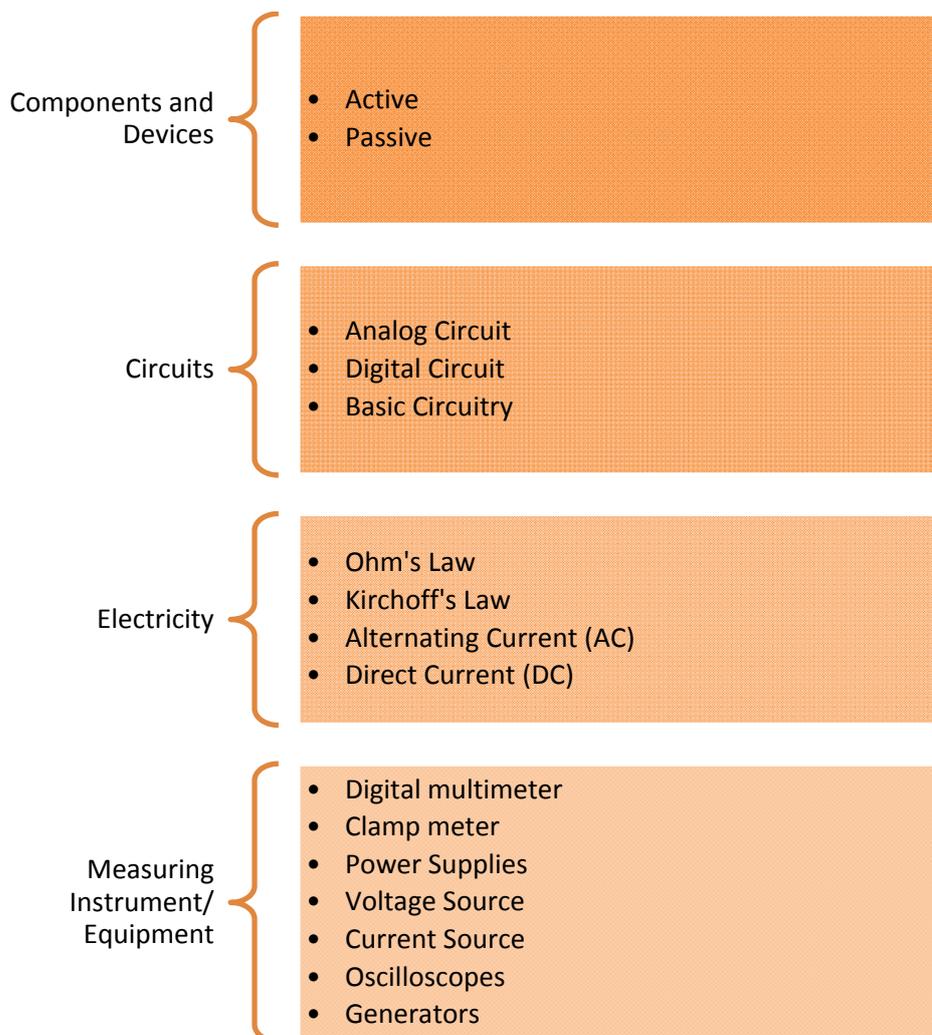
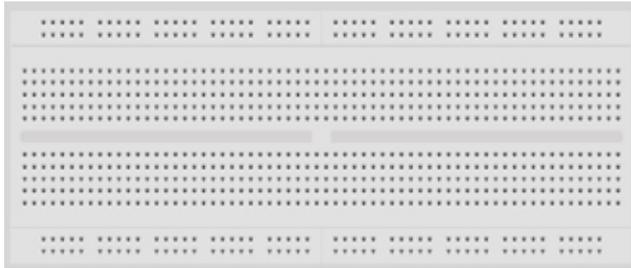


Fig 1.1.1: Concepts of basic electronics

### 1.1.2 Electronic Circuits and Components

In an electronic circuit, components are embedded on a printed circuit boards (PCBs). A PCB acts as a base for the components that are mounted on its surface and soldered. The components are generally soldered on the circuit board according to a specified design. The circuits are initially build and tested on a breadboard before being embedded on a PCB. The following images show a breadboard and a printed circuit board:



Breadboard



PCB

*Fig 1.1.2: Breadboard and PCB*

Electronic components are of two types:

- Active
- Passive

#### **Active Components**

Active components depend on a source of energy to perform their functions. These components can amplify current and can produce a power gain.

The following figure represents list of active components:

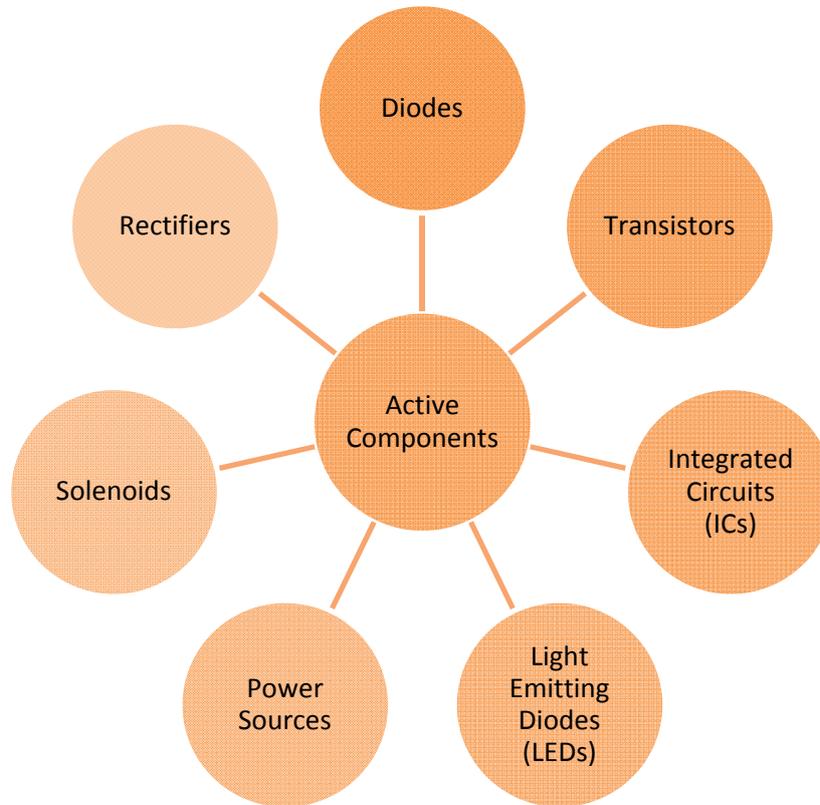


Fig 1.1.3: Active components

### Diodes

A diode is a specialized electronic component with two terminals known as the anode and the cathode. It has asymmetric conductance, which means that it conducts mainly in one direction. It has very less resistance (ideally zero), to the flow of current in one direction. It has high resistance (ideally infinite), in the other direction. Diodes are usually made up of semiconductor materials such as germanium, silicon or selenium. The following image shows diodes:

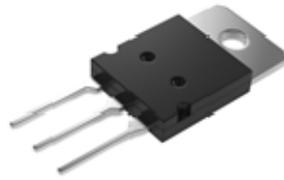


Fig 1.1.4: Diodes

### Transistors

A transistor is an electronic device, made up of semiconductor material. Usually, it has at least three terminals to connect to an external circuit. It is used to amplify or switch electrical power and electronic signals

The following image shows a transistor:



*Fig 1.1.5: Transistor*

### **IC**

An IC, also known as a microchip, is a semiconductor wafer on which a number of small resistors, capacitors and transistors are fabricated. It can work as an oscillator, an amplifier, a timer, a counter, a microprocessor or as computer memory. The following image shows an IC:



*Fig 1.1.6: IC*

### **LED**

A LED is a p-n junction diode which gives out light when it is activated. It is a two-lead semiconductor source of light. Energy is released as photons when a suitable voltage is applied to the leads. The following image shows a LED:



*Fig 1.1.7: LED*

### **Power Sources**

A power source is a source which provides power to a circuit. Generally, it is a generator or a battery.

The following image shows a battery:



*Fig 1.1.8: Battery*

## Passive Components

Passive components are those components which do not require any power source to perform their specific functions. These components are not capable of controlling current.

### Solenoid

A solenoid is an insulated or enamelled wire coil wrapped around a cylindrical solid core. The solid core may be of iron, steel or powdered iron. Solenoids can be used as electromagnets and inductors in electronic circuits. The following image shows a solenoid:



*Fig 1.1.9: Solenoid*

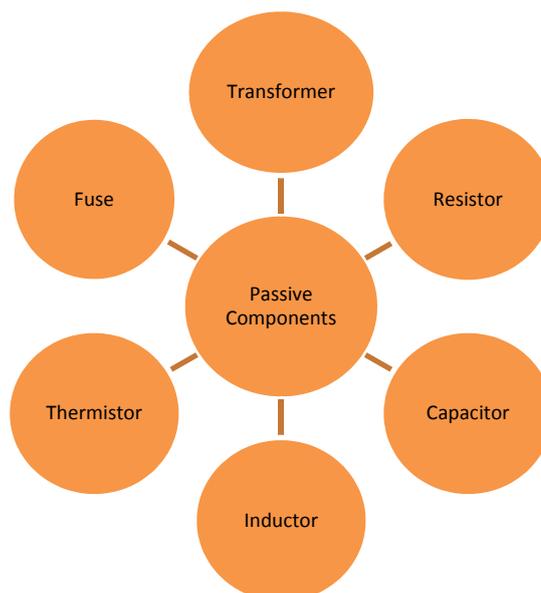
### Rectifier

A rectifier is an electrical device that converts AC, which periodically reverses direction, to DC, which flows in only one direction. The following image shows a rectifier:



*Fig 1.1.10: Rectifier*

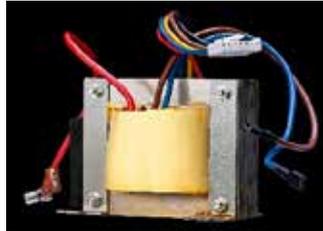
The following figure lists different passive components in a circuit:



*Fig 1.1.11: Passive components*

### Transformer

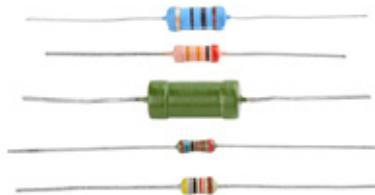
A transformer consists of a metal core with coils of wire around it. It is a device used to convert AC to the required values by decreasing or increasing the alternating voltages in an electronic or electric system. The following image shows a transformer:



*Fig 1.1.12: Transformer*

### Resistors

A resistor is a component in an electronic circuit which is built to resist or limit the flow of current in that circuit. It may be a small carbon device or a big wire-wound power resistor. Its size varies in length from 5mm up to 300mm. The following image shows resistors:



*Fig 1.1.13: Resistors*

### Capacitors

A capacitor is a device which is made up of one or more pairs of conductors and an insulator separating them. It is used to store electric charge. The following image shows capacitors:



*Fig 1.1.14: Capacitors*

### Inductors

An inductor consists of a coil or a wire loop. This component is used to store energy in the form of a magnetic field. The more the turns in the coil, the more will be the inductance. The following image shows inductors:



Fig 1.1.15: Inductors

### Fuse

Fuse is a device used to protect electrical systems against excessive current. The following image represents a fuse.



Fig 1.1.16: Fuse

### Types of Electronic Circuit

An electronic circuit is a combination of electronic components that are connected to provide the flow of current. The different combination of wires and components allows different operations, such as amplification of signals, computation and transmission of data, to be performed. The following figure represents types of electronic circuits:

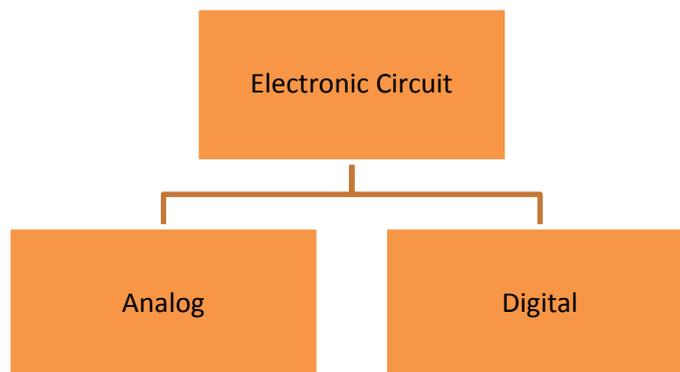


Fig 1.1.17: Classification of electronic circuits

## Analog Circuits

In analog circuits, there is a continuous variation of voltage or current with time.

These circuits are a combination of basic components such as resistors, capacitors, diodes, inductors and transistors. The following figure represents an analog circuit:

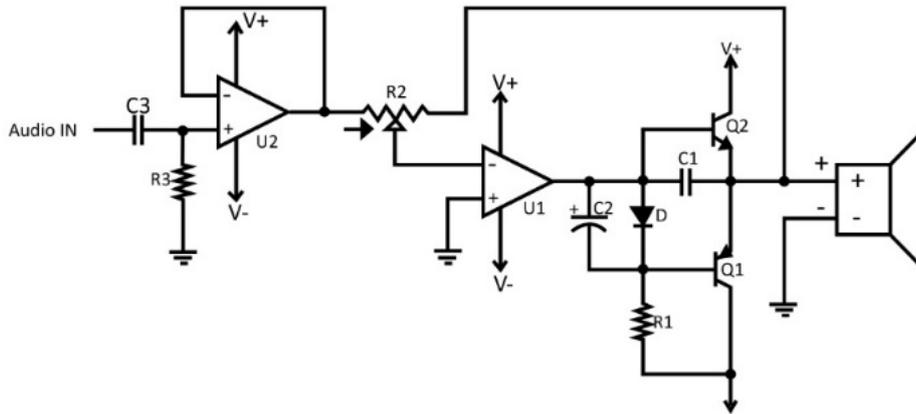


Fig 1.1.18: An analog circuit

The fundamental building blocks of analog circuits are:

- Series connection
- Parallel connection

### Series Connection

In series connection, the magnitude of current is same through all the connected components. The following figure shows a series circuit and in the figure,  $R = R_1 + R_2 + R_3$ , where,  $R$  represents the resistance in the circuit:

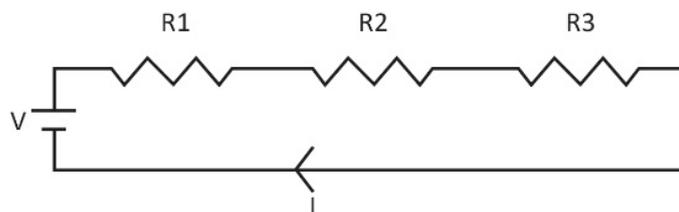


Fig 1.1.19: Series Connection

### Parallel Circuit

In a parallel connection, the magnitude of voltage is same through all the connected components and the current is divided among the various components.

The following figure represents a parallel circuit. In the following figure,  $1/R = 1/R_1 + 1/R_2 + 1/R_3$ , where, R shows the resistance in the circuit and I represents the current:

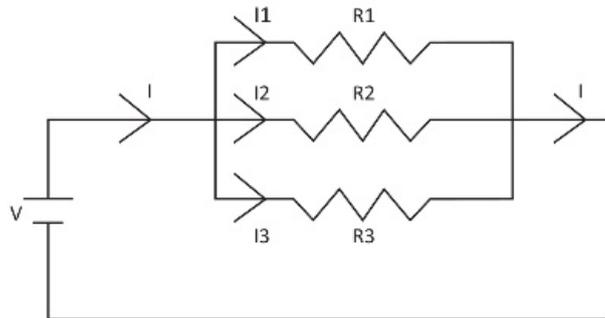


Fig 1.1.20: Parallel circuit

**Digital Circuits**

A binary scheme is used by digital circuits for digital signalling. Two different voltages (high or low) are represented by different logic levels. High voltage, generally 5V, represents one value and the other value represents low voltage that is generally 0V. The following figure shows a digital circuit:

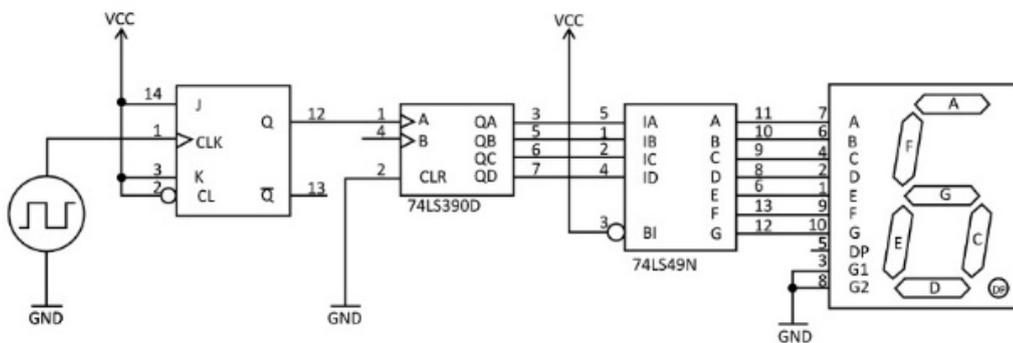


Fig 1.1.21: A digital circuit

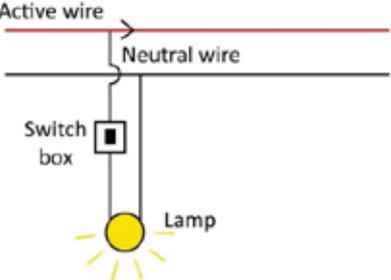
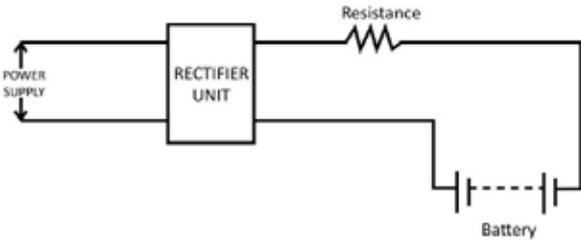
The following table describes basic building blocks of digital circuits:

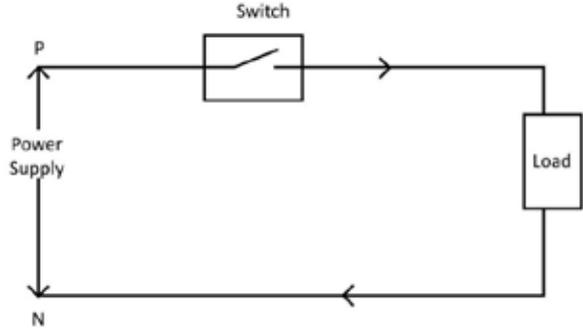
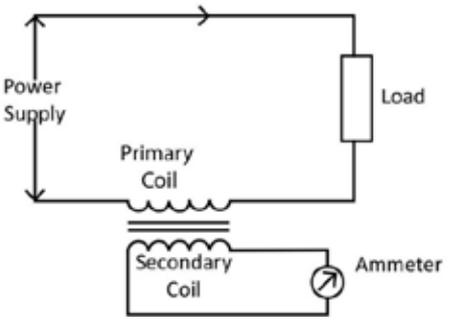
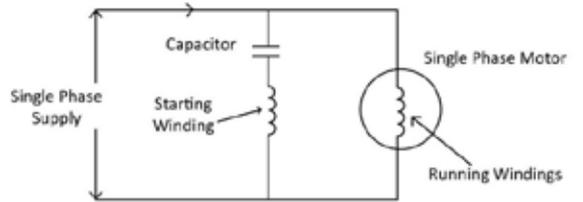
<p><b>Logic Gates</b></p> <p>These are elementary blocks of a digital circuit. At any moment, the terminal voltage level is either high represented by 1 or low represented by 0</p>	<p>OR Gate</p> <p>The output terminal is at 1 when any of the inputs is 1 and is at 0 when all the inputs are at 0.</p>	
	<p>AND Gate</p> <p>The output terminal is at 1 when all the inputs are at 1, otherwise the output is 0.</p>	

	<p>NOT Gate/Inverter</p> <p>The output is 0 when the input is 1 and vice-versa.</p>	
<b>Microprocessor/Chip</b>	An IC containing all the functions of a computer's central processing unit.	
<b>Microcontroller</b>	Is a small computer on an IC which controls devices that contain the microprocessor such as remote controls, office machines and appliances	

### Basic Circuits

The following table describes some basic electronic circuits:

Circuit	Circuit Diagram	Description
AC circuit for Lamp		For connecting a lamp, two wires, neutral and active are connected to the main supply panel. There is a switch between the supply and lamp in the live wire. When the switch is ON, it closes the electric circuit allowing the lamp to glow. If the switch is OFF, the opposite will happen.
Battery Charging Circuit		In this circuit, a rectifier converts AC supply into DC. Resistance is added to the rectifier circuit to limit the current flow. When the AC supply is provided to the rectifier by means of a step-down transformer, it converts the AC supply into direct current, which then charges the battery.

<p>Circuit with a switch</p>	 <p>A schematic diagram of a simple electrical circuit. On the left, a vertical line represents the 'Power Supply', with 'P' at the top and 'N' at the bottom. A horizontal wire goes from 'P' to the right, passing through a rectangular box labeled 'Switch'. After the switch, the wire continues to the right and then turns down to a vertical wire labeled 'Load'. From the bottom of the 'Load', the wire turns left and goes back to 'N' on the power supply. Arrows indicate the direction of current flow: from 'P' through the switch and load, and back to 'N'.</p>	<p>A switch is a component used to complete the circuit between the load and the supply. The power supply passes through the switch to the load and, therefore, by keeping the switch open, it can be cut off.</p>
<p>Current Transformer Circuit</p>	 <p>A schematic diagram of a current transformer circuit. On the left, a vertical line represents the 'Power Supply'. A horizontal wire goes from the supply to the right, passing through a rectangular box labeled 'Load'. After the load, the wire turns down to a horizontal wire labeled 'Primary Coil' which is connected to a transformer core. The transformer core is represented by two horizontal lines with a double line between them. Below the primary coil is the 'Secondary Coil', which is connected to a circular symbol labeled 'Ammeter'. Arrows indicate current flow from the power supply through the load and primary coil.</p>	<p>The current transformer steps down the high voltage current and provide safe monitoring of the actual current flowing in the circuit. The primary coil of the transformer is connected to the power circuit in a way that the current can pass through it. The secondary coil is connected to the ammeter.</p>
<p>Single Phase Motor Circuit</p>	 <p>A schematic diagram of a single-phase motor circuit. On the left, a vertical line represents the 'Single Phase Supply'. A horizontal wire goes from the supply to the right, passing through a rectangular box labeled 'Capacitor'. After the capacitor, the wire turns down to a vertical wire labeled 'Starting Winding'. From the bottom of the starting winding, the wire turns left and goes back to the supply. Another horizontal wire goes from the supply to the right, passing through a circular symbol labeled 'Single Phase Motor'. From the bottom of the motor, the wire turns left and goes back to the supply. The motor symbol has an arrow pointing to it and is labeled 'Running Windings'.</p>	<p>A single-phase motor contains two terminals in the outer casing terminal box. One terminal is connected to the active wire and the other terminal is connected to the neutral wire. The motor will run till it continues to get power in the circuit.</p>

## UNIT 1.2: Fundamentals of Electricity

### Unit Objectives

At the end of this unit, you will be able to:

1. Define Ohm's law and Kirchhoff's law
2. Explain electrical polarity, AC/DC and serial and parallel circuit
3. Describe electric energy consumption

Electricity is a natural force that comes into existence whenever there is a flow of electric charge between any two components. The flow of electric charge is called current. Voltage is the potential difference between negative and positive charged components. When working with circuits, basic knowledge of electricity is very important to ensure that all connections are correct. A wrong connection in a circuit may cause high damage to people and the circuit components.

### 1.2.1 Ohm's Law

According to Ohm's law, current flowing through a conductor is directly proportional to the voltage across the conductor. The mathematical equation of Ohm's law is as follows:

$$I=V/R$$

Where,

I is current flowing through the conductor,

V is the potential difference or voltage across the conductor, and

R is proportionality constant, known as the resistance of the conductor.

Resistance of the conductor is independent of current flowing through it as shown in the following figure:

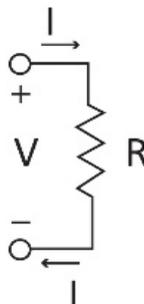


Fig 1.2.1: Simple electric circuit

Kirchhoff's law deals with current flow and voltage in an electrical circuit.

Kirchhoff's current law states that, at any junction in an electrical circuit, the sum of inward currents flowing into the node and the sum of outward currents flowing from that node are equal, as shown in the following figure:

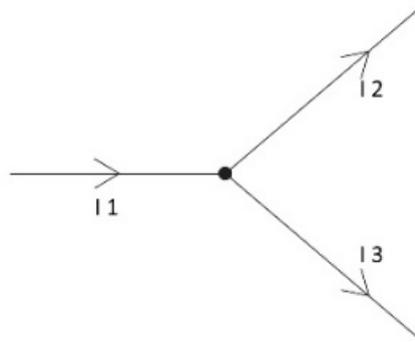


Fig 1.2.2: Inward and outward current

According to Kirchhoff's current law,

$$I_1 = I_2 + I_3$$

Where,

$I_1$  represents inward current and  $I_2$  and  $I_3$  represents outward current flowing through the conductor.

Kirchhoff's voltage law states that, in a closed electrical circuit, the sum of the potential differences across all the elements in the circuit is equal to zero, as shown in the following figure:

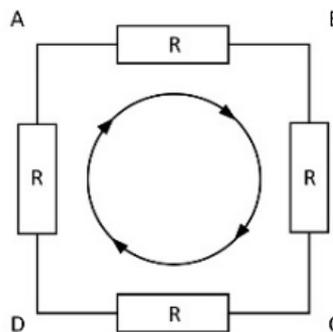


Fig 1.2.3: Kirchhoff's voltage law

According to Kirchhoff's voltage law,  $V_{AB} + V_{BC} + V_{CD} + V_{DA} = 0$

Where,

$V$  is the potential difference or voltage across the elements in the circuit labelled as ABCD.

$V_{AB}$  is the potential difference across node A and B of the circuit,  $V_{BC}$  is the potential difference across node B and C of the circuit and so on.

### 1.2.3 Electrical Polarity

The term electrical polarity is used to describe the direction in which the current flows in a circuit. Consider there is a constant voltage between points of a circuit. One of the points has

more negative charged particles (electrons) than the other. The point or pole with more electrons has negative polarity and the other pole is of positive polarity.

If the two poles are connected by a conductor such as a wire, electrons will flow towards the positive pole from the negative pole and current flows from the positive pole towards the negative pole, as shown in the following figure:

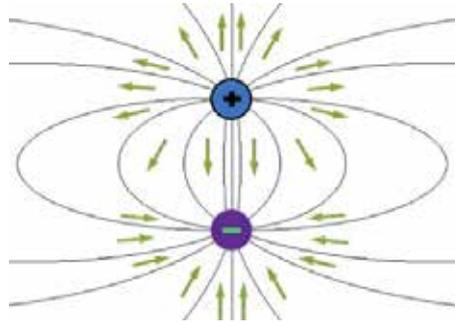


Fig 1.2.4: Electrical polarity

### 1.2.4 AC and DC

AC is an electric current which reverses its direction at a regular interval. DC is the current which flows in one direction. For example, the battery cell in a flashlight is a source of DC power. Power source with AC such as an AC generator, is used to deliver electric power to businesses and residences as shown in the following figures where  $I$ , is the current:

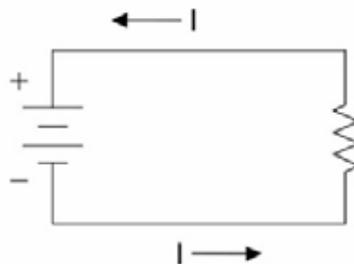


Fig 1.2.5:DC

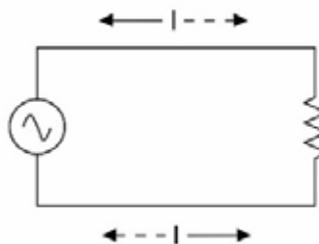


Fig 1.2.6: AC

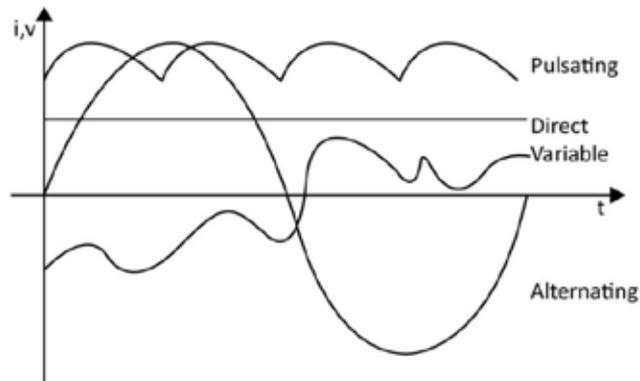


Fig 1.2.7: Signals of AC and D

### 1.2.5 Series and Parallel Circuit

In a series circuit, all the components are connected as a chain and the current flowing through the components is same all over the circuit. There is only one path in the circuit in which the current can flow. So, the current passes through each and every component. Opening or breaking any point of a series circuit causes the whole circuit to stop functioning and the entire circuit needs to be replaced. The following figure represents series circuits with AC:

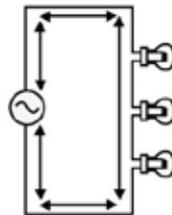


Fig 1.2.8: Series circuit with AC

In a parallel circuit, two or more components are connected in parallel. All the components have the same voltage across them. The current flow varies across the components. If any point of the circuit gets damaged, only that part needs to be replaced.

The following figure represents parallel circuit with AC.

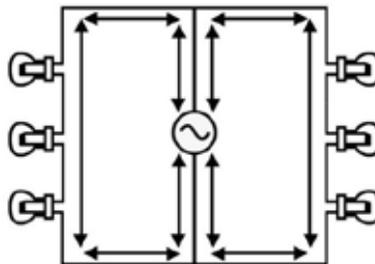


Fig 1.2.9: Parallel circuit with AC

### 1.2.6 Electric Energy Consumption

The actual energy demand made on the available electricity supply is known as electric energy consumption. Electric energy consumption is measured in Watt-hours and is calculated by multiplying the total watt and number of hours

#### Tips



1 Watt-hour = 3600 joule = 859.8 calorie

## UNIT 1.3: Introduction to UPS and Inverter

### Unit Objectives

At the end of this unit, you will be able to:

1. Define UPS and inverter along with their types
2. Explain the functionalities and parts of UPS and inverter
3. Select the UPS and inverter as per given specifications
4. Identify the application of UPS and inverter
5. Explain the basic differences and similarities between UPS and inverter

### 1.3.1 Defining a UPS

An uninterruptible power source/supply (UPS) is also known as a flywheel/battery backup. It is an electrical device which provides back up power to a load if the mains or power source fails or if there are disruptions in the power supply. The following images show a UPS along with its block diagram:



Fig 1.3.1: UPS

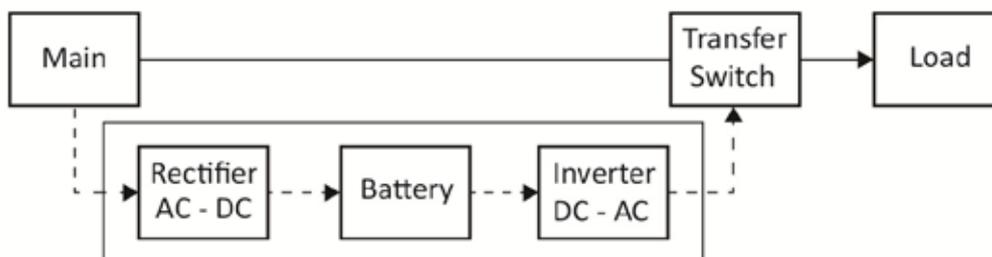


Fig 1.3.2: Block diagram of a UPS

A block diagram is a diagram which depicts main functions or parts of a system or a circuit in the form of a blocks interconnected by lines to show the relation between blocks.

A UPS provides instantaneous protection from power disruptions by supplying energy stored in the batteries. The runtime of continuous battery sources lasts only a few minutes and is enough to start an alternative power source or shut down the equipment properly.

A UPS is also used for protecting hardware such as data centres, computers or any other electrical and telecommunication equipment. Such devices or equipment are susceptible to data/information loss due to sudden power interruption. Moreover, a power interruption or power failure may cause data loss to these device, or in some cases even fatalities or injuries posing threat to human, environment and public safety. For example, a patient's life can be at stake in an operation theatre if medical equipment or devices do not work properly because of power disruptions. UPS units have been designed to cater to a single computer or a large unit used for providing power to data centres.

### Functionalities of a UPS

A UPS is an electrical device positioned between an input power supply and the load (electronic device). It consists of a battery that provides power in case of a power failure. The timespan that a load is supported with power backup depends on:

- The battery size of the UPS
- The number of loads connected to the UPS

In case of a power outage or interruption, the battery ensures an unbroken and seamless power supply, enabling the loads to be operational even during the outage. For example, it allows the information systems to prevent data loss by providing enough power supply for a shut down. The following figures represent a UPS under normal utility power and a standby UPS, when utility power fails:

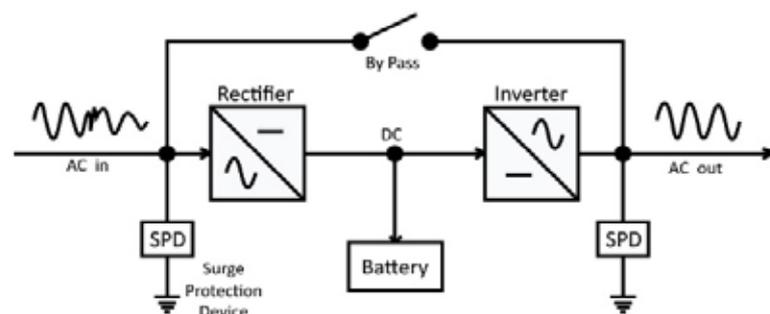


Fig 1.3.3: A UPS under normal utility power

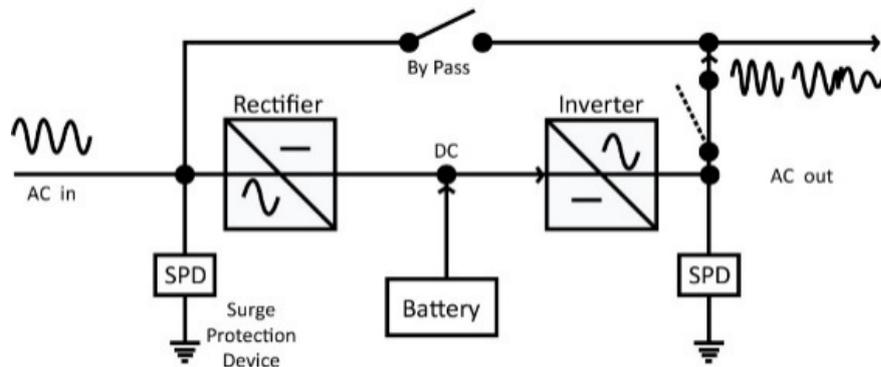


Fig 1.3.4: A standby UPS during utility power failure

Some of the functions of a modern UPS controlled by small computers embedded in it are:

- AC power failures detection
- Regulating status indicators
- Switching between the power sources and administering the battery status

#### Parts of a UPS

There are three main parts of a UPS as listed in the following figure:

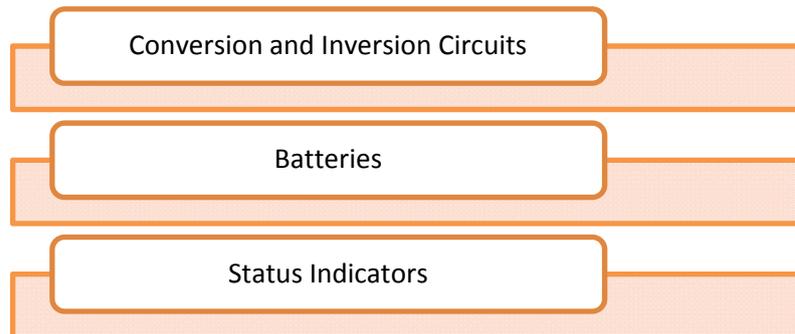


Fig 1.3.5: Parts of a UPS

#### Conversion and Inversion Circuits

Each UPS consists of a core circuitry which converts electricity, to be stored in batteries, from AC power to DC power. This circuitry has rectifier circuit, inverter circuit and a battery bank along with a filter.

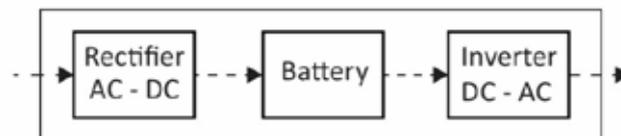
Normally battery will be charging, when power fails, DC power from battery is inverted to AC and supplied to the load with the help of this circuit.

The rectifier circuit converts the AC supply from mains to DC to be stored in a battery. From the AC supply coming in, the UPS charges its battery in the form of DC supply. This AC to DC conversion is done by two main components of the rectifier circuit, the diode and the capacitor. The diode converts AC to DC and the capacitor filters the AC harmonics. AC harmonics is voltage or current in an electrical system because of unsteady load. The inverter circuit converts the stored energy which is in the form of DC supply from a battery to AC supply

again to be fed to equipment or load connected to the UPS.

The quality, nature, size and type of this circuitry depends on the model and design of the UPS being used which will be covered in subsequent topics.

The following figure shows the conversion and inversion circuit of a UPS:



*Fig 1.3.6: Conversion and inversion circuit of a UPS*

### Batteries

Besides the core circuitry of a UPS, battery is another important component as it stores the energy which is used by the UPS for running loads. The size of a UPS unit is dictated by the number of batteries. The batteries are classified as per their capacity in Amp-hours (Ah) and nominal voltage (Volts). The following image shows a battery:



*Fig 1.3.7: A battery*

The running time for a UPS depends upon the following:

- Type of battery
- Size of battery
- Rate of discharge of the battery
- Efficiency of the battery

It is important for a field technician to understand battery characteristics and be able to test load. At times, battery interaction needs to be checked. When battery strings are wired in series- parallel they can develop unusual failure mode due to a defective battery in the multiple parallel strings. The defective battery adversely affects the performance of other good or new batteries in the string.

The following image shows a series-parallel battery interaction:

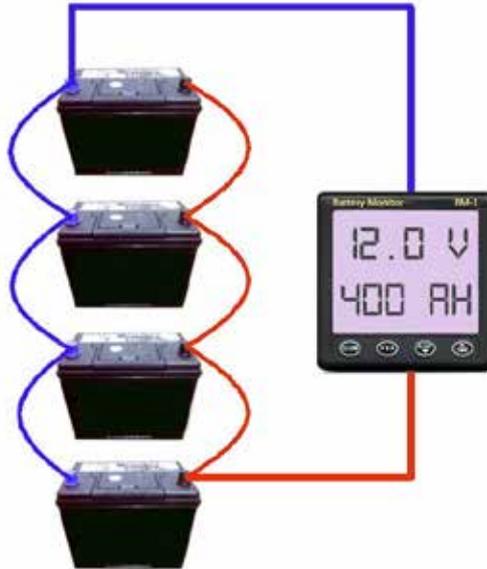


Fig 1.3.8: Series-parallel battery interactions

The Ah capacity of a UPS is not mentioned in manuals or brochures usually. Read the specification sheet to know about the run time of a UPS. Some of them will have battery packs that can be expanded, which enables the load to be added to the system. A better quality of a UPS detects eventual failure of a battery, examining voltage of the batteries when on charge whereas other UPS spots it in self-test. The capacity of a UPS decreases and the battery life degrades eventually. The life of a battery depends on its charge and discharge cycle and the temperature of the working environment. The battery life dramatically reduces if it is kept in a fully-discharged state.

### Tips

1Ah represents the energy that is sufficient to provide 1A current for 1 hour at the voltage specified for it.

### Status Indicators

There are a variety of indicators in a UPS that notifies the current status of the UPS. These indicators are generally classified into two categories:

- Visual indicators: Liquid Crystal Display (LCD) or LED displays indicate the problem condition of a UPS as well as the general status. Some of the visual status indicators are as follows:
  - Online: This LED turns on when UPS is running normal operations.
  - On Battery: This LED turns on when UPS is running on battery. In this case, the Online LED will be off.
  - Overload: This LED turns on in case of heavy load which is beyond the capacity of the UPS.
  - Replace Battery: This LED turns on if the battery needs a replacement. A periodic battery test is performed to ensure it is charging properly. If the battery test fails, this LED turns on.
  - Site Wiring Fault: This LED turns on when there is a problem in wiring which is feeding power to the UPS. It is usually in the back panel of the UPS.
- Audible indicators or alarms: These are used to draw the user's attention to any fault. The alarm makes beep sound to notify a fault. Few UPS, have audio mute button to mute the beep sound else they continue till the problem is rectified. The number of indicators vary with models. It is important to check the details/specifications in the handbook or manual provided by the manufacturer of the UPS.

The following image shows the status indicators of a UPS:



Fig 1.3.9: Status indicators

### Types of UPS

An effective UPS has most of the following features:

- Controlled output voltage with low harmonic distortion unaffected by power disruptions or outage.
- Provides steady current with reduced harmonic distortion
- A low degree of electromagnetic interference and acoustic noise
- Has low transition time to switch between normal and backup operations
- Provides high level of reliability and efficiency
- Has low cost, weight, and size requirements

Most of the individual power supply system's cannot provide all of the preceding features at the same time, it is usually possible to find a UPS with the characteristics suited to an application's needs. Some classifications of the UPS systems is done based on the following criteria:

Design

Form factor

*Fig 1.3.10: Classification of UPS*

### On Basis of Design

There are numerous design approaches for UPS systems which implement different performance characteristics. Some common design approaches are as listed in the following figure:

#### Single Conversion System

- Standby
- Line interactive
- Standby-Ferro

#### Double conversion System

- Double conversion on-line
- Delta conversion on-line

#### Multi-mode System

- Standby On-Line Hybrid.

*Fig 1.3.11: Design approaches of UPS*

### Single Conversion System

In single conversion system, the UPS provides the incoming AC supply to the load or equipment. If the AC supply reduces, it draws current from the battery using its inverter circuit. Simultaneously, it removes the input AC supply to ensure no backfeed of supply happens from the inverter circuit. It consumes the battery power till the AC supply returns to normal or battery runs out. Standby UPS and line interactive UPS are two of the commonly used UPS based on single-conversion system design.

The UPS based on single conversion system design are:

- A standby UPS is used for providing back up power to personal computers. The following figure shows a block diagram of a standby UPS:

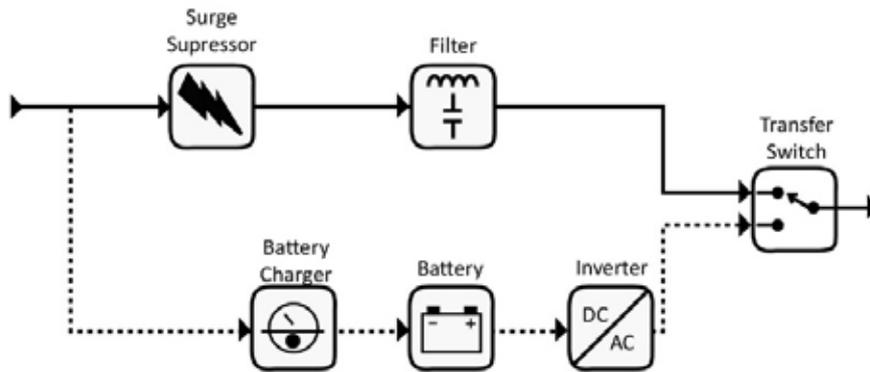


Fig 1.3.12: Standby UPS

In the block diagram, there is a transfer switch which selects the filtered AC input that will act as the primary power source (represented by solid line) and switches the load over to the backup source (represented by dashed line) at the time of failure of the primary source. The benefits of selecting this design is its small size at a low cost with high efficiency. This UPS in combination with surge circuitry and proper filter, can provide surge suppression and noise filtration. The practical power range is 0-0.5kVA.

- A line interactive UPS is used for small business and Web servers use the line interactive UPS. The following figure shows the working of a line interactive UPS:

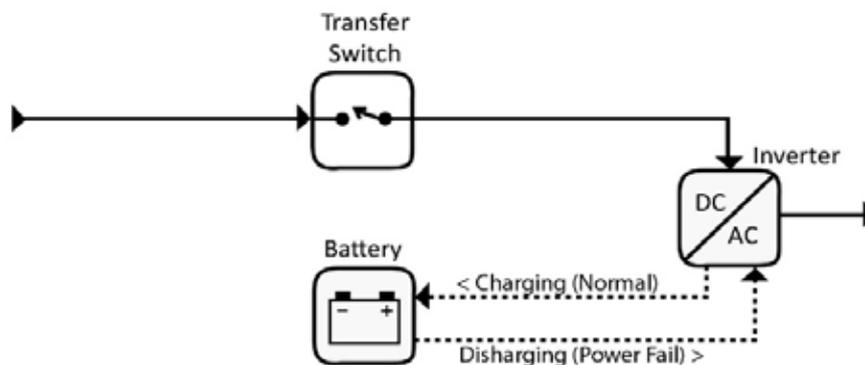


Fig 1.3.13: Line interactive UPS

In this UPS, an inverter always stays connected to the UPS output. The battery is charged when the inverter is operated in reverse and the input AC is normal. When there is a power failure, the transfer switch transfers the power from the battery to the UPS output.

This type of UPS also has the feature of voltage regulation, during low voltage, by adjustment of the transformer taps.

The ability to control voltage conditions along with its low cost, small size and high efficiency makes it a dominant type of UPS, within 0.5 – 5kVA power range.

### Tips

The design of Line Interactive UPS enables additional filtering compared to a standby UPS since the inverter is always connected to the output.

- A standby-ferro UPS contains a special type of transformer that has three power connections. The AC input passes through the transfer switch and the transformer before it goes to the output. When there is a power failure, the output load is picked up by the inverter. The inverter circuit is energized during a power failure but otherwise it remains in a standby mode. The transformer has a ferro-resonant capability that helps in limited voltage regulation and shaping of the output waveform. The practical power range is 3-15kVA.

The following figure shows the working of a Standby-Ferro UPS:

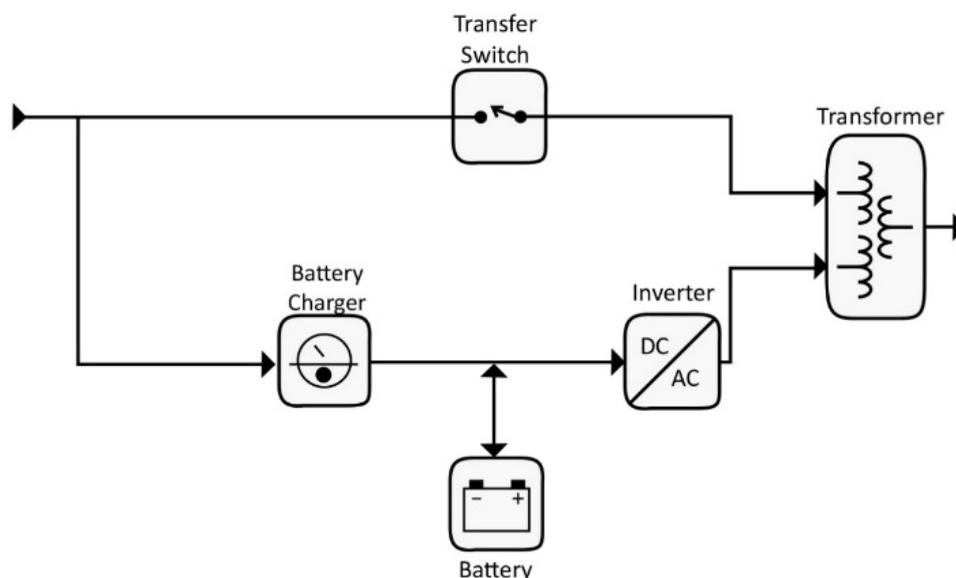


Fig 1.3.14: Standby-Ferro UPS

This design provides line filtering and high reliability. But it is inefficient when it is used in combination with power factor corrected systems and generators.

### Double Conversion System

In double conversion system, the supply/power is converted twice. An input rectifier converts AC supply into DC and feeds it to the output inverter circuit. This inverter circuit converts the supply back to AC before sending it to the device or equipment. If the AC supply reduces, the input rectifier shuts off and the output inverter takes power from the battery.

The UPS consumes the battery power till the AC supply returns to normal or battery runs out. In case of a severe overload of the inverter, or a failure of the rectifier or inverter, the static switch bypass path is turned on quickly, to support the output loads. This kind of system ensures isolation of critical loads from the AC power source completely, ensuring that the load/ equipment receives seamless supply.

Double conversion on-line UPS and delta conversion on-line UPS are two of the commonly used UPS based on double conversion system design. The UPS based on double conversion system design are:

- Double conversion on-line UPS: The backup battery that gets charged by the AC supply provides power to the inverter circuit. In this type of UPS, the main power path is inverter instead of AC mains so power failure does not activate the transfer switch leading to no transfer time. Few situations in which it does exhibit a transfer time is when the main power path fails which means, battery or inverter fails. The inverter power can also reduce causing a transfer, if the inverter is exposed to sudden load changes. A standby and line interactive UPS will exhibit a transfer time when a blackout occurs whereas a double conversion on-line

UPS will exhibit a transfer time when there is a large load change or current change. Although this design provides almost ideal output performance, it gives reduced efficiency and generates heat, as both the inverter and the battery charger engage in load power flow conversion. The practical power range is 5-5000kVA. The following figure shows double conversion on-line UPS:

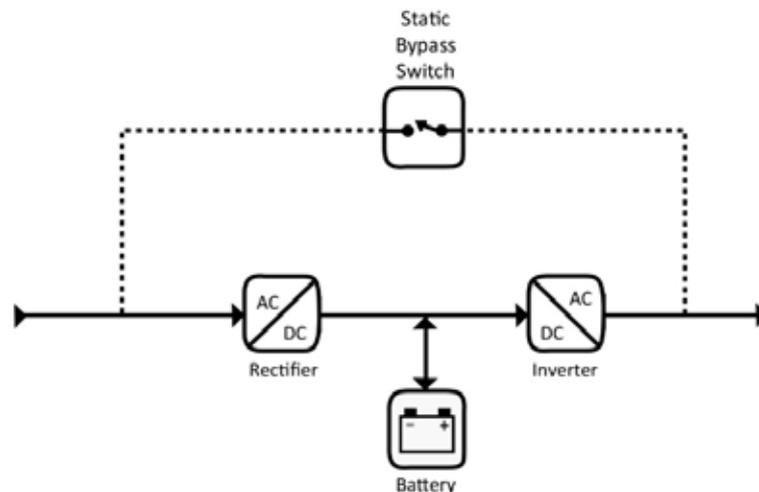


Fig 1.3.15: Double conversion on-line UPS

- Delta conversion on-line UPS: It is available in various sizes that range from 5kVA to 1.6 MW. The delta converter supplies power to the output of the inverter. This type of UPS provides similar output characteristics as the double conversion on-Line design but the input characteristics are different. This design provides both input and output power control using its full power factor correction technique. It controls the input current so that the battery gets charged. This type of UPS significantly reduces energy losses and provides compatibility with different types of generators. The following figure shows a delta conversion on-line UPS:

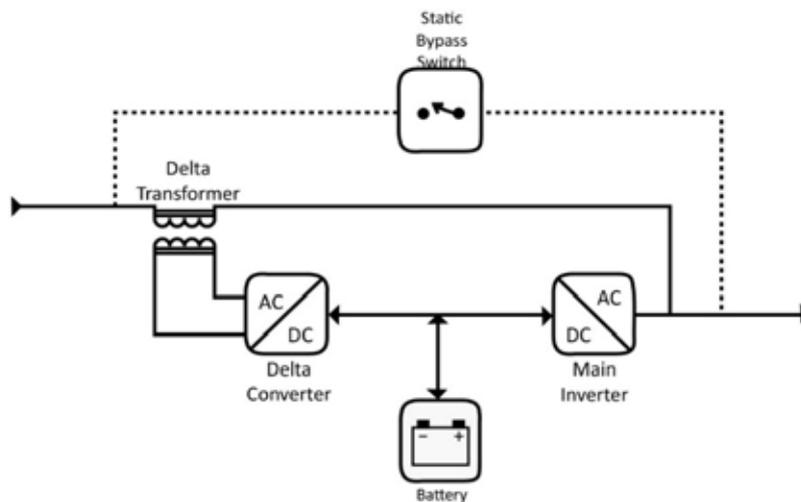


Fig 1.3.16: A Delta conversion on-line UPS

### Multi-mode System

In multi-mode system, there is an optimum blend of efficiency and reliability by combining features of both single- and double-conversion systems. This system works in line interactive mode under normal conditions (steady AC supply) thus saving energy and money.

If AC supply reduces, the system automatically switches from line interactive to double-conversion mode as this mode completely isolates load/equipment from the incoming AC supply. If AC input supply further goes out of the tolerance limits specified for a double-conversion rectifier, the UPS uses the battery power to run the loads. As soon as the generator is up, the UPS switches to double-conversion mode till input supply gets stable.

Finally, transitioning back to the highly efficient line-interactive mode as under normal conditions, they provide maximum efficiency. Standby on-line hybrid UPS is one of the most commonly used multi-mode system. If an AC supply failure or disruption occurs in the hybrid model, the standby DC to DC converter from the battery is switched as done in standby UPS. As the DC combiner has capacitors, the UPS takes control without any time lag during an AC power failure. It has an additional transfer switch to bypass an overload or a malfunction.

The following figure shows a standby on-line hybrid UPS:

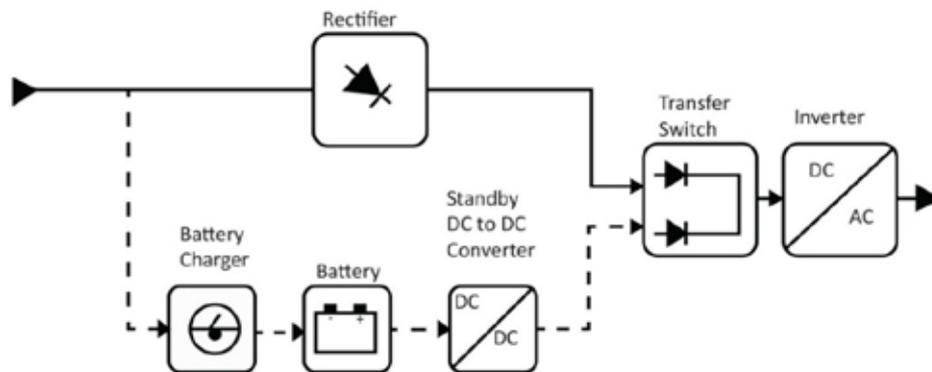


Fig 1.3.17: A Standby on-line hybrid UPS

### Tips

The design of delta conversion on-line UPS shows similar behaviour with double conversion on-line UPS when there is AC failure.

### On the Basis of the Form Factor

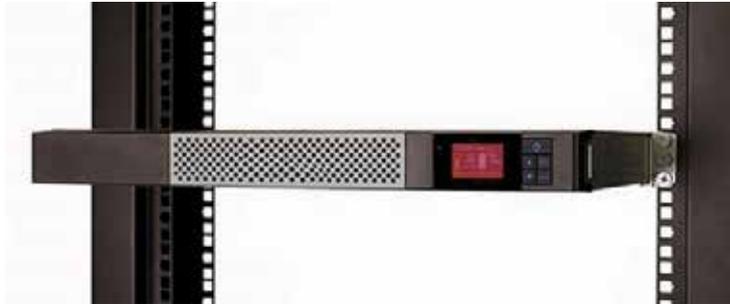
The commonly used UPS based on their size and form are:

- **Tower model:** These models are like cabinets usually in shape of tower which can be easily placed on the ground, desk or a shelf. These are typically used with desktop computers or with computer workstations in a network. The following figure shows a tower model:



Fig 1.3.18: Tower model UPS

- Rackmount model: These models are mounted in standard nineteen inch (19") rack enclosures and need 1U to 12U rack space. These are typically used in servers and networking applications. The following figure shows a rackmount model:



*Fig 1.3.19: Rackmount model UPS*

### Consideration for selecting a UPS

Based upon the requirement, following factors should be taken into consideration while choosing a UPS:

#### Type of UPS

- Requirement of energy efficiency and protection requirement:
  - Single conversion
  - Double conversion
  - Multi-mode

#### Utility

- Purpose, home or commercial and industrial:
  - Single Phase
  - Three Phase

#### Rating

- Amount of load in volt-amperes:
  - High load
  - Low load

#### Form

- Power requirement:
  - Rack mounting
  - Tower model

#### Availability

- Zone, technology and service used

#### Scalability

- Investment of time and money:
  - Parallel UPS architecture
  - Modular UPS products

#### Software

- Communication between UPS and server helps monitor Internet access

#### Service

- With proper care and maintenance UPS works really efficiently. Hence an apt service plan for UPS is also very important

Fig 1.3.20: Considerations for selecting the right UPS

Some more considerations for seamless working of UPS are:

- **N+1:** When a single huge inverter fails, it disrupts many other systems making a large business environment highly unreliable and susceptible to system failure or data loss. It is recommended to use multiple smaller UPS modules and batteries having equal power as one large UPS. N+1 means that if the capacity can be met by N modules, the installation will have N+1 modules to cover for the failure of the module.
- **Multiple Redundancy/2N Redundancy:** Each power supply is connected to a different circuit. This can be further enhanced by connecting each power supply to its own UPS, thus providing double protection both in case of power and UPS failure. This is done to ensure uninterrupted power supply in case of one power supply failing.
- **Outdoor use:** A UPS which is placed outside should be such that it is able to bear the weather conditions of high or low temperature, humidity, rain and snow. The operating temperature for the UPS installed outside should be between  $-40^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$ . It can be mounted on a pole, pedestal or host mounted.

### 1.3.2 Defining an Inverter

It is an electronic device that converts DC into AC. The characteristics such as input and output voltage, frequency and power handling capacity depend on the design of the circuitry or device.

#### Tips

- The inverter itself cannot produce power, it only stores the power provided by the DC supply.
- A power inverter can either be a totally electronic device or an electronic circuitry with rotary apparatus that provides mechanical effects.

The following figure represents a block diagram of an inverter, consisting of battery, oscillator, metal–oxide–semiconductor field-effect transistor (MOSFET) driver circuit, power switch and a step-up transformer:

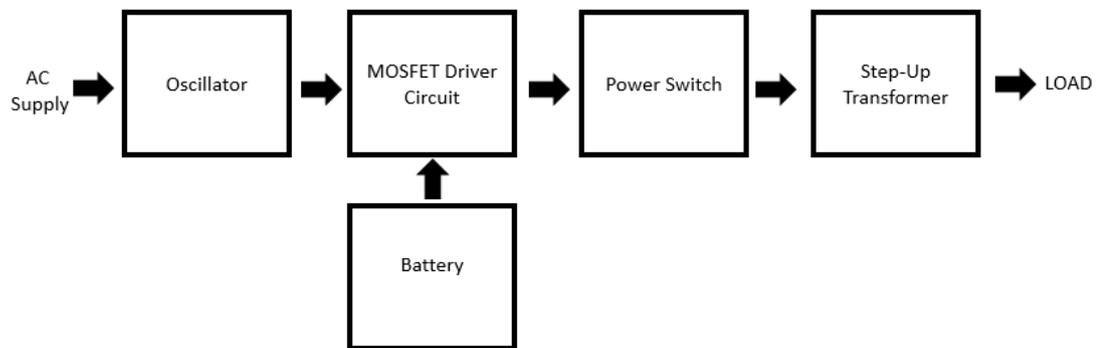


Fig 1.3.21: Blockdiagram of an inverter

#### Functionalities and Part of an Inverter

The primary purpose of an inverter, commonly called power inverter, is to provide a backup in case of a power failure. To provide this backup the inverter requires a battery to store power or energy.

The functionality of inverter is broadly classified as follows:

- Functionality of the inverter if AC supply is there: If AC supply is there, then the AC supply flows through relay and battery charging circuit. The relay directly passes the supply to the load. In the battery charging circuit, the AC supply converts to DC to charge the battery. Once the battery is fully charged, the AC supply to battery stops. At times, inverters have special circuitry called a trickle charging circuitry to ensure a constant full charge in the battery.
- Functionality of the inverter in absence of AC supply: In case the AC supply is not available, the oscillator circuit in the inverter produces 50 Hertz MOS drive signal to be fed to MOS driver circuit. These signals are amplified by the driver circuit to be fed into the load. MOSFETs (transistors) are connected to the primary coil or winding of the transformer and are used for switching purpose. As soon as MOSFETs receive signals from MOS driver circuit, they start switching (ON-OFF) at 50 Hertz producing 50 Hertz current to primary coil of the transformer. Based upon the winding ratio of transformer, this current produces 220 V to 1100 V AC supply at the secondary of the transformer. This AC supply is then fed to the load.

## Main Components Used in the Inverter

### Oscillator

Oscillator or a pulse generator is an electronic circuit used to generate rectangular pulses or signals at regular intervals. The oscillator helps to generate DC signals to control the switching operation in inverter.

### Microcontroller

It is a vital part of an inverter circuit. Microcontroller is used to control the signal switching as per requirements. It can perform various functions such as controlling the protection mechanism which enables the inverter to trip in case of a short circuit or overload. It also controls the pulse with modulation coming from the oscillator. It also controls the indicator circuit of the inverter which enables status to be displayed on the front panel of inverter.

### MOSFET

MOSFETs have three terminals – source (S), drain (D) and gate (G).

N-channel and p-channel are the two types of MOSFETs. In an n-channel MOSFET, the arrow in the middle of the symbol is pointing in whereas in a p-channel MOSFET, the arrow is pointing out. It is used for switching of signals because of its high switching speed. At times, the DC supply from a battery converts into an AC supply by an oscillator but the current output is very low so a power switching device MOSFET is required which boosts the signals or the voltage.

The following figures show the symbols of MOSFETs:

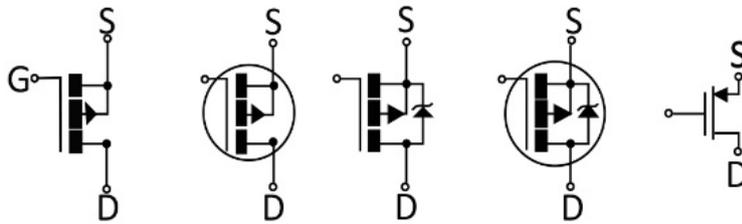


Fig 1.3.22: Symbols of P channel MOSFET

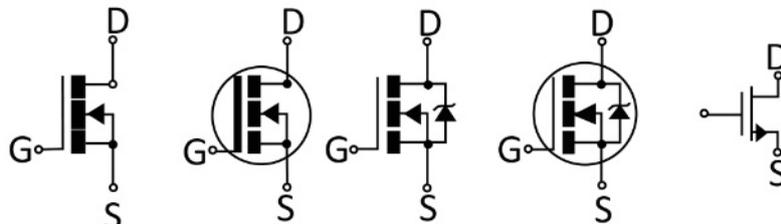


Fig 1.3.23: Symbols of N channel MOSFET

## Filters

In combination to MOSFETs, the filter circuit in inverter helps to filter the variation in frequency to a required frequency before feeding in the power to the transformer. Filters are applied to the primary or the secondary coil of the transformer or to both sides. For example, low-pass filters are applied to allow the basic component of the waveform/signal or power to pass to the load while reducing the AC harmonics. Resonant filters are used to provide power to the load at a fixed frequency.

The following image shows a filter circuit which is filtering the input pulsating DC to a required range of frequency:

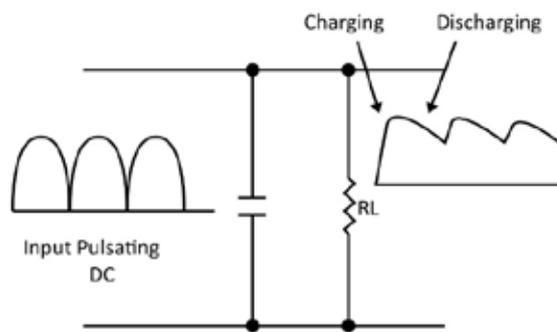


Fig 1.3.24: Capacitor filter circuit

## Status Indicators, Switches and Buttons

There are different types of switches and buttons on the inverter for performing a variety of tasks along with a status indicator panel. They are listed in the inverter manual that is part of the delivered package to the customer. Similar to UPS, inverter also has visual indicators and audio indicators. The following image shows an inverter with buttons on the indicator panel:



Fig 1.3.25: An inverter showing buttons on the indicator panel

Some buttons on various models of inverters are:

Power ON/OFF Button	Trip Reset Button	Display Button
<ul style="list-style-type: none"> <li>• Used to switch the inverter on or off.</li> <li>• The power button must be turned OFF to avoid electric shocks while cleaning or changing the batteries of the inverter or performing its maintenance.</li> </ul>	<ul style="list-style-type: none"> <li>• Is either on the front or at the back of a model.</li> <li>• The function of this button is to reset the trip state of an inverter that occurs to protect the circuit and the devices connected to it in case of an overload, short circuit or any other cause.</li> </ul>	<ul style="list-style-type: none"> <li>• Used to turn the LCD/LED display ON or OFF according to convenience.</li> <li>• The button if designed that way, can also be used to display the input and output voltage, battery charge status, load and so on.</li> </ul>

Fig 1.3.26: Different types of buttons

Trip state of an inverter helps in protecting the equipment or load connected to inverter in case of a short circuit or an overload. Ideally, an inverter should trip automatically to prevent the excess of power/current to reach the equipment. It trips when the load exceeds the capacity of inverter and the Trip Reset button is used to resume the normal mode of inverter after the load has been managed.

Some switches present on various models of power inverters are:

#### Voltage Range Switch

This switch is used for adjusting the range of input voltage for which the inverter will operate on line mode and then again switch to its back up mode.

#### Charging Rate Switch

A charging rate switch allows to adjust charging rate of the charger for the batteries connected to the inverter. The charge of current can also be adjusted. Large batteries need high charging current for getting charged faster whereas charging small batteries with a higher current can wear them off early.

#### Batteries Voltage Switch

Some inverters are used by connecting single battery or even multiple batteries. These inverters, using their batteries voltage switch can make the adjustments in battery voltage on their own or may notify the user to do the needful manually.

#### Input/Output Voltage Switch

For the power inverter to function properly, one must select the input/output voltage as per the region with the help of the input/output switch. If wrong voltage is selected, the electronic appliances connected to it may get damaged.

Fig 1.3.27: Different types of switches

### Classification of Inverters

Inverters are broadly classified on the basis of input and output requirement.

#### Classification on the basis of input

A stable DC source that is able to supply enough current required to meet the power demand of the device, is required for a typical inverter circuit or device. The input voltage is built depending upon the purpose and design of the inverter. A few examples of inverters based on the input are listed in the following figure:

<b>12 VDC</b>	<ul style="list-style-type: none"> <li>• Are commercial or smaller consumer inverters.</li> <li>• A 12V lead acid battery (rechargeable) or an automotive electrical outlet is used to run the inverter.</li> </ul>
<b>24, 36 and 48 VDC</b>	<ul style="list-style-type: none"> <li>• Are generally used for the energy systems at home.</li> </ul>
<b>200 – 400 VDC</b>	<ul style="list-style-type: none"> <li>• Have Input power as photovoltaic solar panel</li> </ul>
<b>300 – 450 VDC</b>	<ul style="list-style-type: none"> <li>• Are used in vehicle to grid systems.</li> <li>• The input power is from electric vehicle battery.</li> </ul>
<b>More than 1000 volts</b>	<ul style="list-style-type: none"> <li>• Have large number of volts.</li> <li>• Are used in power transmission systems with high voltage and direct current.</li> </ul>

Fig 1.3.28: Type of inverter on basis of input

#### Tips

VDC is an abbreviation for volts DC.

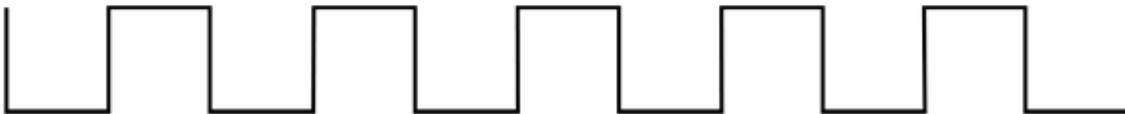
### Classification On the Basis of Output

Most of the electrical equipment such as TV, chargers work on AC supply where the current is in the form of a sine wave pattern. This sine wave pattern represents a gradual transition of current from one direction to other as shown in the following figure:



*Fig 1.3.29: Sine wave pattern*

On the other hand, inverters convert DC into AC voltage which is in the form of a square wave pattern which are used in loads or equipment like heaters and lamps. This square wave pattern represents current flowing in one way or the opposite way or continuously transitioning in ON-OFF state as shown in the following figure:



*Fig 1.3.30: Square wave pattern*

Electrical equipment like TV and chargers produce humming sound (AC harmonics) which makes it less efficient and there is loss of power if they are used with inverters producing square wave output. These equipment require inverters which can produce sine wave output or output which is very similar to sine wave. So, inverters are designed to produce waveform which is close to a sine wave (voltage).

Hence, inverters are differentiated based on the types of output given from the inverter:

- Square Wave Inverter
- Sine Wave Inverter

#### **Square Wave Inverter**

This type of inverter converts the DC signal to a phase shifting AC. The output is in the form of a square wave and not a pure sine wave. A square wave inverter is cheaper. They can be

constructed by placing an on-off switch before a voltage amplifying circuitry, similar to the one in a transformer. The following figure shows the circuit of a square wave inverter:

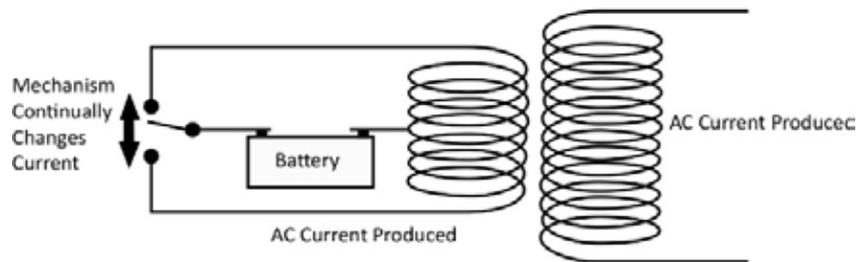


Fig 1.3.31: Square wave circuit

### Sine Wave Inverter

The inverters that produces sine wave as output are of two types. The following table describes the sine wave inverters:

Type	Description	Output Wave
Modified or Quasi Sine Wave Inverter	The output signal shows pause before the phase shifts of the wave. It is not like a square sine wave where there is an abrupt phase shift from positive to negative. It is different from a sine wave signal where the transition of current is smooth.	
Pure Sine Wave Inverter	It contains a complex electrical circuit. The output of square wave inverter can also be modified to obtain a pure sine wave. There are a number of advantages of having a pure sine wave inverter: <ul style="list-style-type: none"> <li>• It consumes a lesser amount of power and is more efficient at the same time.</li> <li>• According to the power requirement, power output can be adjusted.</li> <li>• This works best for sensitive equipment.</li> </ul>	

Some common types of inverters are Z-source inverters, power inverters, solar inverters, Grid-tie inverters and resonant inverters. The following figure lists the description of these inverters:

#### Z-source Inverter

- It is a type of power inverter with a special circuitry which does not require DC-DC converter bridge and converts DC to AC. It functions as a buck-boost inverter where the output voltage is of the opposite polarity to the input voltage.
- It is used in renewable energy sources, vehicles and motor drives.

#### Solar Inverter

- It converts the variable DC signal from a photovoltaic (PV) solar panel into AC to be fed into a commercial electrical power grid or to a local off-grid electrical network.

#### Grid-tie Inverter

- It is a type of a solar inverter which converts DC into AC, generally 120 V to 240 V at 50 Hertz, to be fed into an electrical power grid.
- It is used between the local power generators, solar panels, wind turbines and the grid.

#### Resonant Inverter

- It produces almost an exact sine wave output at a high output frequency (20 kHz to 100 kHz).
- It is used for fixed output applications such as sonar transmitters, fluorescent lighting, or ultrasonic generators.

Fig 1.3.32: Commonly used inverters

Based on their structure, inverters are classified as:

- **Single Phase Inverter:** It consists of two legs or two poles where a pole is a connection of two insulated-gate bipolar transistors (IGBTs). In this type of connection, the source of one IGBT and drain of other IGBT are connected and the common point (supply) is taken to the load, as shown in the following figure:

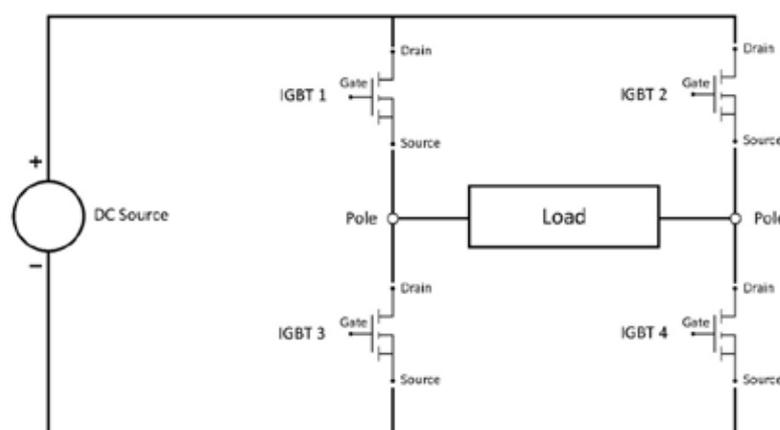


Fig 1.3.33: Single Phase Inverter

- Three-phase Inverter: It consists of three single-phase inverter switches each connected to one of the three load terminals, as shown in the following figure:

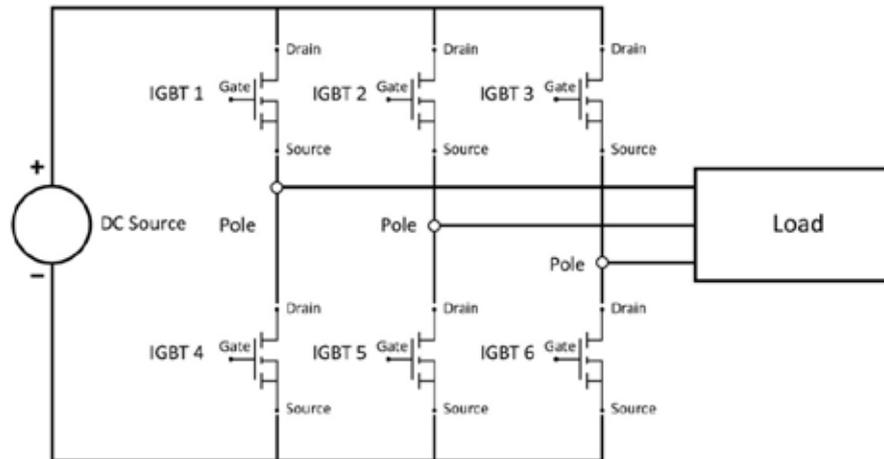


Fig 1.3.34: Three-phase Inverter

### Considerations for Selecting an Inverter

As a field technician, it is important to know the considerations for selecting an inverter. This will enable the field technician to help the customer and resolve technical as well as user related queries around the inverter. The following points list out the factors to be considered for correct selecting an inverter:

Application Environment

Electrical Standards

Safety Certification

Power Capacity and Quality

Efficiency

Internal Protection

Inductive Loads and Surge Capacity

Low Switching Frequency vs. High Switching Frequency

Fig 1.3.35: Considerations for selecting an inverter

### Application of Inverters

An inverter is used in the following areas:

#### DC power source

- Converts DC electricity from source (battery/cell) to AC electricity.

#### Uninterruptible power supply

- Uses batteries and inverter to supply AC power when main power is not available. The rectifier supplies DC power to recharge batteries when power is restored.

#### Electric Motor Speed Control

- Produces variable output voltage range.

#### High Voltage Direct Current (HVDC) power transmission

- Converts power back to AC, AC power is rectified and high voltage is transmitted to another location.

#### Electricshock weapons

- Generates several thousands of VAC out of small 9 V DC battery.

Fig 1.3.36: Applications of inverter

### 1.3.3 Basic Differences and Similarities between UPS and Inverter

The electricity can be at any desired voltage. It's usually set to home voltage for normal home appliances application. UPS uses battery and an inverter to supply AC power when the main power is not available. When main power is restored a rectifier supplies DC supply to recharge the batteries. Nowadays, with the advent of new technologies and new inverter types, the demarcating line between inverters and UPS is gradually diminishing. Inverters are doing all the work that a UPS does.

The following table represents the differences between a UPS and an inverter:

Parameters	UPS	Inverter
<b>Back up</b>	Power supply back up is rapid and is not a reason for loss of data or system crash.	Power supply back up is not rapid. Data loss or system breakdown may happen due to interruption.
<b>Technical Variation</b>	UPS converts AC supply to DC to charge the battery for providing continuous supply to the load in case of power outage.	Inverter converts the AC supply to DC to charge the battery as well as provide the AC supply to the load simultaneously. In case of outage, the transfer switch circuit works to provide the supply to the load.
<b>Time Lag</b>	Time lag for the backup after power outage ranges from 3 to 8 milliseconds.	Time lag for the backup after power outage is about 500 milliseconds.
<b>Connection</b>	Different appliances can be connected to a UPS directly.	To provide electricity to various appliances, an inverter connects itself to the main line of power supply.
<b>Price</b>	Due to circuit and machinery, a UPS is expensive.	Inverters are relatively cheaper compared to a UPS.
<b>Circuit</b>	Generally includes an inverter, charger/rectifier and a controller.	Includes a controller circuit and inverter circuit.
<b>Voltage</b>	Automatic Voltage Regulation (AVR) is almost 220 volts.	Input and output voltage are same and they are equal to 230 volts.
<b>Size</b>	Size may be equal to 2 kVA (size of UPS varies in Volt Amps based on the load connected to the UPS)	Size may be equal to 16 kVA (size of inverter varies in Volt Amps based on the load connected to the inverter)
<b>Usage</b>	Due to system of double conversion, a UPS is used for offices houses, commercial and industrial purpose.	Inverter is not ideal for a commercial or industrial use since it cannot bear a huge load. However, it can be used for small offices and houses.

Fig 1.3.37: Difference between UPS and inverter

These new generation inverters can be used as a substitute for UPS due to the reasons as shown in the following figure:



A UPS requires 240-270V to function and an inverter can function at 170-270V.



The change over time of a UPS is 10 to 15 milliseconds and that of an inverter is 500 microseconds.



Both UPS and inverter take negligible time to give the back-up but performance of inverters is better in case of sensitive power operating appliances.



Inverters are less expensive than UPS.



The new pure sine wave inverters have less fluctuations.  
The lag in output voltage has also decreased.

*Fig 1.3.38: Reasons for using inverters as a substitute for a UPS*

### Tips

Change over time is the duration that a battery back-up system takes to resume the power supply when there is electricity failure or interruption.

### 1.3.4 Communication Interface of UPS/Inverter

With variety of electrical equipment, electronic systems and computer systems integrated together for various applications, such as security system for houses or data centres for large business applications, power management becomes a crucial aspect to be taken care of. Be it energy consumption, or energy saving or uninterrupted energy supply to the load, UPS/Inverters are used to provide the uninterrupted power supply. For any integrated system or application to work efficiently, a communication interface is required which enables timely notification to the devices or equipment connected together. In case of UPS/Inverter, a communication interface is required wherein a UPS/Inverter connected to any device will notify its status to the controlling device such as a computer through various communication links such as Ethernet and SNMP, USB, Serial port or GPRS/GSM.

For example, a single UPS/Inverter may connect to a single computer to provide status notification about the UPS/Inverter to computer for controlling it. Notification of UPS/Inverter status and control data requires that all devices such as Ethernet switches are powered by one or more UPS/Inverter so that the UPS/Inverter alerts reach all the devices during a power outage. The UPS/Inverter can be connected directly to main control server by using GSM/GPRS channel to prevent the dependency on Ethernet infrastructure. For example, in data centres or computer related applications, the SMS or GPRS data packets sent from UPS/Inverter triggers software to shut down the computers to reduce the load.

#### Tips

- Some common abbreviations are
  - **SNMP:** Simple Network Management Protocol
  - **USB:** Universal Serial Bus
  - **GPRS/GSM:** General Packet Radio Service/Global System for Mobile Communication
- A single computer may be connected to a single UPS to let the computer control the UPS and get its status information. A USB is also used to connect multiple peripheral devices to a computer.

### 1.3.5 Wiring Procedure of UPS/Inverter

Appliances such as servers, surveillance cameras and desktops are connected to an inverter or UPS to ensure their working despite a power outage. Any device can easily be wired with an inverter or UPS provided the combined load does not exceed the capacity limit of inverter or the UPS. That is why it is essential to follow a correct wiring procedure so that the power back up system is not overloaded.

**Method 1**

The inverter or UPS can be directly connected to the common neutral of a building, without connecting its output neutral with the loads, as shown in the following figure:

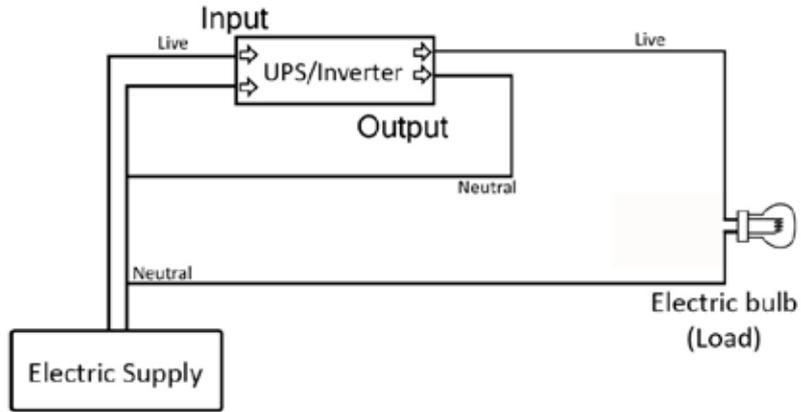


Fig 1.3.39: UPS/Inverter directly connected to the common neutral

There may be a need to detach the UPS from a circuit. To be able to connect the wires back, it is advisable to label the plugs such that they indicate live and neutral wires. For such wiring, ensure the alignment of the UPS input and output, otherwise the UPS will not function due to an incomplete circuit. The following figure shows a correct connection of wire from UPS/Inverter to live and an incorrect connection from UPS/Inverter to live:

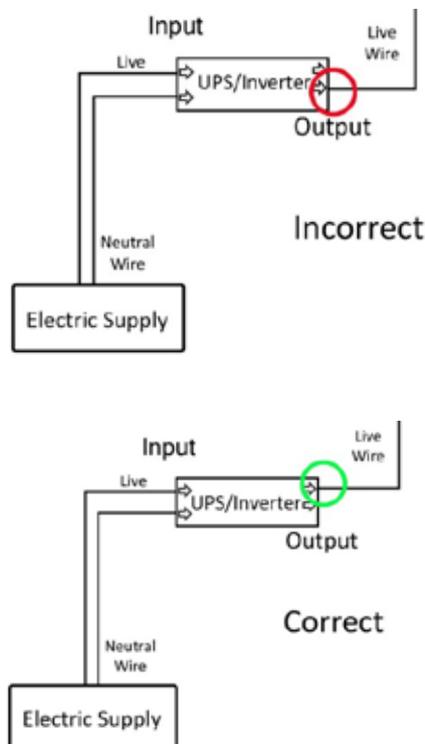


Fig 1.3.40: Troubles with single line/phase wiring

### Method 2

The appliances and devices (load) can also be connected directly to the live and neutral wires coming out from the UPS/Inverter. The following figure shows the UPS/Inverter directly connected to the appliances:

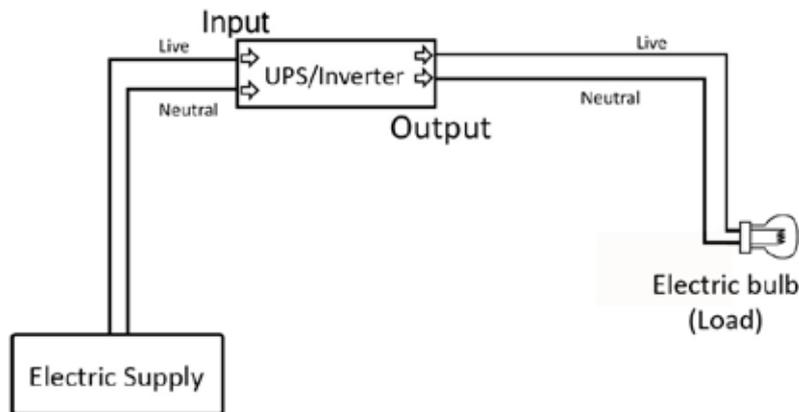


Fig 1.3.41: UPS/ Inverter directly connected to the appliances (load)

This method is the easiest approach to connect an appliance with the UPS/Inverter. Such wiring is essential for a UPS/Inverter that cannot function with only phase wiring. It is designed in such a way that neutral and live circuits are disconnected while battery backup is in operation. The wiring is appropriate if sensitive electronic devices such as computers, TV and media players have to be connected.

### Tips



The following table represents different indicators and their description:

Indicators	Description
Red Colour	Phase/hot/live/electricity wire
Black Colour	Cold/neutral wire
Red Arrows	Terminals (phase) of UPS/inverter
Black Arrows	Neutral terminals

## UNIT 1.4: Tools and Equipment

### Unit Objectives

At the end of this unit, you will be able to:

1. List tools used for installing and repairing UPS/Inverter
2. Identify the equipment used for installing and repairing UPS/Inverter

#### 1.4.1 Tools

The tools used for installation and repairing of UPS/inverter are listed in the following table:

Name	Function	Image
Screw driver	Used to turn or remove screws	
Ratchets	Used to allow continuous motion (linear or rotary) in only one direction and preventing the motion in opposite direction	
Spanner/Wrenches	Used to provide grip to apply torque for turning objects such as a nut or a bolt	
Wire cutter	Used for cutting wires	

Pliers	Used to hold objects firmly	
Tester	Used to verify presence of electric voltage in an equipment	
Hammer	Used to drive nails, fit parts, or forge metal	
Hand bender	Used to bend objects	
Ladder	Used to climb up to reach high places (6 to 7 feet) in case of tower units of a UPS/Inverter	
<b>Utility Knife</b>	Used to cut various objects such as wires, cords and tapes	

Fig 1.4.1: Tools used in installation

## 1.4.2 Equipment

The equipment used for installation and repairing of UPS/inverter are listed in the following table:

Test Equipment	Function	Image
Oscilloscope	Used for observing signal voltages that are varying constantly and represented graphically as a function of time	
Voltmeter	Used to measure potential difference between two points in the electric circuit	
Ammeter	Used to measure current flow in a circuit	
Wattmeter	Used to measure electric power of any given circuit (in watts)	
Megger	Used to measure leakage in wires	

Multimeter	Used to measure resistance, current and voltage	
Clamp meter	Used to measure the vector sum of the currents flowing in all the conductors passing through a cable or probe, which depends on the phase relationship of the currents.	

## Activity: Identification Game

Answer the following questions.

1. Which of the following is used to measure power for an electric circuit?



Wattmeter



Megger



Ammeter

2. Which of the following is used to turn a nut or bolt?



Ratchet



Pliers



Wrench

## QR Code

Scan the QR code below to access the ebook



<https://www.youtube.com/watch?v=VBZ-3Ma7Ohc>  
1.1: Basics Of Electronics and Electronics Components



<https://www.youtube.com/watch?v=mc979OhitAg>  
1.2: Fundamentals of Electricity



<https://www.youtube.com/watch?v=6Q0t0iQINw4>  
1.3: Introduction to UPS & Inverters



<https://www.youtube.com/watch?v=tc0u8GYxBus>  
1.3.3 Basic differences and similarities between UPS & Inverters



<https://www.youtube.com/watch?v=htf0ftt3ddk>  
1.3.5 Wiring procedure of UPS/inverter



<https://www.youtube.com/watch?v=jzAQ9Yx9EfM>  
1.4.2 Equipment-Oscilloscope



<https://www.youtube.com/watch?v=yE3eQ6q39f4>  
1.4.2 Equipment-Voltmeter/ Ammeter



<https://www.youtube.com/watch?v=uS4ltXu3wQ8>  
1.4.2 Equipment-Voltmeter/ Ammeter



<https://www.youtube.com/watch?v=CnjV86pLaJE>  
1.4.2 Equipment-Voltmeter/ Ammeter



## 2. Role of a Field Technician – UPS/Inverter

Unit 2.1 – Responsibilities of a Field Technician

Unit 2.2 – Understanding the Requirements of a Customer

Unit 2.3 – Organizational Context

Unit 2.4 – Health and Safety Norms

Unit 2.5 – Improve Work Process



## Key Learning Outcomes

**At the end of this module, you will be able to:**

1. Determine the responsibilities of a field technician
2. Analyse the customer requirements
3. Adhere to the reporting and documentation process
4. Follow the health and safety norms
5. Identify ways to improve the work process

## UNIT 2.1: Responsibilities of a Field Technician

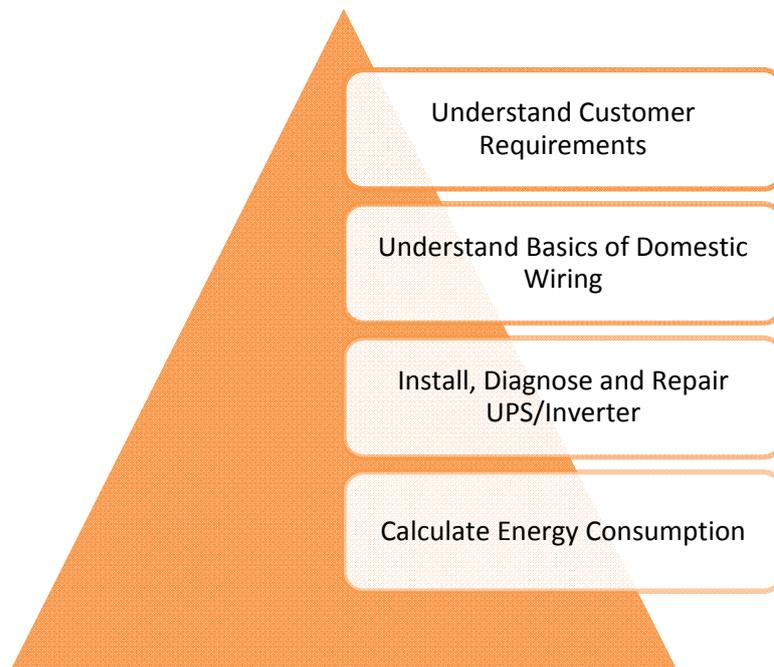
### Unit Objectives

**At the end of this unit, you will be able to:**

1. Describe the responsibilities of a field technician
2. Develop personality traits and skills to work

### 2.2.1 Job Role Description

A field technician is responsible for installing or repairing a UPS/Inverter. Field technicians need to commute from one customer's site to another to attend to their complaints registered at the service centres. They directly interact with the customer to diagnose the issues related to the UPS/Inverter. The following figure represents the description of a field technician's job role:



*Fig. 2.1.1: Job role of a field technician*

#### **Understand Customer Requirements**

Understanding the needs of a customer is one of the foremost parts of a technician's job role. This includes the following practices:

- Greet the customer and talk politely
- Understand the customer's requirement
- Provide the best possible and cost effective solution to the customer
- Ensure that the customer is satisfied with the service

### Understand Basics of Domestic Wiring

It is essential that a field technician has a basic knowledge of domestic wiring as connecting UPS with other devices or installing the UPS/Inverter may involve simple wire connections but lack of knowledge in wiring may lead to dangerous or accidental situations. For example, the field technician should know that the main supply of an electrical cable consists of following three wires:

- Live – Brown in colour, provides the current supply.
- Neutral – Blue in colour, is a circuit conductor which carries current to the source and is also connected to the earth at the electrical panel.
- Earth – Green or yellow in colour, returns current to the earth. It is usually connected to a metal plate which is deep in the ground and is used as a safety measure for appliances and equipment.

### Install, Diagnose and Repair UPS/Inverter

The key technical responsibilities of a field technician is installing the UPS/Inverter, fixing faults and repairing the faulty modules of UPS/Inverter.

#### Installation

A field technician is responsible for visiting the customer's site, reading the equipment manual and understanding how the equipment works and should be installed. The following figure lists the steps which a field technician should ideally follow post installation of an



equ Fig 2.1.2: Steps to follow post installation of an equipment

#### Diagnosis and Repair

A field technician's role is not limited to installation of an equipment only. It also includes:

- Understanding the fault in UPS/Inverter
- Identifying the reason for the fault
- Rectifying faults identified in a dysfunctional UPS/inverter

#### Calculation of Energy Consumption

It is common for a customer to ask questions about electricity consumption while getting a new equipment installed. Therefore, a field technician should be able to do some basic calculation of energy consumption, to be able to answer the customer's queries, such as:

- How many equipment can be connected to the UPS/Inverter?
- What can be the average billing after installation of a particular equipment?
- Whether the estimated consumption will be more/less than actual consumption?

In addition to giving a valuable response to customers, calculation of energy consumption will help in installing and repairing UPS/Inverters according to the type of wiring done at the site, be it domestic, residential or industrial. The following figure shows four easy steps for

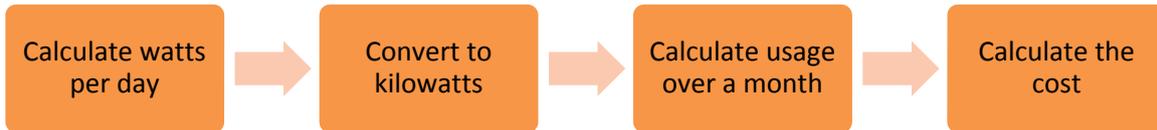


Fig 2.1.3: Steps to calculate energy consumption

### 2.1.2 Personality Development

Apart from having technical knowledge, it is important for a field technician to develop some basic personality traits and skills, such as communication and personal grooming.

#### Communication Skills

When on a visit to a customer’s site, to ensure good service, the customer’s requirement should be understood and a solution should be suggested.

The following figure represents the points to be taken care of while communicating with a customer:

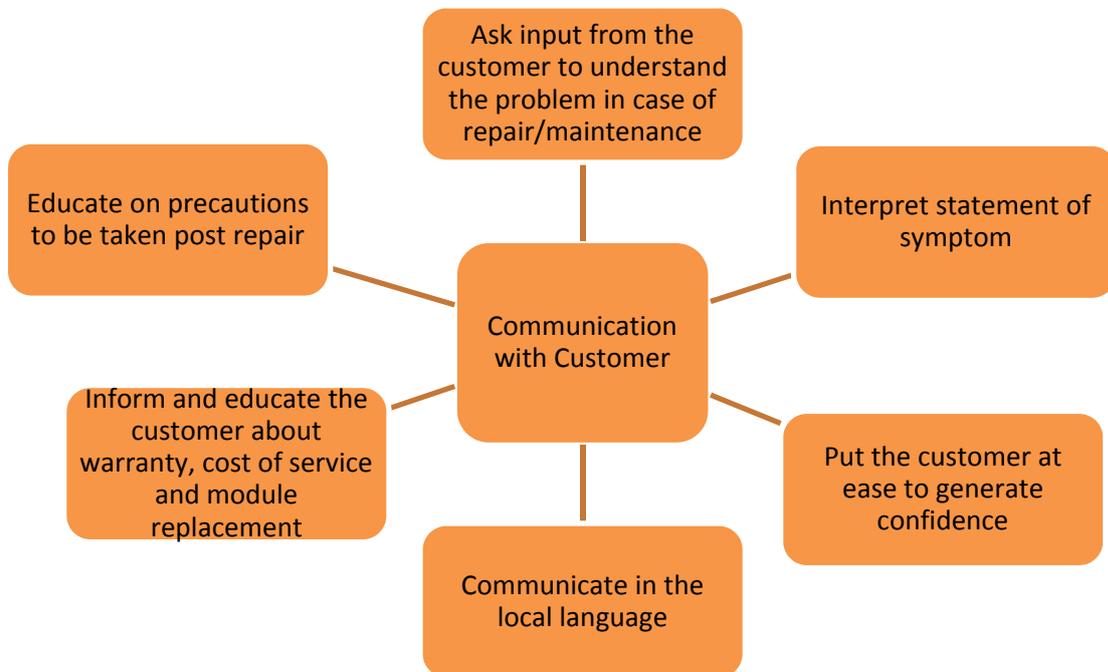


Fig 2.1.4: Communicating with a customer

The following table depicts the dos and don'ts which should be followed by a field technician at a customer's site:

Dos	Don'ts
<ul style="list-style-type: none"> <li>• Be polite and courteous to the customer.</li> </ul>	<ul style="list-style-type: none"> <li>• Keep too much distance while standing and interacting with the customer.</li> </ul>
<ul style="list-style-type: none"> <li>• Maintain clean work area.</li> </ul>	<ul style="list-style-type: none"> <li>• Enter the room without permission of the customer.</li> </ul>
<ul style="list-style-type: none"> <li>• Have patience while handling all types of customers.</li> </ul>	<ul style="list-style-type: none"> <li>• Be untidy or shabbily dressed on a customer call.</li> </ul>
<ul style="list-style-type: none"> <li>• Suggest the most appropriate solution to the customer. Always take approval from the customer by giving complete details.</li> </ul>	<ul style="list-style-type: none"> <li>• Have an unnecessary conversation.</li> </ul>
<ul style="list-style-type: none"> <li>• Always take approval from the customer by giving complete details.</li> </ul>	

Fig 2.1.5: Dos and don'ts of communication

### Personal Grooming

Being well groomed at workplace reflects a positive and professional attitude towards work.



The following figure includes aspects of personal grooming:

Fig 2.1.6: Aspects of grooming

The following figure lists few of the good practices classified under different aspects of grooming:

		
<p><b>Dressing</b></p> <p>Clothes should be neat and clean.</p> <p>Clothes should be ironed.</p> <p>If a company has a uniform, it should be worn.</p>	<p><b>Personal Hygiene</b></p> <p>Hair should be neatly combed and trimmed.</p> <p>Nails and hair should be cut.</p> <p>Teeth should be clean.</p> <p>Bath should be taken everyday.</p> <p>Body odor and sweating should be taken care of.</p>	<p><b>Workplace Etiquette</b></p> <p>Smile and greet the customer.</p> <p>Be punctual.</p> <p>Apologize on making a mistake.</p> <p>Be polite.</p> <p>Be careful of body language.</p>

Fig 2.1.7: Good practices for personal grooming

**Activity: Group Discussion** 

Get together in groups of three or four. List down at least three things related to grooming which you should do and which you should avoid while on a visit to a customer's site. Use the following table to make the list.

	<b>Dressing</b>	<b>Personal Hygiene</b>	<b>Etiquette</b>
<b>To Do</b>			
<b>To Avoid</b>			

**Activity: Solve** 

Solve the following numerical:

1. Your refrigerator runs 24 hours a day. Assume that you bought a model which uses only 300 watts. Calculate the energy consumption and cost over a month. (Assume the cost of 1 unit = ₹10)

**Answer:**

2. Find the electrical energy cost to run the following:
  - a) A 5 kW microwave oven for 1 hour
  - b) A 400 W fan for 14 hours
  - c) A 4 kW AC for 8 hours a day for 5 months(Assume the cost of 1 kWh = ₹9)

**Answer:**

## UNIT 2.2: Understand the Customer Requirement

### Unit Objectives

At the end of this unit, you will be able to:

1. Discuss the right way to interact with a customer
2. Analyse the customer's requirements

### 2.2.1 Interact with the Customer Prior to Visit

A field technician is responsible for the installation or repair/maintenance of a UPS/Inverter. When work is allocated, it is important to understand and analyse the requirement before going ahead with the plan of action, or visiting the customer's site. The following figure shows the workflow for the role of a field technician:

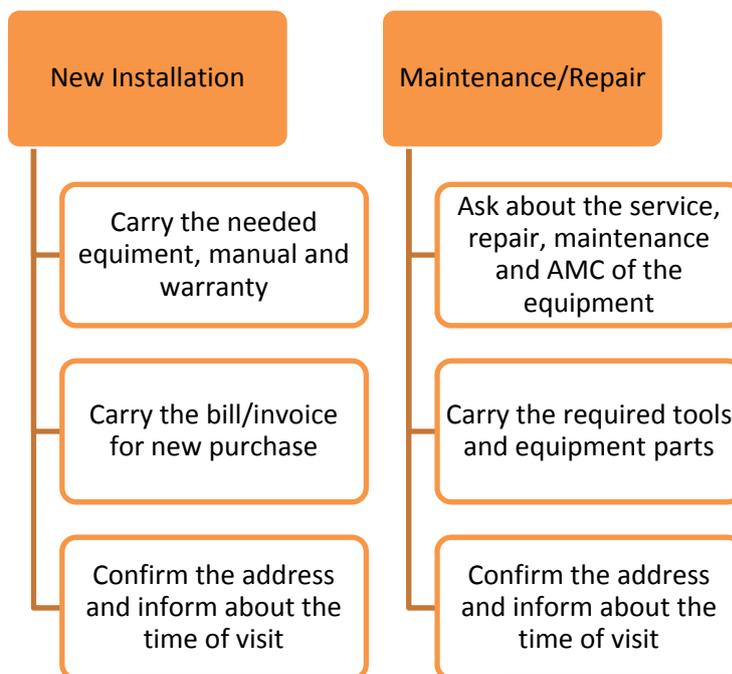


Fig 2.2.1: Workflow for installation and repair

Before visiting the customer for installation or repair, it is important to understand the requirement of the customer. The following figure represents the various activities which should be done before a visit to the customer's site is scheduled:

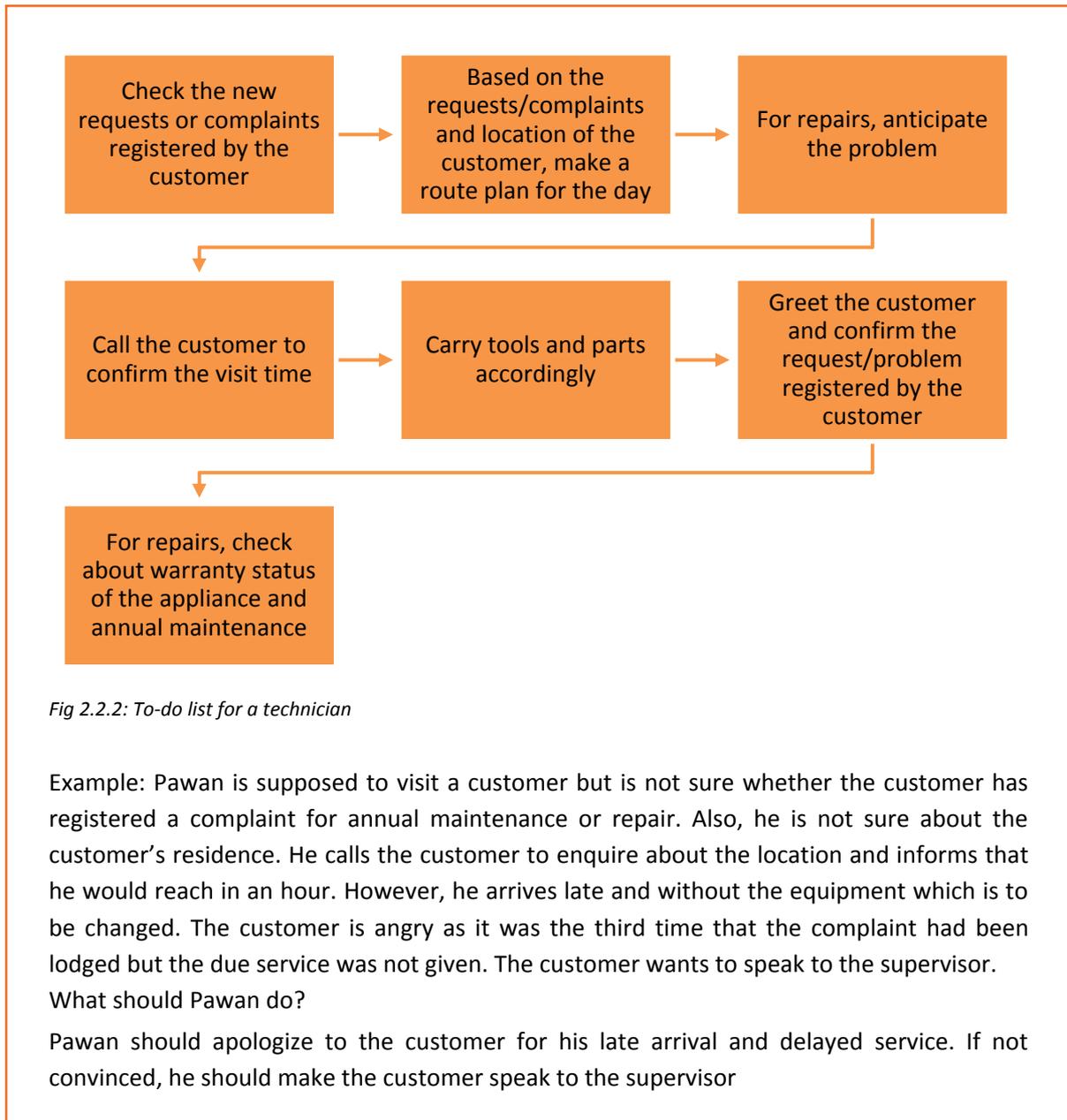


Fig 2.2.2: To-do list for a technician

Example: Pawan is supposed to visit a customer but is not sure whether the customer has registered a complaint for annual maintenance or repair. Also, he is not sure about the customer's residence. He calls the customer to enquire about the location and informs that he would reach in an hour. However, he arrives late and without the equipment which is to be changed. The customer is angry as it was the third time that the complaint had been lodged but the due service was not given. The customer wants to speak to the supervisor. What should Pawan do?

Pawan should apologize to the customer for his late arrival and delayed service. If not convinced, he should make the customer speak to the supervisor

## 2.2.2 Interact with the Customer at their Premises

It is a good practice to be humble and respectful towards the customer. The following figure represents how to interact with a customer when visiting the premises for service/installation/repair:

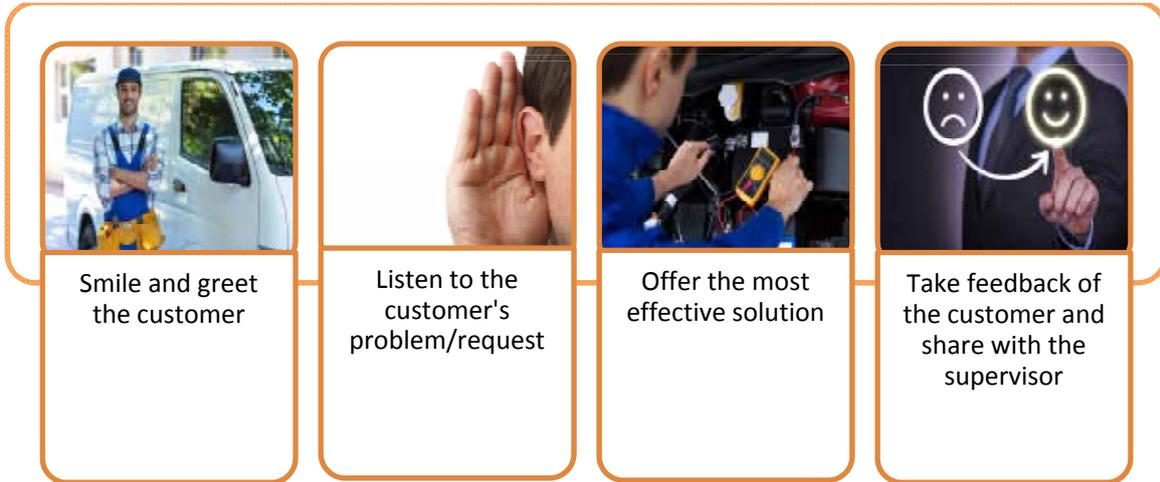


Fig 2.2.3: Interacting with a customer

When visiting a customer for a repair/servicing request, it is important to know the details of the problem and accordingly suggest a corrective measure. The customer should be satisfied with the suggested solution. The following figure highlights the to-do list to be followed at a customer's premises:

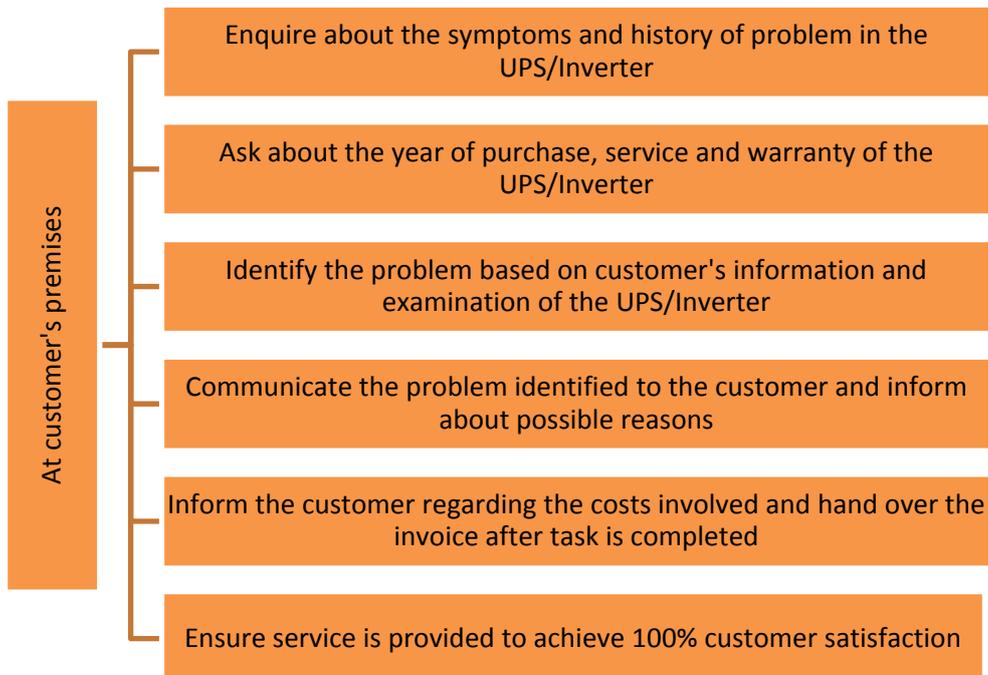


Fig 2.2.4: To-do list to be followed at a customer's premises

### 2.2.3 Suggest a Solution to the Customer

After identifying the issue, a field technician needs to offer solutions. The field technician should explain all the possible solutions along with the cost associated. The field technician should then propose the best solution and let the customer decide whether to go ahead with the given solution or not. The following figure shows the steps involved in offering solutions to a customer:

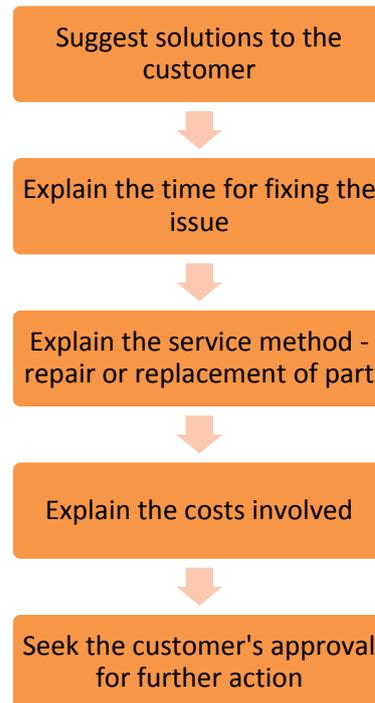


Fig 2.2.5: Suggesting a solution to the customer for an issue

## UNIT 2.3: Organizational Context

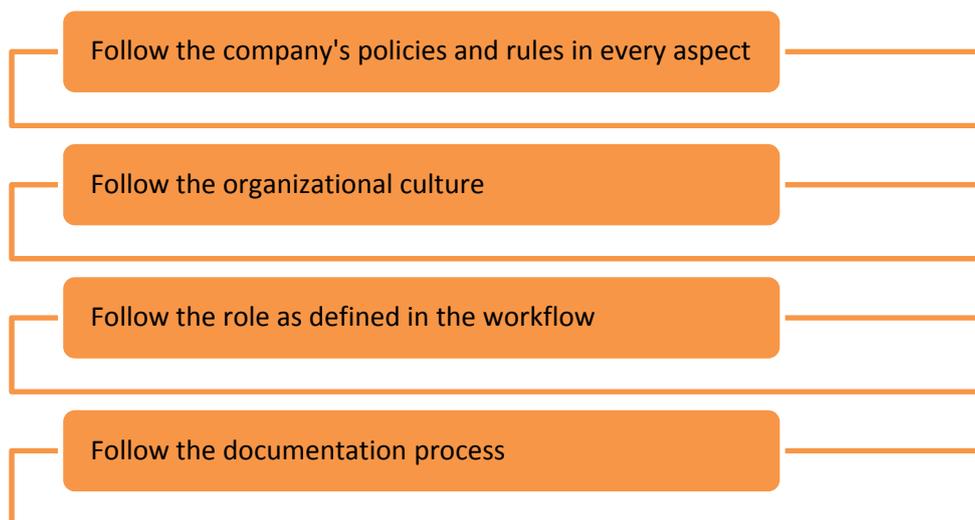
### Unit Objectives

At the end of this unit, you will be able to:

1. Implement the reporting and documentation process
2. Identify the organizational culture and customer profile

### 2.3.1 Reporting and Documentation

There are set rules and regulations within an organization which an employee, a field technician, needs to follow. These rules and regulations outline responsibilities of both the employers and the employees. The following figure explains what practices an organization requires a person, working for it, to ensure:



*Fig 2.3.1: Reporting and documentation process*

#### Company Policies and Rules

There are certain company policies in terms of installation and servicing of UPS/inverter which the technician should understand and follow. This ensures that the company's service standards are always met. Proper knowledge of these policies require the field technician to be aware of the following points:

- Customer care requisition for installation and service
- Warranty of product
- Company's sale, installation and after sale support policy
- Incentives on meeting targets
- Delivery standards
- Call initiation and call closure

If the company policies and rules are not defined clearly, then the employees may not comply with the disciplinary standards whole heartedly. The following figures are a few examples of personnel policies in an organization:

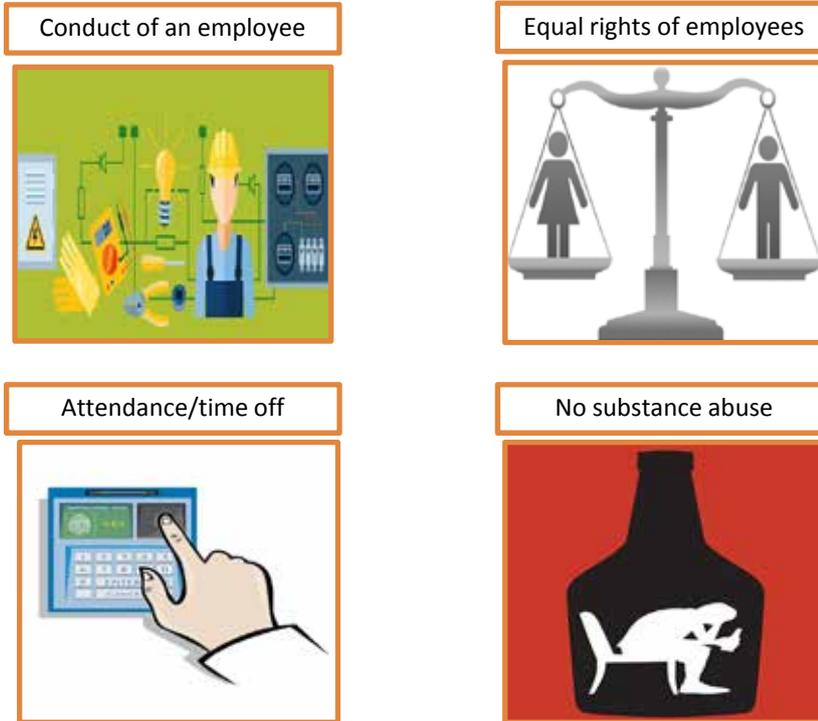


Fig 2.3.2: Common personnel company policies

**Maintain Records and Fill Forms**

It is the responsibility of the management as well as the employee to keep an updated record of the employees and complete forms such as invoices, work orders and maintenance records. The following images are the examples of various forms used to record information:

**Invoice Format**

INVOICE			
Company Logo and Name		Invoice Number: _____	
Address		Invoice Date: _____	
City and Pin code			
Phone number: _____			
Name: _____			
Address: _____			
Sl. No.	Description	Rate	Total
Sub Total: _____			
Tax: _____			
Total Bill Amount: _____			
Thank You for doing business with us!			

**Work Order**

COMPANY NAME			WORK ORDER
XXX, Street no. X City, Pin code - XXXXXX Phone no: XXXXXXXXXX			
Customer Order No.:	Phone:	Order Date:	Signature of Recipient
Order Taken by:	Starting Date:	Service:	
Bill To:			Job Order No.:
Address:			
City-State-Pin Code:			
Job Name/Location:			
Description			
Comments:		Total Material:	
		Total Labour:	
		TAX:	
		Total Due:	
Date completed:			
I hereby acknowledge that work specified above is completed.		signature	



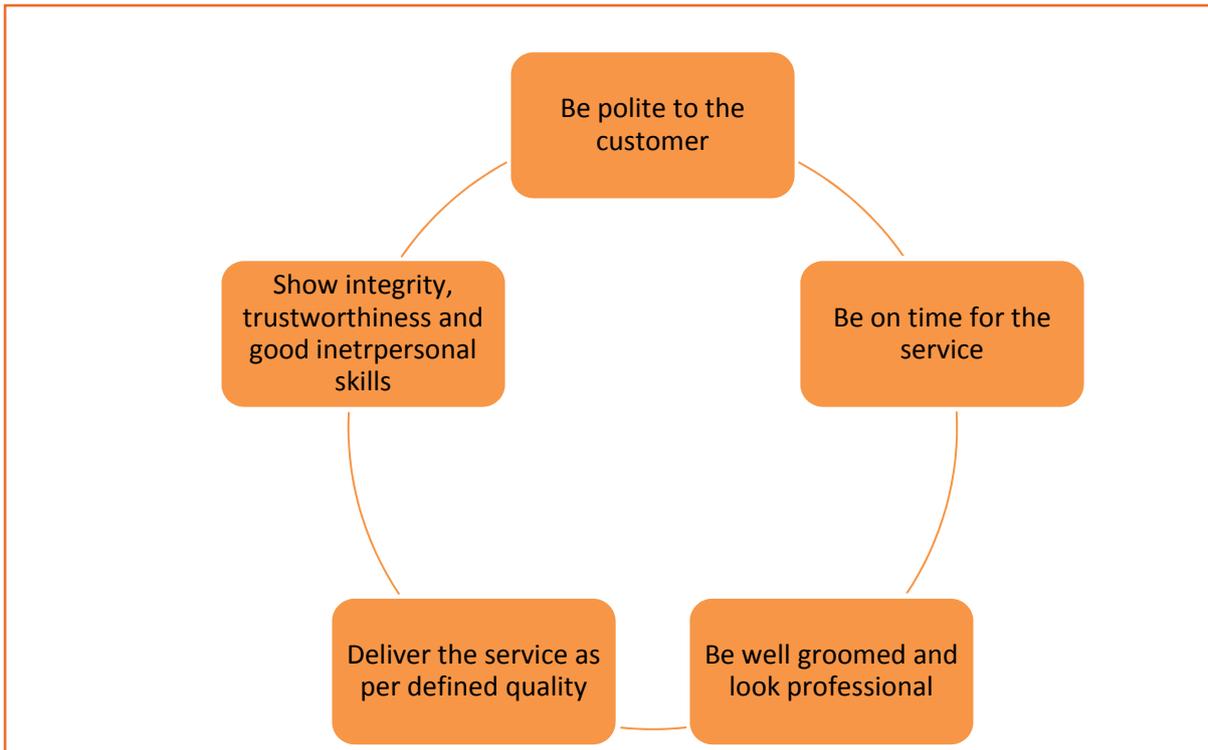


Fig 2.3.4: Characteristics of organizational culture

As a field technician, you may need to cater to different set of customers, from different backgrounds. The following figure represents the broad classification of customer profiles:

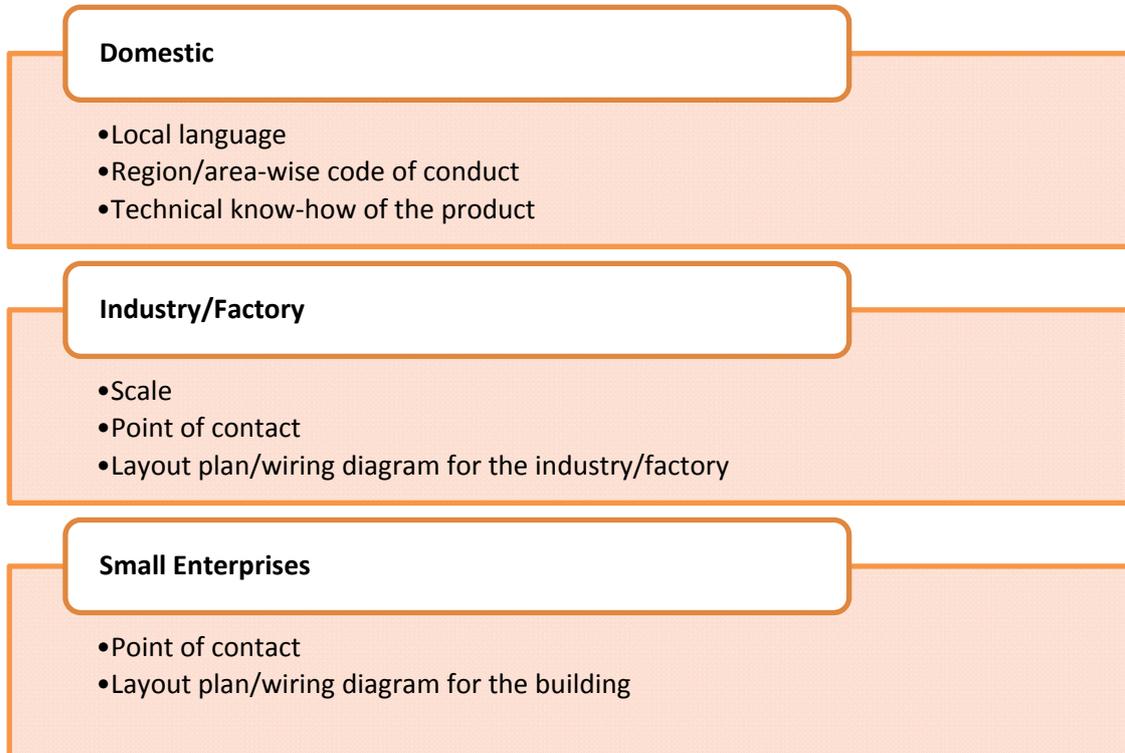


Fig 2.3.5: Classification of customer profiles

## UNIT 2.4: Health and Safety Norms

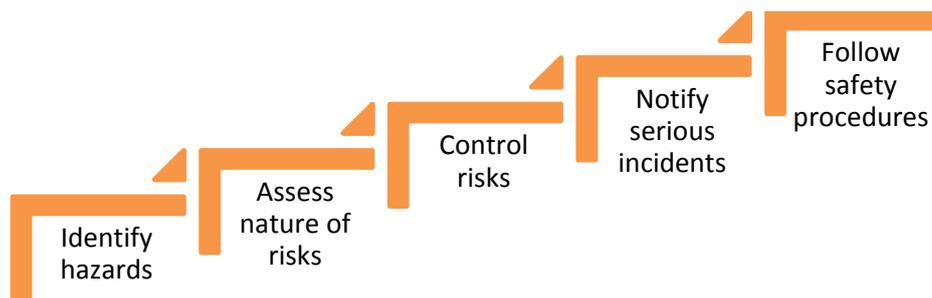
### Unit Objectives

At the end of this unit, you will be able to:

1. Determine safety issues at work
2. Classify health issues at work
3. Analyse the preventive measures to be taken

### 2.4.1 Health and Safety

An organization is supposed to provide protection to its employees. The primary responsibility of an organization is to ensure health and safety of the employees. However, it cannot guarantee an accident free arena to work in. Hence, it is the responsibility of both the employer and the employee to follow the safety norms. The following figure explains how an employee must contribute towards maintaining health and safety in an organization:



*Fig 2.4.1: Steps to maintain health and safety*

#### Safety Guidelines

As a field technician, there are certain guidelines that must be followed to ensure own safety, and that of the co-workers. These guidelines provide a sound, safe and flexible environment to work.

The following figure represents the general safety guidelines to be followed at workplace:

- Always follow the correct procedures to ensure zero accidents at work.
- Always use an appropriate tool for the respective task.
- Always read labels and instructions given on the components.
- Always wear appropriate clothing and remove metal objects before working.
- Use prescribed protective safety equipment only.
- Always follow Electrical Safety Rules when working with electrical machinery or equipment.
- Report all unsafe acts or unsafe conditions to the supervisor.

*Fig 2.4.2. Safety guidelines*

The following table represents the dos and don'ts of safety measures at a customer's home:

<b>Dos</b>	<b>Don'ts</b>
Place the inverter in a well aerated place	Never place the battery in a closed container
Installation should be done on a flat surface	Never keep batteries close to water or other chemicals
Battery terminals should be tightened	Never load the connection with more than the mentioned capacity
All battery cables should be connected in right direction	Do not operate device with damaged cables
Keep the batteries connected when the device is in 'ON' state	Never connect the inverter to an incoming power supply

*Fig 2.4.3. Dos and don'ts of safety measures*

## 2.4.2 Potential Health and Safety Risks for a Technician

Often at the workplace, a technician is exposed to a lot of issues related to health and safety. The following figure highlights the points important for a technician to understand from a safety point of view:

### Safety Issues at Work

- Electrical shocks and/or burns
- Extreme temperature
- Closed space for work
- Heavy tool or equipment
- Fire
- Risk to customer safety

### Health Issues at Work

- Stress due to extended work shift
- Wrong posture
- Risk of falling or tripping
- Exertion due to manual work

Fig 2.4.3: Safety and health issues at work

## 2.4.3 Preventive Measures for a Technician

It is always better to take preventive measures to avoid accidents. The following figure explains the preventive health and safety measures which should be considered at work:



Fig 2.4.4: Preventive health and safety measures

### Use of Safety Gears

Personal Protective Equipment (PPE) is essential to avoid any electrical, heat or physical hazard. A PPE may not eliminate a particular hazard from occurring but it avoids the situation of an employee getting exposed to it. The following figure represents the usage of the various PPE:



Fig 2.4.5. Items for personal safety

### 2.4.5 Signage Used for Electrical Safety

There are several signs at the workplace which an employee must be aware of. The following images show some examples of signage for electrical safety:



Fig 2.4.6: Signage for electrical safety

## 2.4.6 Electrostatic Discharge (ESD)

ESD protection is essential for sensitive components such as microchips, during and after production, while shipping, during assembly of the device and in the finished device. For example while unpacking the UPS/Inverter, the metal casing of the UPS/Inverter may have ESD or the packaging material could have ESD. Grounding is imperative for ESD prevention. An ESD Simulator having special output circuit called human body model (HBM), is generally utilized to test the vulnerability of electronic devices to ESD from human contact. The following protective gears should be used while handling components that are prone to ESD:



Wire Strap



Rubbern Gloves



Safety Clothes

*Fig 2.4.7: Safety gears for protection from ESD*

## eContent

You can visit the following links to know more about health and safety at workplace:

- <https://www.youtube.com/watch?v=Jgfe5O6xwA8>
- <https://www.youtube.com/watch?v=a5MnE0q3azY>

## UNIT 2.5: Improve Work Process

### Unit Objectives

At the end of this unit, you will be able to:

1. Identify ways to do defect-free work
2. Maintain quality and ensure timely completion of work
3. Keep work area clean

### 2.5.1 Work Process Improvement

If the processes work well, within the defined parameters to achieve a goal, there are less errors and delays in the schedules. This helps to increase the productivity of the people and attain maximum customer satisfaction.

To ensure work process improvement, you must adhere to the following practices:

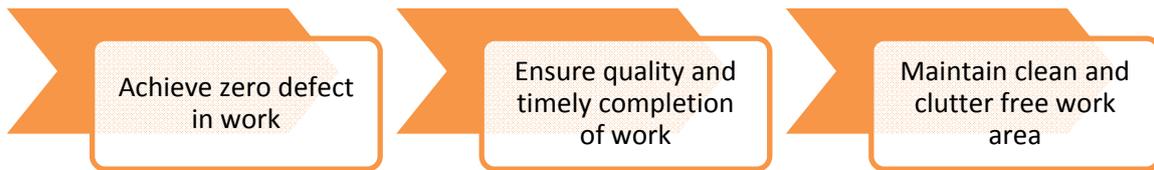


Fig 2.5.1: Ways for improving work process

### 2.5.2 Achieve Zero Defect in Work

Zero defects is a measurement of quality which is based on the concept of ensuring adherence to quality standards and eliminating defects to a zero level. This concept of achieving zero defect in work motivates people and prevents them from making mistakes. People develop a consciousness towards carrying out work correctly in the first time.

The following figure explains the ways to ensure zero defect in work:

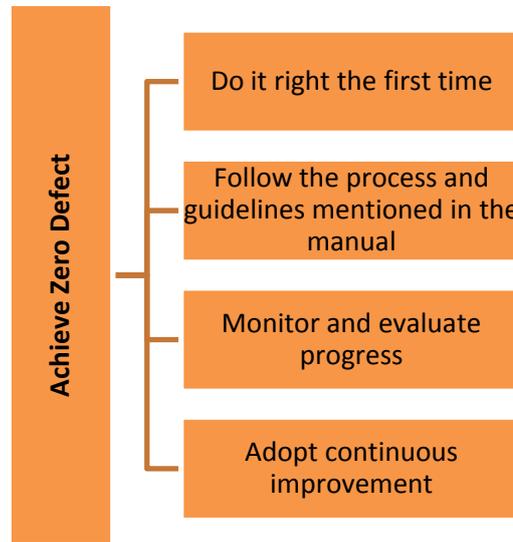


Fig 2.5.2: Measures to achieve zero defect in work

### 2.5.3 Quality and Timely Completion of Work

A few simple principles, if adhered to, can ensure production of quality work. As a field technician, maintenance of quality and timely completion of work can be done in the following ways:

- Ensure that work is done as per the guidelines and standard of the company.
- Plan and organize the allocated work for the day.
- Follow the proposed plan of action.
- Inform the supervisor in case of any deviation or emergency.
- Work to ensure 100% customer satisfaction.

The field technician would get a job sheet or work allocation from the supervisor. The supervisor will also share a plan of action with field technician to ensure adherence to timelines and quality for the work assigned. The following figure highlights the points which help a field technician in understanding the plan to achieve 100% quality and timely completion of work:

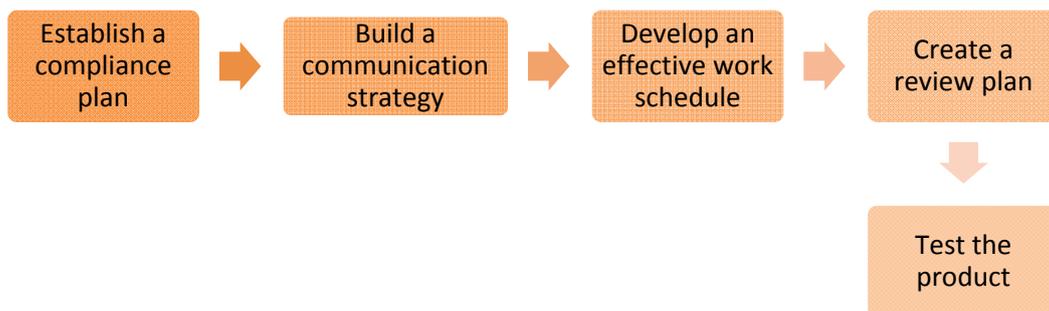


Fig 2.5.3: Achieving quality and timely completion of work

To prevent accidents and wastage of time, it is important to maintain a clean and safe work area. The following figure represents some benefits of a clean work area:



*Fig 2.5.4: Benefits of a clean work area*

Consider a situation where a field technician may have to look for a valve cover in an unorganized environment. It is obvious that the technician would have to jump in the cluster of unmanaged work area to look for the required part/unit, which would eventually lead to wastage of time. Hence, both work quality and productivity is related to a clean work environment. The following images represent tools kept in an unorganized and organized manner respectively:



*Fig 2.5.5: Tools kept in an unorganized manner*



*Fig 2.5.6: Tools kept in an organized manner*

### Activity: Match the following

Match the following components of a UPS/Inverter kit with their respective names and function.

Names	Function
1. Conduit Box	A. To make electrical connections of battery and AC source
2. AWG AC Wiring	B. To protect electrical devices that operate with direct current
3. Conduit Bushings	C. To connect generator to electrical system safely without danger of back feed to utility power
4. AWG Ground Wire	D. To distribute power at short distances
5. Rap Straps	E. To connect inverter to AC breakers
6. Bus bar for DC Positive	F. To make battery connections
7. 4-tab power distribution bus bars	G. To protect inverter, battery and wiring connections
8. 250A 160VDC 3/8" stud DC breaker	H. To hold wires together
9. Custom-designed bypass interlock plate	I. To protect the wire ends without damaging protection coating
10. One Pair #4/0 AWG battery cables	J. To carry substantial electric current over relatively short distances
11. AC Sync Cables	K. To protect device from high voltage by enabling circuit breaker

### Activity: Identification Game

Identify the components and write their names in the space provided below each of them.



**Activity: Discussion**

Discuss in groups and write at least three things to be done for the following:

- Maintaining a clean work environment

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- Ensuring timely completion of work

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- Achieving zero defect in work

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### Activity: Identification



Tick the actions which can prove to be a threat to the health and safety of a technician.

- Smoking near combustible substances
- Oil spill near customer interaction area
- Tools lying on the table of a technician
- Tools lying on the floor
- Entering a 'No Entry' zone at customer's site
- Touching an ungrounded inverter
- Working in dim light
- Walking on a wet floor



## 3. Working with UPS/Inverter

Unit 3.1 – Install the UPS/Inverter

Unit 3.2 – Repair Dysfunctional UPS/Inverter



## Key Learning Outcomes

**At the end of this module, you will be able to:**

1. Identify the installation process of UPS/Inverter
2. Identify the faults and repair the faulty modules of UPS/Inverter

## UNIT 3.1: Install the UPS/Inverter

### Unit Objectives

At the end of this unit, you will be able to:

C

1. Identify the pre-installation steps for installing UPS/Inverter
2. Install the UPS/Inverter

Installing a UPS or an inverter is a part of after sales service job for providing technical help/support to the customers after they purchase new UPS or inverters. Installing a UPS/Inverter at a customer's site and making it ready for use involves the following workflow:

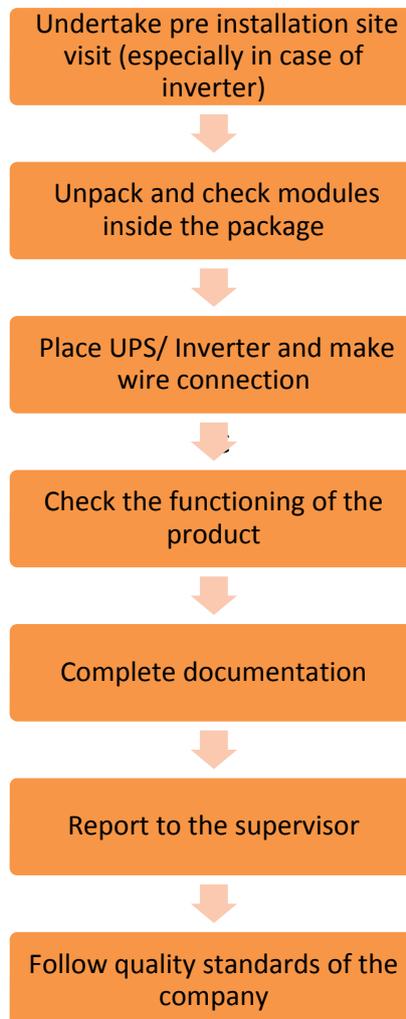


Fig 3.1.1: Workflow for Installing a UPS/Inverter

### 3.1.1 Undertake Pre-Installation Site

Pre-installation site visit involves inspection of customer's site and preparation of the site as per the requirement of the product.

#### Inspection of Site

Purpose of the inspection of customer's site is to ensure the following:

- Availability of the customer when the product will be delivered.
- Ensuring correct environmental parameters such as temperature and humidity, as specified in the manual.
- Availability of minimum requirements for product installation such as AC socket, proper space and ventilation.

#### Preparation of Site

If the location or place does not adhere to the requirements of installation, then the field technician needs to prepare the site according to the requirements. While placing the system, keep in mind the following aspects:

- The inverter should be connected to an AC outlet on a nearby wall, which should be easily accessible. This is done to ensure that in case of an emergency the inverter can be disconnected from the power source.
- The ratings of the AC power system and the equipment to be connected to the UPS/Inverter system should match.
- The places that are not appropriate for placing a UPS/Inverter are as shown in the following images:



Under sink or near water/gas pipelines



Nearby inflammable containers



Inaccessible corners such as drawers



Below air conditioner or hot outlets



Near cars



Near electrical wirings and miniature circuit breaker (MCB) boards

Fig 3.1.2: Inappropriate places for placing a UPS/Inverter

After getting the inverter on site, remove the package carefully and check the modules inside the package. The modules should match the checklist.

### Tips

- Install the UPS/Inverter in a dust-free and a shaded place which is not exposed to any heat source or direct sunlight.
- Before installation, UPS/Inverter system must be stored in a dry place.
- The inverter's ventilation grates should never be blocked.

### Unpack the UPS/Inverter

The steps for unpacking the system to ensure proper installation are listed in the following figure:

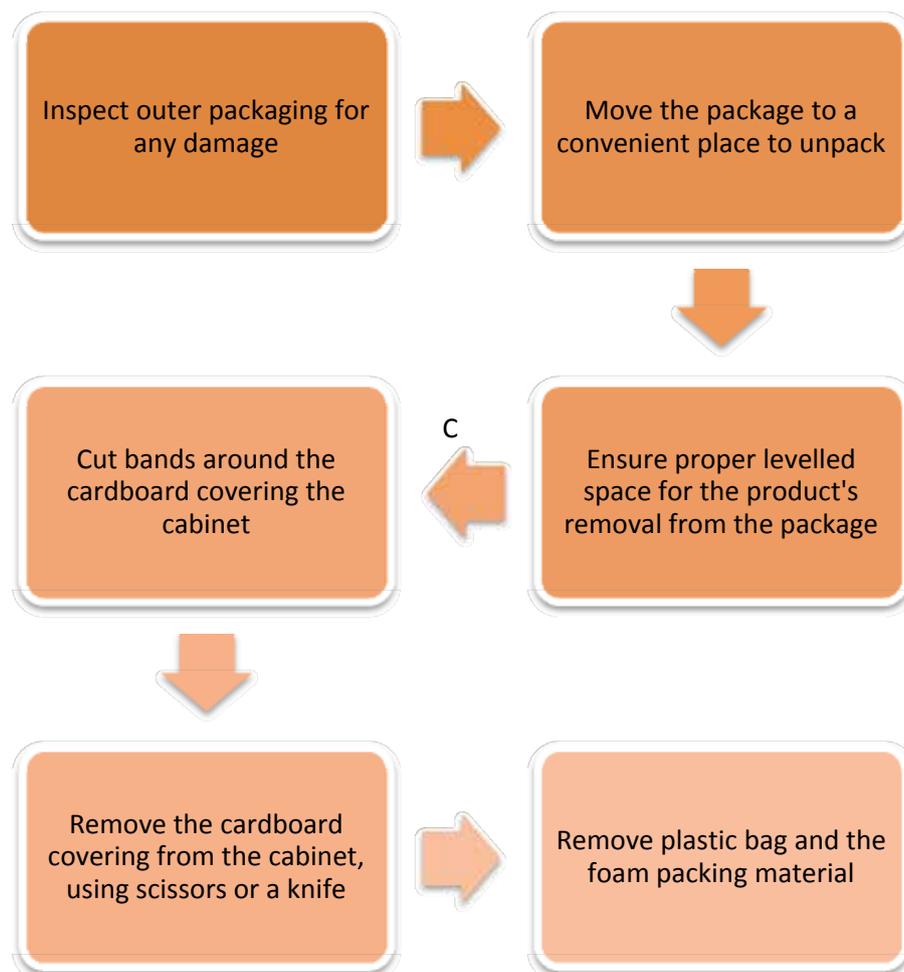


Fig 3.1.3: Steps for unpacking a UPS/Inverter

The tools used for handling and unpacking the UPS/Inverter are shown in the following figure:



Fig 3.1.4: Tools used in handling and unpacking a UPS/Inverter

#### Check the Modules inside the Package

To ensure smooth installation, the modules inside the package must be checked so that if there is any module missing or any damage found, it can be informed to the company as early as possible. In addition, check the following things:

- Check the UPS/Inverter for any damage that may be caused during shipping. If any damage is found, it should be reported to the carrier and the dealer.
- Check the fluid and charge of the battery.
- Match the accessories against the delivery checklist. Though the accessories vary from model to model, but most of the time it includes the items shown in the following images:

Inverter



Tubular Batteries



Main Cabinet



Wiring Kit



Wire Management Kit



Fill Kit

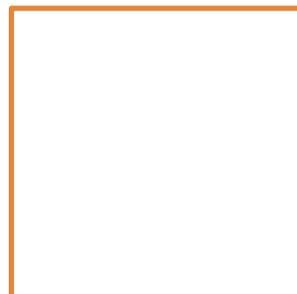


Fig 3.1.5: Accessories inside the package

Check and understand the symbols on the package to know about the cautions and warnings related to the installation. The symbols along with their meanings are shown in the following images:

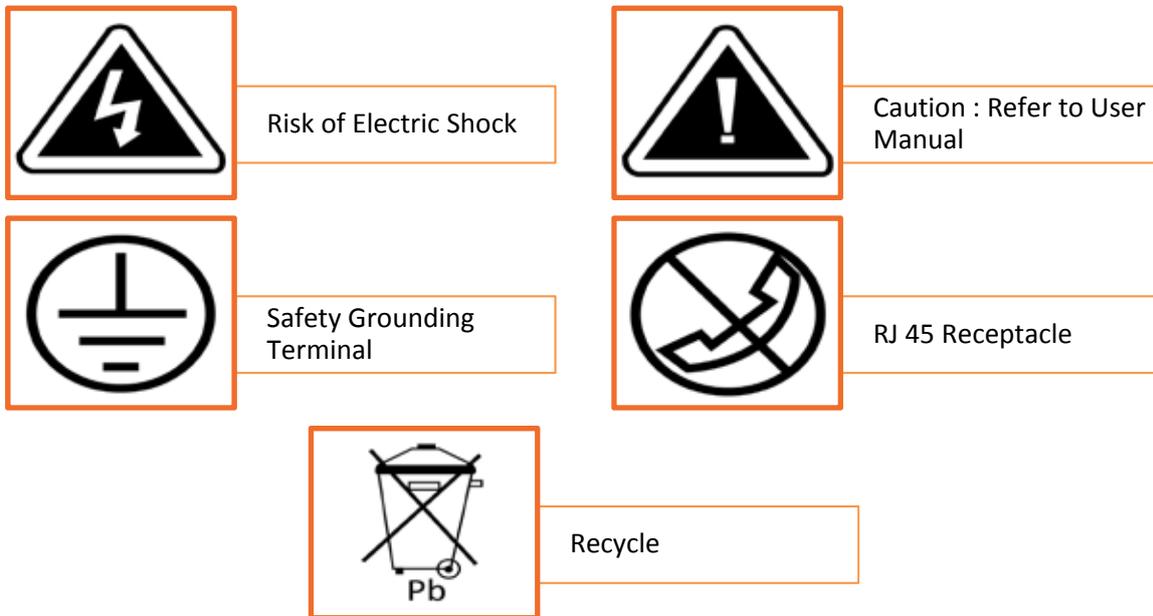


Fig 3.1.6: Symbols on a module package

### 3.1.3 Place and Wire the UPS/Inverter

To install a UPS/Inverter, placing and wiring of the UPS/Inverter are the initial steps. To place the UPS/Inverter, consider some of the following precautions to be taken at the designated place:

- The air inlets and air outlets of the UPS/Inverter should not be blocked. Blocking them reduces ventilation and leads to shortening of the service life of the unit.
- A minimum clearance of 100 mm on both the front and rear side of the UPS/Inverter must be maintained.

Once the UPS/Inverter is placed, the next step is to wire it. The tools used for the wiring of the UPS/Inverter are as follows:

1. Socket wrench
2. Utility knife
3. Flat head screwdriver
4. Wire/cable cutters
5. Electrical tape
6. Allen wrench

The following image shows the tools required for the wiring of a UPS/Inverter:



Fig 3.1.7: Tools required for the wiring of a UPS/Inverter

### Steps for Wiring of UPS/Inverter



The steps for wiring the UPS/inverter unit are:

- **STEP 1:** Prepare lead cables as shown in the following image:



Fig 3.1.8: Lead cables preparation

- **STEP 2:** Install batteries in the enclosure.
- **STEP 3:** Connect the negative and positive terminals of the batteries and close the enclosure. The following images represent connecting the batteries:



Fig 3.1.9: Connect the battery terminals

- **STEP 4:** Attach leads to the inverter as shown in the following figure:



*Fig 3.1.10: Attach leads to the inverter*

- **STEP 5:** Connect the battery temperature sensing cable as per the manual.
- **STEP 6:** Connect inverter to the power source as shown in the following figure:



*Fig 3.1.11: Connect inverter to the power source*

- **STEP 7:** Check the system and test the functionalities.

### 3.1.4 Check Functioning of the Product

After installing the battery in the racks or enclosures where the UPS/Inverter is placed, connect it to the inverter or UPS. Then, start the system and check whether the UPS/Inverter is running properly. Perform the following checks:

- Check that all the loads, input, output and battery cables are connected in a proper manner.
- Check that the battery cables are inserted in the sockets properly, if external cabinets for battery are used.
- Verify the voltages at input and output terminals with the help of a voltmeter.
- Press the 'ON' button for a few seconds, to start the system. A battery test will be run automatically for a few seconds if the battery has charge above 80%. You can also test the battery manually.

- Apply input power, keeping all the access panels to the distribution box closed and the branch circuit power turned off. After input circuit breaker located on the distribution box is closed, check whether the AC input lead on the front panel illuminates.
- Check the power at the output terminal block.
- Check that all the loads are operating normally after they are connected

### 3.1.5 Complete the Documentation

After completing the installation at the site, the technician should complete the documentation to record the details related to installation. Along with completing the documentation, the field technician should tell the customer about some dos and don'ts for using the UPS/Inverter such as, keep the area near the product clean and dry. The field technician will also tell the customer about important pages to be referred to from the product manual such as the trip switch and its functionality. The documents may include the following:

- Work related documents:
  - Customer hand over slip
  - Customer feedback form
  - Servicing date or period
  - Warranty documents
- UPS/Inverter related document:
  - Checklist
  - Status of UPS/inverter at the time of installation
  - Installation date and equipment model number
  - Tests performed on the UPS/inverter with results, in case there is a complaint or an issue in already installed UPS/Inverter

### 3.1.6 Interact with Supervisor or Superior

A technician must communicate with the supervisor in case they face problem with the installation process. If there is any damage found in the product, the supervisor needs to be informed immediately. In addition, the technician needs to report to the senior about the task status and submit the documents collected from the customer's site. Listen carefully to the senior if he/she has any queries or any suggestions

### 3.1.7 Achieve Productivity and Quality

To achieve productivity and quality as per company standards follow the working instructions given by the company. The following figure lists some ways to achieve productivity and quality:



Fig 3.1.12: Ways to achieve productivity and quality

## Activity

Make a three pin AC plug connection for an inverter and check the continuity of the cable.

### Components:

- Three pin AC plug
- AC power cable (Three wires)

### Tools:

- Philips screwdriver
- Wire stripper
- Multimeter

## Activity

Check the battery of the UPS/Inverter using a voltmeter and a power probe.

### Components:

- Voltmeter
- Power probe
- Battery

## Activity

Connect three 120 Volt batteries using an 800 Watt inverter.

### Components:

- Three 120 Volt batteries
- Jumper cables (blue and black)
- Wrench
- 800 Watt inverter

## Activity

Install solar inverter.

### Components:

- Solar Con Panel (12V-24V Su-Kam)
- Solar Panel
- 1000 VA inverter
- Battery
- Wrench
- Screws

## Activity

Test the voltage of an inverter during installation.

### Components:

- 800 watt battery
- Inverter
- Wires
  - Live wire
  - Neutral wire
- Wrench
- Multimeter

### Activity: Identification Game



Choose the correct options for the following questions:

1. Which among the following indicators is used to display the level of water in a battery?



(a)



(b)



(c)

2. Which among the following symbols will glow when the battery of an inverter is overloaded?



(a)



(b)



(c)

3. For which of the following inverters, the electrolyte, which fills the cavity of the plates, is in the form of a gel?

Tubular inverter battery

(a)

Valve-regulated Lead-Acid (VRLA) / sealed maintenance free (SMF) inverter battery

(b)

Flat plate inverter battery

(c)

4. Which among the following symbols will glow when the battery is low?



(a)



(b)



(c)

## UNIT 3.2: Repair Dysfunctional UPS/Inverter

### Unit Objectives

At the end of this unit, you will be able to: C

1. Identify the faults and the causes of faults
2. Repair the faulty unit

### 3.2.1 Common Causes of UPS/Inverter Failure

One of the common causes of malfunctioning of UPS and inverters may be its improper installation, which may happen due to non-compliance of user manual instructions or use of cables, gauges and fuses which are inappropriate for the system. Some common causes of UPS/Inverter failure are listed in the following figure:

<b>Improper Maintenance</b>	Electrical connections become loose or the internal components get corroded.
<b>Battery Condition</b>	Battery is not fully charged or in a discharged condition for a long time or the consumption is greater than its capacity.
<b>Overload Protection</b>	Load is higher than the normal capacity of the inverter.
<b>Reverse Polarity</b>	Lack of attention or absence of colour coding of cable.
<b>Capacitor Wear</b>	Life of capacitors is reduced due to over temperature, caused by high current.
<b>Overuse</b>	Inverter is used beyond its operating limit.
<b>Over and Under Voltage</b>	Increase or decrease of voltage or current beyond the rating of the inverter causing damage to the internal components of the device.

Fig 3.2.1: Common causes of UPS/Inverter failure

The following figure shows a general work flow of repairing a faulty or a dysfunctional UPS/Inverter:

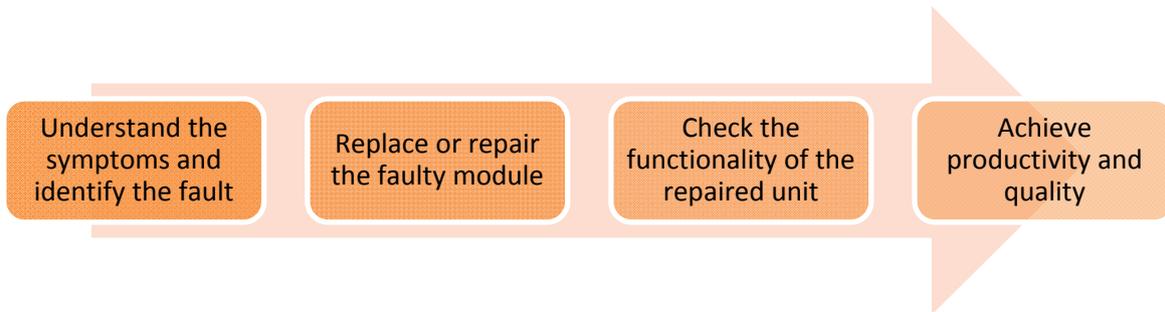


Fig 3.2.2: Workflow of repairing a dysfunctional UPS/Inverter

### 3.2.2 Understand the Symptoms and Identify the Fault Failure

It is very important for a technician to identify the fault in the UPS/Inverter. Wrong identification of fault will lead to waste of time and money and it can also cause damage to the equipment. Some basic steps which need to be followed during fault identification are:

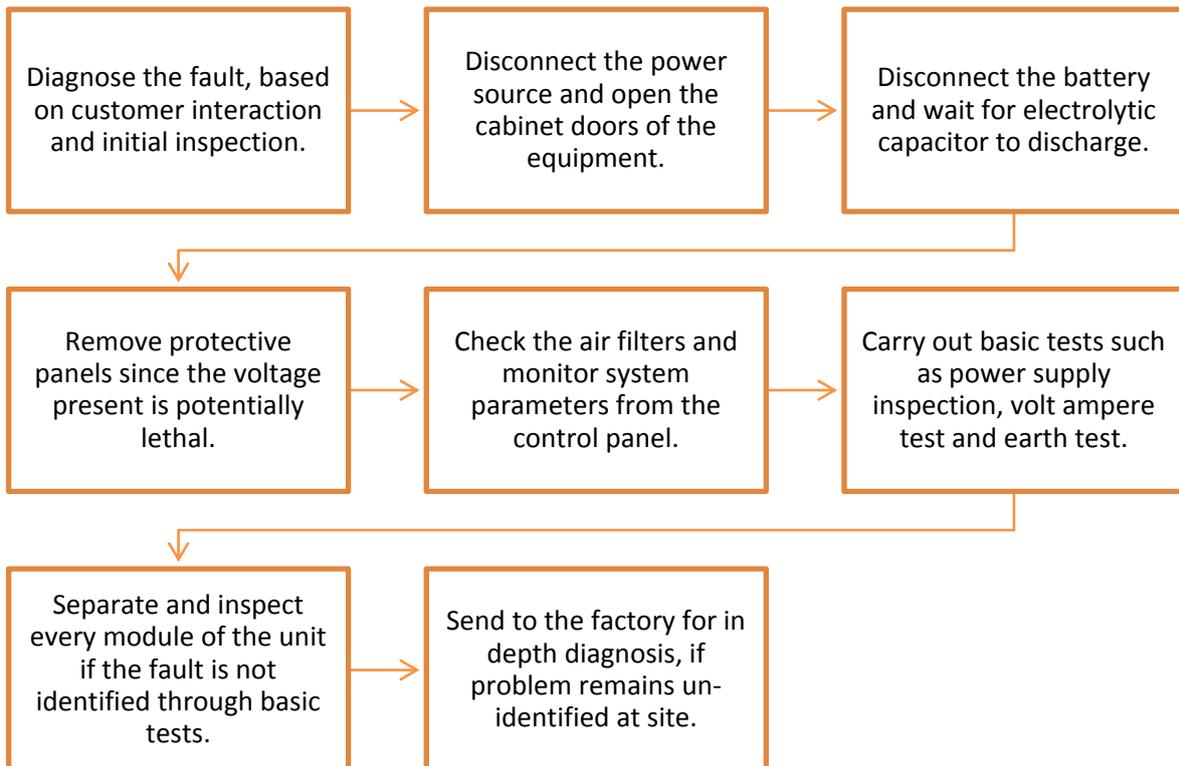


Fig 3.2.3: Workflow for understanding symptoms to identify fault in a UPS/Inverter

### Faults and Symptoms of Dysfunctional UPS/Inverter

It is important to understand the symptoms of the dysfunctional UPS/Inverter for identifying the faults in it. The following table represents the faults along with their potential causes and solutions:

Fault/Symptoms	Potential Causes	Recommended Solutions
<b>Power is on, but there is no display on the panel</b>	R\S\T terminal or L1\L2\L3 terminals do not have input terminal	Check the input power using multimeter.
	Abnormal connection of operation panel	Check the connection between the operation panel and control board.  If the problem is with extension line of the operation panel, replace the extension line.
	Poor contact of control board with function board	Properly connect the flat cable between the two boards.
<b>Display of incorrect numbers on the operation panel</b>	Abnormal connection of operation panel	Check the connection between the operation panel and control board.  If the problem is with extension line of the operation panel, check the wiring and replace the extension line if required.
	Failure in setting up of connection between the UPS and the computer	Verify the communication interface.
<b>Fails to start when it is switched on</b>	Overloading or Short circuit	Switch off the UPS/Inverter and ensure all loads are disconnected.  Ensure that the loads are not internally shorted or defective.

<b>Flashing of AC input indicator</b>	Lack of proper grounding	Verify the wiring.
<b>Flashing of the battery indicator or the indicator is illuminated</b>	Unavailability of battery source or inconsistent supply	Test the battery connections, and restart the UPS/Inverter.
	Defect in input protection fuse	Replace the input protection fuse.
	Mains power supply is beyond the tolerance limit	Check that the supply voltage is within the specified limits of the system.
<b>Reduced backup time</b>	Incomplete charge of batteries	Ensure that the UPS/Inverter is plugged in to recharge the batteries.  Change or clean the terminals of the batteries if they are rusty.
	Overloading of UPS/Inverter	Check load level indicator and reduce the load on the UPS.
	Batteries are unable to hold charge because of their age	Replace the batteries.
<b>UPS is running in inverter mode though there is main electricity supply present</b>	Improper connection with the mains electricity	Ensure the connection and continuity of input power supply.
	Damage in fuses of input	Change the fuse.
	Low input voltage	Install a stabilizer.

<b>Over temperature protection of heatshrink1 and heatshrink2</b>	Over-temperature	Ensure ambient temperature is low by strengthening the ventilation and radiation.
	Blockage of air duct	Clean any foreign object such as dust and wool, in the air duct.
	Fan failure	Check the wiring connection of the fan Replace the fan if required.
	Failure of inverter module	Technical support is required such as trained technician or specialized technician.
	Problem in temperature detection circuit	Contact technical support department for sending the specific module which cannot be fixed at the site.
	Failure of rectifier module	Technical support is required such as trained technician or specialized technician.
<b>Relay contact failure</b>	Loose connection of the internal connectors	Contact specialized technicians for the maintenance.
	Faulty power-on buffer circuit	Technical support is required such as trained technician or specialized technician.

<b>Output to ground short circuit</b>	Wrong ground connection	Remove the connection, correct the error and make the connection as per the manual.  If there is high ground leakage current at the output end of the inverter, then technical support is required.
	Abnormal motor condition	Perform the ground insulation test and then replace the motor if required.
<b>Abnormal power failure while running</b>	Fluctuation in mains power	Test the mains power supply.
<b>Input power failure</b>	Problem in connection in the power terminal	Check power connections following operational regulations.
	Burning of capacitor	Ask for technical support.
	Faulty power-on buffer circuit	Technical support is required such as trained technician or specialized technician.
<b>Abnormal output phase</b>	Problem in connection in the output terminal	Check power connections following operational regulations.
	Output three phases are unbalanced	Stop the power supply and check whether the terminal characteristics at the output side and inverter's direct current (DC) side are consistent.
<b>Failure of Electrically Erasable Programmable Read-only Memory (EEPROM)</b>	Problem in reading and writing of EEPROM	Technical support is required such as trained technician or specialized technician.

<b>Power is under voltage</b>	<b>Power voltage is lower than required operating voltage</b>	<b>Check the input power supply.</b>
	Loose connection at input power terminal	Measure the DC bus voltage and input power using multimeter.  Tighten the terminals for input power.
	Signal failure appeared	Check grid capacity.
	Power supply to internal switching is abnormal	Technical support is required such as trained technician or specialized technician.
<b>Overload protection of Inverter (drive)</b>	Input power is under voltage	Check the input power supply.
	Keeps on overloading for a long time	Reduce load and shorten overloading time.
	Short acceleration/deceleration time	Make the acceleration/deceleration time longer.
	V/F curve ratio is set too large	Adjust V/F curve setting and torque boost.
	Power level of the inverter is less	Replace the inverter with high power level.

### 3.2.3 Replacement of Dysfunctional Module in the UPS/Inverter Unit

Sometimes only the connections of inverter need to be checked and fixed for a dysfunctional UPS/Inverter. This can be done by a field technician. But at times, a specialized technical help/support is required to repair internal circuits or fix a fault. If the first level maintenance cannot rectify a fault, then a trained technician is called. If even the trained technician cannot solve the issue, then a specialized technician associated with third-party or vendor is called.

In such a case, the specialized technician removes and replaces the faulty module with a functional one, either on a second visit or as pre-identified.

In case even the specialized technicians are unable to repair the components or fix the fault, or if the problem is at the PCB level or components cannot be replaced at customer's site, then the faulty module/component is sent to the service centre. The field technician then collects the functional module from the service centre and fixes the inverter at the

customer's site. For example, there is a fault in fuse in an inverter which cannot be repaired. Then, in such as case, the typical steps to replace the dysfunctional fuse in an inverter are listed in the following figure:

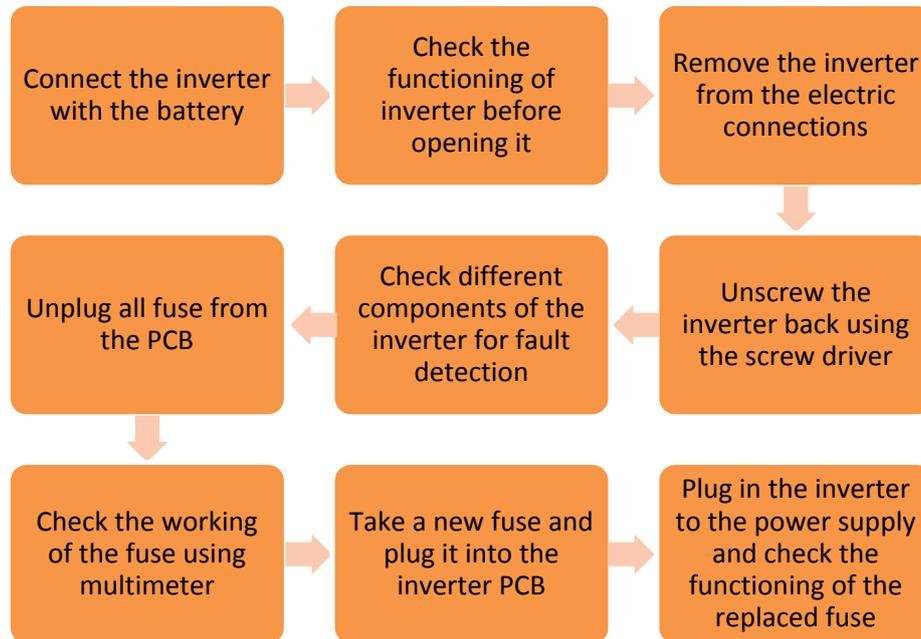


Fig 3.2.4: Replacement of a dysfunctional fuse in an inverter

### 3.2.4 Confirmation of Functionality of the Repaired Module

Once the dysfunctional module has been repaired/replaced, check the new module with testing equipment such as multimeter and ammeter. This is done to ensure whether the module is working fine with the other parts of the inverter. For example, while changing the wires in the inverter circuit, test the connectivity of the wires with the help of continuity tester before plugging into the mains. Otherwise, any loose connection or reverse polarity of cables may cause damage to the circuit. After testing the connection, plug in the repaired inverter to the power supply. Then, again check the functionality of the repaired unit.

The steps that must be followed in order to confirm the functionality of the repaired/replaced module and to record complaint closure:

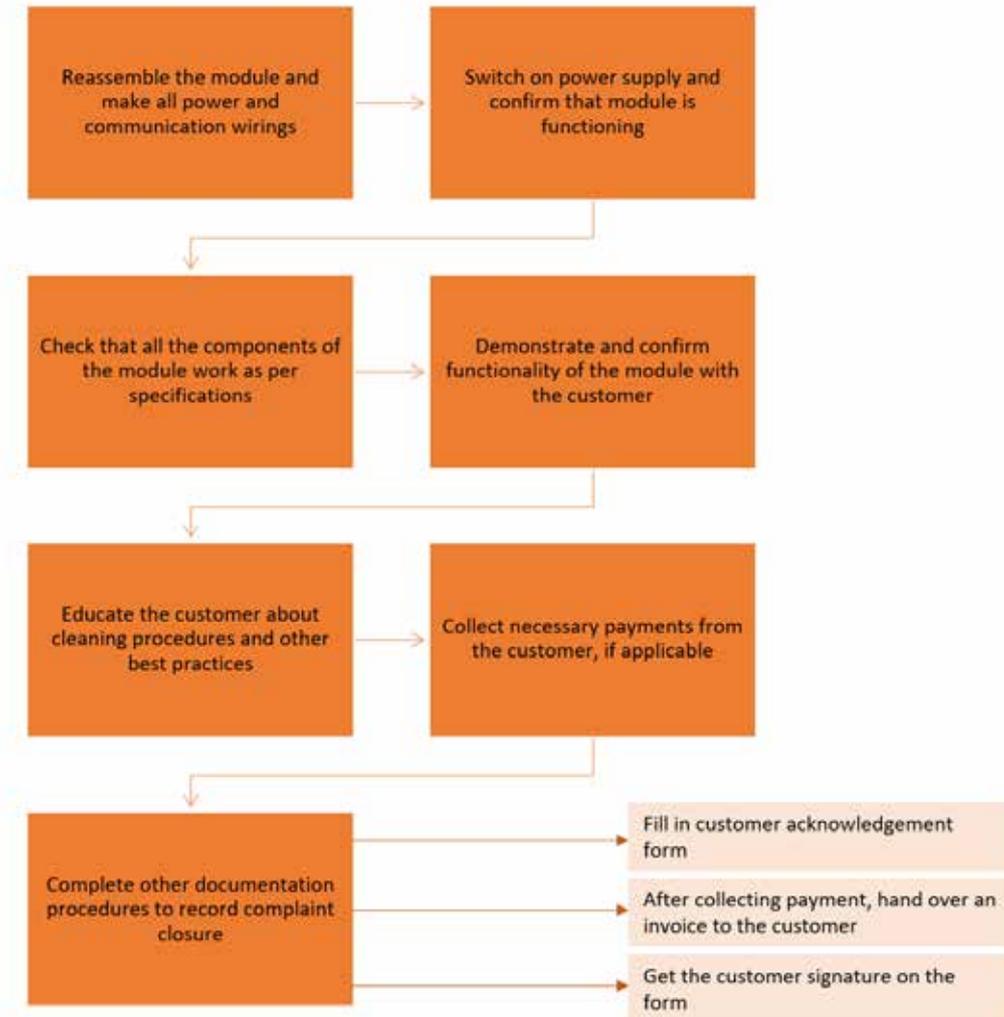


Fig 3.2.5: Steps to confirm functionality of the repaired unit

### 3.2.5 Achieve Productivity and Quality as per Company's Norms

To achieve productivity and quality as per company standards, a technician should follow the working instructions given by the company.

To achieve productivity and quality practise the following:

#### Diagnose

- Diagnose the problem correctly.

#### Resolve

- Repair and show the working of the repaired unit
- Suggest solution to the customer as per requirement
- Resolve the customer's problem within stipulated time.

#### Take feedback

- Ensure 100% customer satisfaction with the service
- Receive the signature of the customer on work completion form
- Receive feedback from the customer

*Fig 3.2.6: Work flow to achieve productivity and quality in repairing*

## Activity

Perform the following activities:

- Connect three batteries in series
- Connect three batteries in parallel
- Connect batteries in series and parallel combination

### **Components:**

- Batteries
- Wires
- Insulation tape
- Wire stripper

## Activity

Repair a dysfunctional 12V inverter which has stopped working due to overheating:

### Components:

- Faulty inverter
- Screw driver set
- Continuity tester
- MOSFET
- Soldering iron
- Soldering wire
- Soldering flux

## Activity

An inverter is showing “ON” but there is no electricity/output in the circuit. Identify and repair the fault.

### **Components:**

Faulty Inverter

- Soldering iron
- Soldering wire
- Soldering flux
- Ammeter
- Indicator circuit
- Green LEDs
- Screw driver set

## Activity

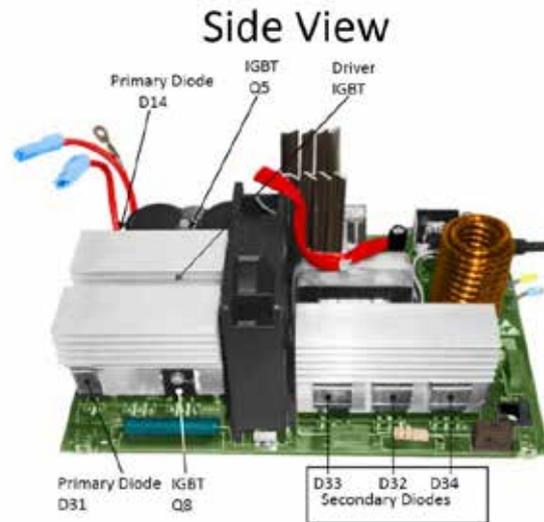
A UPS connected with mains gives 250-volt output but drops to 150 volts when there is no electricity. Debug and repair the fault.

### Components:

- UPS
- Ammeter
- Voltmeter
- Batteries

## Activity

Replace the 3 Secondary diodes (D32, D33 and D34) from an inverter.

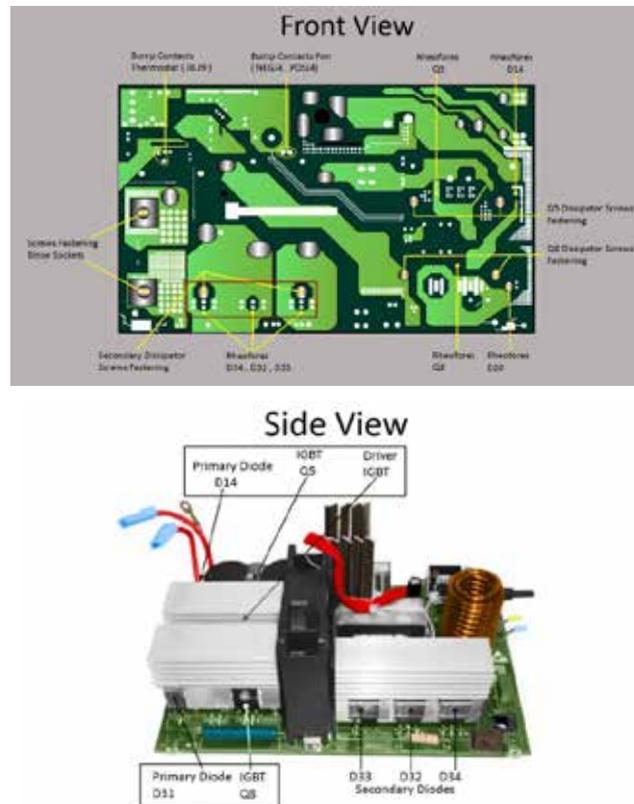


### Components:

- Inverter
- Screw driver set
- IGBT (HGTG20N60A4D)
- Diodes (MUR860)
- Soldering iron
- Soldering wire
- Soldering flux
- Thermo-conductive grease
- Multimeter
- Spacers

## Activity

Replace the IGBT's from the PCB of an inverter.



### Components:

- Inverter
- Screw driver set
- IGBT (HG20N60A4D)
- Diodes (MUR860)
- Soldering iron with stand
- Soldering wire
- Soldering flux
- Thermo-conductive grease
- Multimeter
- Spacers

## Activity

Prepare the inverter and carry out the following test on it:

- Minimum load test
- Intermediate load test
- Rated load test
- Testing the secondary diode voltages

### **Components:**

- Inverter
- Dual trace oscilloscope
- Multimeter
- Screw driver set

## Activity

Perform the task of Battery Test for an inverter.

### Components:

- Inverter
- Digital multimeter
- Battery tester
- Screw drive set
- Screw, bolts and nuts

## Activity

Replace the battery of an inverter.

### Components:

- Inverter
- Digital multimeter
- Battery tester
- Screw drive set
- Screw, bolts and nuts

## Activity

There was a short circuit due to reverse polarity and now the inverter is not working. Identify the fault and correct it.

### Components:

- Inverter
- Philips screwdriver
- Fuses 40A
- Multimeter

## Activity

Perform the task of Inspection and Periodic Maintenance

### Components:

- Screw driver set

## Activity

Connect the power optimizer to each photovoltaic module of a solar inverter.

### Components:

- Inverter
- Allen screwdriver for 5mm screw type for the inverter cover
- DC Safety Unit cover (if applicable)
- Inverter side screws
- Allen screwdriver for M5/M6/M8 screw types
- Standard flat-head screw drivers set
- Non-contact voltage detector
- Cordless drill or screwdriver and bits suitable for the surface on which the inverter will be installed
- Suitable hardware for attaching the inverter mounting bracket to the surface to which it will be connected
- M6 (1/4") or M8 (5/16") stainless bolts, nuts, and washers for attaching the power optimizer to the racking (not required for smart modules)
- MC4 crimper
- Wire cutters
- Wire strippers
- Voltmeter for installing the communication options

## Activity

Mount an inverter on a wall.

### **Components:**

- Inverter
- Mounting bracket
- Make shift rack/wall
- Allen screws for fastening the inverter to the mounting bracket
- Installation guide (with activation card and instructions)
- If a built-in global system for mobile communication (GSM)/Wi-Fi modem is installed – radio frequency (RF) antenna and mounting bracket
- AC ferrite bead kit

## Activity

Connect the AC grid to the inverter and start the inverter.

### Components:

- Three wire cable and five wire cable
- Inverter
- Wire stripper
- Screw driver set
- Connectors

## Practical

Install a Sine wave inverter at a customer's site.

### Components:

- Inverter
- Wire cutters/strippers
- Drill and 1/8" (3 mm) drill bit
- Philips and flat-head screw drivers
- 3A AC in-line fuse
- 100A DC in-line fuse
- Toggle switch (if remote switch is used)

## Practical

Perform installation of an UPS/Inverter at site.

### Components:

- Packaged inverter and housing set up
- Two lead acid batteries
- Battery connecting wires with connectors (Red and Black)
- AC wire with three pin socket
- Unpacking knife
- Trolley
- Multimeter
- Safety gloves
- Cleaning brush and distilled water
- Hydrometer
- Screw driver Philips head

## Practical



Troubleshoot an UPS/Inverter after installation and perform a manual bypass test.

### Components:

- Set of a UPS/Inverter
- Loads connected with the UPS/Inverter like computer system

## Practical

Install the UPS in smart mode and in standard mode.

### Components:

- UPS
- RS-232 cable
- Philips screw driver
- RS-232 connector
- P/N 226-341-005, six foot cable or P/N 226-341-006, three foot cable

## Practical

Perform installation of UPS Internal Power control wiring and External Power Control Wiring.

### **Components:**

- Inverter and battery set up
- DC link cables (negative and positive)
- Module Bypass Cabinet cables
- 15-pin control wiring harness connector.
- 3-pin control wiring harness connector
- DC power wirings



## 4. Soft Skills and Work Ethics

Unit 4.1 – Effective Communication and Coordination at Work

Unit 4.2 – Working Effectively and Maintaining Discipline at Work

Unit 4.3 – Maintaining Social Diversity at Work



## Key Learning Outcomes



**By the end of this unit, participants will be able to:**

1. State the importance of work ethics and workplace etiquette
2. State the importance of effective communication and interpersonal skills
3. Explain ways to maintain discipline in the workplace
4. Discuss the common reasons for interpersonal conflict and ways of managing them effectively.

## UNIT 4.1: Effective Communication and Coordination at Work

### Unit Objectives

**By the end of this unit, participants will be able to:**

1. Work effectely at the workplace.
2. Demonstrate practicesrelated to gender and PwD sensitazation.

### 4.1.1 Importance of Work Ethics and Workplace Etiquette

Workplace ethics are a set of moral and legal guidelines that organizations follow. These guidelines influence the way customers and employees interact with an organization. Workplace ethics essentially guide how an organization serves its clients and treats its employees.

For example, if a company seeks to fulfil the promises it makes, it may develop processes and set up a robust support system to address this policy and build customer/client loyalty. To achieve this goal, the company may implement specific incentive programs for employees to encourage them to produce high-quality work and ensure the organization fulfils the promises it makes to its clients/ customers.

Many organizations, often the large ones, set detailed ethical codes to guide their operations and control how the organizational processes impact the stakeholders. These ethics usually help organizations maintain certain standards of responsibility, accountability, professionalism and among others, as they navigate through different challenges and day-to-day circumstances. By following these guidelines, organizations often experience several benefits that improve the lives of stakeholders, such as customers, employees, leaders, etc.

#### Examples of Common Workplace Ethics



*Fig. 4.1.1 Examples of Common Workplace Ethics*

Workplace ethics are essential for a successful organization with a satisfied and loyal team. High ethical standards help in ensuring all stakeholders, such as customers, investors, employees, and other individuals involved in the workplace operations, feel the organization is safeguarding their interests. By creating and implementing ethical guidelines, organizations can keep the best interests of their employees in mind while maintaining a positive influence on those they impact through their processes. As a result, employees maintain the organization's best interests by being ethical in their daily work duties. For example, fairly-treated employees of an organization who understand the organization's commitments to environmental sustainability are usually less likely to behave in a manner that causes harm to the environment. Thus, they help maintain a positive public image of the organization. It means that workplace ethics help in maintaining reciprocal relationships that benefit organizations at large and the individuals associated with and influenced by the organizational policies.

### Benefits of Workplace Ethics

There are various benefits of implementing workplace ethics. When organizations hold themselves to high ethical standards, leaders, stakeholders, and the general public can experience significant improvements. Following are some of the key benefits of employing ethics in the workplace:



Fig. 4.1.2 Benefits of Workplace Ethics

## 4.1.2 Interpersonal Communication

Interpersonal communication is a process that involves sharing ideas and emotions with another person, both - verbally and non-verbally. It is essential to interact effectively with others in both personal and professional lives. In professional life or the workplace, strong interpersonal skills play a crucial role in achieving effective collaboration with colleagues.

### Interpersonal Skills

Interpersonal skills, in other terms, are known as people skills, which are used to communicate and interact with others effectively. These are soft skills one uses to communicate with others and understand them. One uses these skills in daily life while interacting with people

### Examples of Interpersonal Skills



Fig 4.1.3 Examples of Interpersonal Skills

Numerous interpersonal skills involve communication. Communication can be verbal, such as persuasion or tone of voice — or non-verbal, such as listening and body language.

### Importance of Interpersonal Skills

Interpersonal skills are essential for communicating and collaborating with groups and individuals in both personal and professional life. People with strong interpersonal skills often are able to build good relationships and also tend to work well with others. Most people often enjoy working with co-workers who have good interpersonal skills.

Among other benefits of good interpersonal skills is the ability to solve problems and make the best decisions. One can use the ability to understand others and good interpersonal communication skills to find the best solution or make the best decisions in the interest of everyone involved. Strong interpersonal skills help individuals work well in teams and collaborate effectively. Usually, people who possess good interpersonal skills also tend to be good leaders, owing to their ability to communicate well with others and motivate the people around them.

Interpersonal communication is the key to working in a team environment and working collectively to achieve shared goals. Following are the interpersonal

### **Verbal Communication**

The ability to speak clearly, appropriately and confidently can help one communicate effectively with others. It is vital to select the appropriate vocabulary and tone for the target audience.

For example – one should speak formally and professionally in the work environment, while informal language is acceptable in an intimate environment with close friends and family. Also, one should avoid using complex or technical language while communicating with an audience that may not be familiar with it. Using simple language in a courteous tone helps achieve better communication, irrespective of the audience.

### **Active Listening**

Active listening is defined as the ability to pay complete or undivided attention to someone when they speak and understand what they are saying. It is important for effective communication because without understanding what the speaker is saying, it becomes difficult to carry forward a conversation. One should ensure to use appropriate verbal and non-verbal responses, e.g. eye contact, nodding, or smiling, to show interest in what the speaker says. Active listening is also about paying attention to the speaker's body language and visual cues. Asking and answering questions is one of the best ways to demonstrate an interest in conversing with the other person.

Active listening is critical for communicating effectively without ambiguity. It helps one understand the information or instructions being shared. It may also encourage co-workers to share their ideas, which ultimately helps achieve collaboration.

### **Body Language**

One's expression, posture, and gestures are as important as verbal communication. One should practice open body language to encourage positivity and trust while communicating. Open body language includes - maintaining eye contact, nodding, smiling and being comfortable. On the other hand, one should avoid closed body language, e.g. crossed arms, shifting eyes and restless behaviour.

### **Empathy**

Empathy is the ability to understand the emotions, ideas and needs of others from their point of view. Empathy is also known as emotional intelligence. Empathetic people are good at being aware of others' emotions and compassionate when communicating with them. Being empathetic in the workplace can be good to boost the morale of employees and improve productivity. By showing empathy, one can gain the trust and respect of others.

### **Conflict Resolution**

One can use interpersonal communication skills to help resolve disagreements and conflicts in the workplace. This involves the application of negotiation and persuasion skills to resolve arguments between conflicting parties. It is also important to evaluate and understand both sides of the argument by listening closely to everyone involved and finding an amicable solution acceptable to all.

Good conflict resolution skills can help one contribute to creating a collaborative and positive work environment. With the ability to resolve conflicts, one can earn the trust and respect of co-workers. Interpersonal communication skills that are vital for success at work:

## Teamwork

Employees who communicate and work well in a team often have better chances of achieving success and common goals. Being a team player can help one avoid conflicts and improve productivity. One can do this by offering to help co-workers when required and asking for their feedback and ideas. When team members give their opinions or advice, one should positively receive and react to the opinions/advice. One should be optimistic and encouraging when working in groups.

## Improving Interpersonal Skills

One can develop interpersonal skills by practising good communication and setting goals for improvement. One should consider the following tips to improve their interpersonal skills:

- One should ask for feedback from co-workers, managers, family or friends to figure out what needs improvement concerning their interpersonal skills.
- One can identify the areas of interpersonal communication to strengthen by watching others.
- One can learn and improve interpersonal skills by observing co-workers, company leaders and professionals who possess good interpersonal skills. This includes watching and listening to them to note how they communicate and the body language used by them. It is vital to note their speed of speaking, tone of voice, and the way they engage with others. One should practice and apply such traits in their own interactions and relationships.
- One should learn to control their emotions. If stressed or upset, one should wait until being calm to have a conversation. One is more likely to communicate effectively and confidently when not under stress.
- One can reflect on their personal and professional conversations to identify the scope of improvement and learn how to handle conversations better or communicate more clearly. It helps to consider whether one could have reacted differently in a particular situation or used specific words or positive body language more effectively. It is also vital to note the successful and positive interactions to understand why they are successful.
- One should practice interpersonal skills by putting oneself in positions where one can build relationships and use interpersonal skills. For example, one can join groups that have organized meetings or social events. These could be industry-specific groups or groups with members who share an interest or hobby.
- Paying attention to family, friends and co-workers and making efforts to interact with them helps a lot. One should complement their family, friends and co-workers on their good ideas, hard work and achievements. Trying to understand someone's interests and showing interest in knowing them can help one build strong interpersonal skills. Offering to help someone, especially in difficult situations, helps build stronger and positive workplace relationships.
- One should avoid distractions, such as a mobile phone, while interacting with someone. Giving someone full attention while avoiding distractions helps achieve a clear exchange of ideas. By listening with focus, one can understand and respond effectively.

- One can attend appropriate courses on interpersonal skills or sign up for workshops at work to improve interpersonal skills. One can find many resources online also, such as online videos.
- For personal mentoring, one can approach a trusted family member, friend, co-worker, or current/former employer. A person one looks up to with respect and admires is often a good choice to be selected as a mentor. One can even hire a professional career or communication coach.

Interpersonal communication skills often help one boost their morale, be more productive in the workplace, complete team projects smoothly and build positive and strong relationships with co-workers.



## UNIT 4.2: Working Effectely and Maintaining Discipline at Work

### Unit Objectives

**By the end of this unit, participants will be able to:**

- Discuss the importance of following organizational guidelines for dress code, time schedules, language usage and other behavioural aspects
- Explain the importance of working as per the workflow of the organization to receive instructions and report problems
- Explain the importance of conveying information/instructions as per defined protocols to the authorised persons/team members
- Explain the common workplace guidelines and legal requirements on non-disclosure and confidentiality of business-sensitive information
- Describe the process of reporting grievances and unethical conduct such as data breaches, sexual harassment at the workplace, etc.
- Discuss ways of dealing with heightened emotions of self and others.

### 4.2.1 Discipline at Work

Discipline is essential for organizational success. It helps improve productivity, reduce conflict and prevent misconduct in the workplace. It is important to have rules concerning workplace discipline and ensure that all employees comply with them. In the absence of discipline, a workplace may experience conflicts, bullying, unethical behaviour and poor employee performance. An efficient workplace disciplinary process helps create transparency in the organization. Benefits of disciplinary standards:

All employees follow the same rules which helps establish uniformity and equality in the workplace

Managers and supervisors have defined guidelines on what actions to take while initiating disciplinary action

With well-defined and enforced disciplinary rules, an organization can avoid various safety, security, reputational risks

*Fig 4.2.1 Benefits of Disciplinary Standards*

Maintaining an organized and cohesive workforce requires maintaining discipline in both personal and professional behaviour. It is important to follow the appropriate measures to keep employees in line without affecting their morale.

### Defining Discipline

The first and crucial step in maintaining workplace discipline is to define what is meant by discipline. It helps to evaluate common discipline problems and devise guidelines for handling them effectively.

Among a number of areas, discipline usually covers:

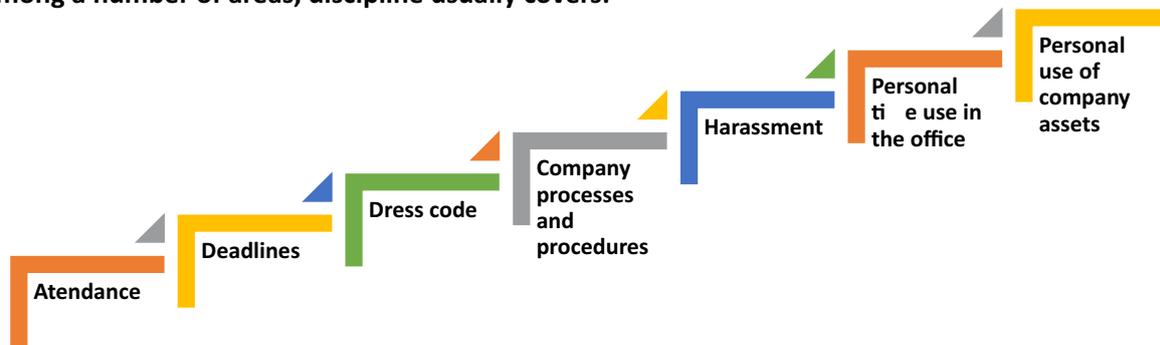


Fig 4.2.2 Examples of Workplace Discipline

According to demography and local issues, it may also include substance use and related issues.

It is vital for a workplace to have an employee handbook or company policy guide, to serve as a rulebook for employees to follow. The employee handbook/ company policy guide should be reviewed and updated periodically according to any issues or areas, or concerns identified concerning workplace discipline. Such manuals should also cover all the laws and regulations governing workplace behaviour.

Defining and documenting workplace rules aids in their implementation, ensuring little or no ambiguity. All employees in a workplace should also have easy access to the workplace guidelines so that they can refer to them to get clarity whenever required. To maintain discipline at work, it is also critical to ensure uniform application of workplace guidelines to all employees without exception.

## 4.2.2 Employee Code of Conduct

The employee code of conduct manual serves as a guide for employees to inform them regarding the behaviour expected from them at work. It helps create a good work environment with consistent behaviour from employees. The manual should list examples of acceptable and not acceptable behaviours at work. The code of conduct should be discussed with employees so that they have the clarifications required.

For example, an organization may create guidelines concerning the conduct with clients to ensure no contact is made with them except for business purposes, also prescribing the use of appropriate means of communication.

Employees should have a clear understanding concerning their job responsibilities and the behaviour expected from them with all stakeholders, e.g. company personnel, clients and associated third parties. It is critical to have documented guidelines for employees to follow concerning all aspects of work. It should also document the disciplinary action to be followed in case of non-compliance, e.g. verbal and

then written warning, temporary suspension or eventual termination of service in case of repeated non-compliance with the employee code of conduct. Employees should know what the company rules are and what will happen if they break the rules. However, disciplinary action should be initiated only when reasonably required to avoid its misuse for employee harassment.

There should also be an effective mechanism for employees to raise their concerns/ grievances and have them addressed while maintaining privacy, as required, e.g. raising concerns regarding the behaviour of a co-worker.

The employee code of conduct manual must be duly reviewed and approved by the concerned stakeholders, such as the Human Resources (HR) department and company executives.

### 4.2.3 Interpersonal Conflicts

Interpersonal conflict is any type of conflict between two or more people. These are found in both - personal and professional relationships - among friends, family, and co-workers. In the workplace, interpersonal conflict is often observed when a person or group of people interfere with another person's attempts at completing assignments and achieving goals. It is critical to resolve conflicts in the workplace to boost the morale of employees, repair working relationships among them, and improve customer satisfaction.

#### Reasons for Workplace Conflicts

Workplace conflicts are often observed when two or more people have different points of view. This can happen between managers, co-workers, or clients and customers. In general, interpersonal conflicts are caused by a lack of communication or unclear communication.

Some of the leading reasons for workplace conflicts are:

- Difference in values
- Personality clashes
- Poor communication

Example of poor communication – if a manager reassigns a task to another employee without communicating with the employee to whom it was originally assigned, interpersonal conflict can arise among them. This may potentially make the first employee, i.e. who was originally assigned the task, feel slighted and mistrusted by the manager. It may even cause animosity in the first employee toward the employee who has now been assigned the task.

### Types of Interpersonal Conflict

Following are the four types of interpersonal conflicts:

**a. Policy-related interpersonal conflict**

When a conflict relates to a decision or situation that involves both parties, it can be called a policy-related interpersonal conflict. Example – two people or groups working on the same project, trying to adopt different approaches. To resolve policy-related interpersonal conflicts, the parties involved should try to look for a win-win situation or make a compromise. This is especially critical to resolve trivial issues so that work is not affected and common goals are achieved.

**b. Pseudo-conflicts**

Pseudo-conflict arises when two people or groups want different things and cannot reach an agreement. Pseudo-conflicts usually involve trivial disagreements that tend to hide the root of the issue.

**c. Ego-related interpersonal conflicts**

In ego conflicts, losing the argument may hurt or damage a person's pride. Sometimes ego conflicts arise when a number of small conflicts pile up on being left unresolved. To resolve ego-related conflicts, it's best to find the root of the issue and work towards a resolution.

**d. Value-related interpersonal conflicts**

Sometimes conflicts may occur between people when they have different value systems. Such conflicts can be difficult to identify initially, making the people involved think the other party is being disagreeable or stubborn, wherein they just have different values. Some co-workers may highly value their personal/ family time after office that they may be unreachable to clients during non-office hours, while others may place a high value on client satisfaction and may still be available for clients during non-office hours. Conflict may arise among such people when they may be required to coordinate to help a client during after-office hours. Value-related interpersonal conflicts are often difficult to settle since neither party likes to compromise.

### Resolving Interpersonal Conflicts

Conflicts are usually likely in the workplace; they can, however, be prevented. Often resolving interpersonal conflicts through open communication helps build a stronger relationship, paving the way for effective coordination and success. Some ways to resolve interpersonal conflict:

- **Communication** - A great way to resolve interpersonal conflicts is for the opposing parties to listen to one another's opinions and understand their viewpoints. Meeting in person and keeping the conversation goal-oriented is important. One can have effective communication by following some measures, e.g. staying on the topic, listening actively, being mindful of the body language, maintaining eye contact, etc.

- **Active Listening** - One should patiently listen to what the other person is saying without interrupting or talking over them. It helps one display empathy and get to the root of the issue. Asking questions to seek clarification when required helps in clear communication and conveys to the other person that one is listening to them. Practising active listening is a great way to improve one's communication skills.
- **Displaying Empathy** - Listening attentively and identifying the anxieties/ issues of co-workers is a great way to show empathy and concern. It is essential to understand their feelings and actions to encourage honesty and avoid future conflict.
- **Not Holding Grudges** - With different types of people and personalities in a workplace, it is common for co-workers to have conflicts. It is best to accept the difference in opinions and move on. Being forgiving and letting go of grudges allows one to focus on the positive side of things and perform better at work.

Work-related interpersonal conflicts can be complicated because different people have different leadership styles, personality characteristics, job responsibilities and ways in which they interact. One should learn to look above interpersonal conflicts, resolving them to ensure work goals and environment are not affected.

#### 4.2.4 Importance of Following Organizational Guidelines

Policies and procedures or organizational guidelines are essential for any organization. These provide a road map for the operations of the organization. These are also critical in ensuring compliance with the applicable laws and regulations by guiding the decision-making process and business operations.

Organizational guidelines help bring uniformity to the operations of an organization, which helps reduce the risk of unwanted and unexpected events. These determine how employees are supposed to behave at work, which ultimately helps the business achieve its objectives efficiently.

However, organizational guidelines are ineffective and fail to serve their purpose if they are not followed. Many people don't like the idea of following and abiding by specific guidelines. Such people should be made to understand the benefits of following the organizational guidelines. Some of the key benefits are given below:

With well-defined organizational guidelines in place, no individual can act arbitrarily, irrespective of their position in the organization. All individuals will know the pros and cons of taking certain actions and what to expect in case of unacceptable behaviour. Benefits of following organizational guidelines:

- Consistent processes and structures - Organization guidelines help maintain consistency in operations, avoiding any disorder. When all employees follow the organizational guidelines, an organization can run smoothly. These ensure that people in different job roles operate as they are supposed to, knowing what they are responsible for, what is expected of them, and what they can expect from their supervisors and co-workers. With clarity in mind, they can do their jobs with confidence and excellence. With every person working the way intended, it's easy to minimise errors.

With all the staff following organizational guidelines, the organization has a better scope of using time and resources more effectively and efficiently. This allows the organization to grow and achieve its objectives.

- **Better quality service** - By following organizational guidelines, employees perform their duties correctly as per the defined job responsibilities. It helps enhance the quality of the organization's products and services, helping improve the organization's reputation. Working with a reputable organization, employees can take pride in their work and know they are contributing to the reputation.
- **A safer workplace** - When all employees follow organizational guidelines, it becomes easy to minimise workplace incidents and accidents. It reduces the liabilities associated with risks for the organization and limits the interruptions in operations. Employees also feel comfortable and safe in the workplace, knowing their co-workers are ensuring safety at work by following the applicable guidelines.

Different organizations may have different guidelines on dress code, time schedules, language usage, etc. For example – certain organizations in a client-dealing business requiring employees to meet clients personally follow a strict dress code asking their employees to wear formal business attire. Similarly, organizations operating in specific regions may require their employees to use the dominant regional language of the particular region to build rapport with customers and serve them better. Certain organizations, such as banks, often give preference to candidates with knowledge of the regional language during hiring.

Working hours may also differ from one organization to another, with some requiring employees to work extra compared to others. One should follow the organizational guidelines concerning all the aspects of the employment to ensure a cohesive work environment.

## 4.2.5 Workflow

Workflow is the order of steps from the beginning to the end of a task or work process. In other words, it is the way a particular type of work is organised or the order of stages in a particular work process.

Workflows can help simplify and automate repeatable business tasks, helping improve efficiency and minimise the room for errors. With workflows in place, managers can make quick and smart decisions while employees can collaborate more productively.

Other than the order that workflows create in a business, these have several other benefits, such as:

- Identifying Redundancies - Mapping out work processes in a workflow allows one to get a clear, top-level view of a business. It allows one to identify and remove redundant or unproductive processes.

Workflow gives greater insights into business processes. Utilizing such useful insights, one can improve work processes and the bottom line of the business. In many businesses, there are many unnecessary and redundant tasks that take place daily. Once an organization has insight into its processes while preparing workflow, it can determine which activities are really necessary.

Identifying and eliminating redundant tasks creates value for a business. With redundant tasks and processes eliminated, an organization can focus on what's important to the business.

- Increase in Accountability and Reduction in Micromanagement - Micromanagement often causes problems in a business setting as most employees don't like being micromanaged, and even many managers don't like the practice. Micromanagement is often identified as one of the reasons why people quit their job.

However, the need for micromanagement can be minimized by clearly mapping out the workflow. This way, every individual in a team knows what tasks need to be completed and by when and who is responsible for completing them. This makes employees more accountable also.

With clearly defined workflow processes, managers don't have to spend much time micromanaging their employees, who don't have to approach the manager to know what the further steps are. Following a workflow, employees know what is going on and what needs to be done. This, in turn, may help increase the job satisfaction of everyone involved while improving the relationships between management and employees.

- Improved Communication - Communication at work is critical because it affects all aspects of an organization. There are instances when the main conflict in an organization originates from miscommunication, e.g. the management and employees disagreeing on an aspect, despite pursuing the same objectives. Poor communication is a common workplace issue that is often not dealt with.
- This highlights why workflow is important. Workplace communication dramatically can increase with the visibility of processes and accountability. It helps make the daily operations smoother overall.

- **Better Customer Service** - Customers or clients are central to a business. Therefore, it is imperative to find and improve ways to improve customer experience. Relying on outdated manual systems may cause customer requests or complaints to be overlooked, with dissatisfied customers taking their business elsewhere. However, following a well-researched and defined workflow can help improve the quality of customer service.

By automating workflows and processes, an organization can also reduce the likelihood of human error. This also helps improve the quality of products or services over time, resulting in a better customer experience.

### 4.2.6 Following Instructions and Reporting Problems

All organizations follow a hierarchy, with most employees reporting to a manager or supervisor. For organizational success, it is vital for employees to follow the instructions of their manager or supervisor. They should ensure they perform their duties as per the given instructions to help achieve the common objectives of the organization and deliver quality service or products. This consequently helps maintain the reputation of the organization.

It is also important to be vigilant and identify problems at work or with the organizational work processes. One should deal with the identified within their limits of authority and report out of authority problems to the manager/ supervisor or the concerned person for a prompt resolution to minimise the impact on customers/clients and business.

### 4.2.7 Information or Data Sharing

Information or data is critical to all organizations. Depending on the nature of its business, an organization may hold different types of data, e.g. personal data of customers or client data concerning their business operations and contacts. It is vital to effective measures for the appropriate handling of different types of data, ensuring its protection from unauthorized access and consequent misuse.

One should access certain data only if authorised to do so. The same is applicable when sharing data which must be shared only with the people authorised to receive it to use it for a specific purpose as per their job role and organizational guidelines. For example – one should be extra cautious while sharing business data with any third parties to ensure they get access only to the limited data they need as per any agreements with them. It is also critical to monitor how the recipient of the data uses it, which should strictly be as per the organizational guidelines. It is a best practice to share appropriate instructions with the recipient of data to ensure they are aware of the purpose with which data is being shared with them and how they are supposed to use and handle it. Any misuse of data must be identified and reported promptly to the appropriate person to minimise any damage arising out of data misuse.

These days most organizations require their employees and business partners or associated third parties to sign and accept the relevant agreement on the non-disclosure of business-sensitive information. In simple terms, business-sensitive information is confidential information. It is proprietary business information collected or created during the course of conducting business, including information about the business, e.g. proposed investments, intellectual property, trade secrets, or plans for a merger and information related to its clients. Business-sensitive information may sometimes also include information regarding a business's competitors in an industry.

The release of business-sensitive information to competitors or the general public poses a risk to a business. For example, information regarding plans for a merger could be harmful to a business if a competitor gets access to it.

#### 4.2.8 Reporting Issues at Work

Most organizations have defined guidelines on appropriate reporting processes to be followed for reporting different types of issues. For example – one can report any grievances or dissatisfaction concerning co-workers to their manager/supervisor, e.g. data breaches or unethical conduct. If the concern is not addressed, then the employee should follow the organizational guidelines and hierarchy for the escalation of such issues that are not addressed appropriately.

For example – any concern related to sexual harassment at the workplace should be escalated to the concerned spokesperson, such as Human Resources (HR) representative, and if not satisfied with the action taken, it should be reported to the senior management for their consideration and prompt action.

#### 4.2.9 Dealing with Heightened Emotions

Humans are emotional beings. There may be occasions when one is overwhelmed by emotions and is unable to suppress them. However, there may be situations when one must manage emotions well, particularly at work.

Stress in one's personal and professional life may often cause emotional outbursts at work. Managing one's emotions well, particularly the negative ones, is often seen as a measure of one's professionalism. Anger, dislike, frustration, worry, and unhappiness are the most common negative emotions experienced at work.

##### **Ways to manage negative emotions at work:**

- **Compartmentalisation** – It's about not confining emotions to different aspects of one's life. For example, not letting negative emotions from personal life affect work-life and vice versa. One should try to leave personal matters and issues at home. One should train their mind to let go of personal matters before reaching work. Similarly, one can compartmentalise work-related stresses so that negative emotions from work don't affect one's personal life.

- **Deep breathing and relaxation** – Deep breathing helps with anxiety, worry, frustration and anger. One should take deep breaths, slowly count to ten - inhaling and exhaling until one calms down. One can also take a walk to calm down or listen to relaxing music. Talking to someone and sharing concerns also helps one calm down.
- **The 10-second rule** - This is particularly helpful in controlling anger and frustration. When one feels their temper rising, they should count to 10 to calm down and recompose. If possible, one should move away to allow temper to come down.
- **Clarify** - It is always good to clarify before reacting, as it may be a simple case of misunderstanding or miscommunication.
- **Physical activity** - Instead of losing temper, one should plan to exercise, such as running or going to the gym, to let the anger out. Exercise is also a great way to enhance mood and release any physical tension in the body.
- **Practising restraint** - One should avoid replying or making a decision when angry, not allowing anger or unhappiness to cloud one's judgement. It may be best to pause any communication while one is angry, e.g. not communicating over email when angry or upset.
- **Knowing one's triggers** - It helps when one is able to recognise what upsets or angers them. This way, one can prepare to remain calm and plan their reaction should a situation occur. One may even be able to anticipate the other party's reaction.
- **Be respectful** - One should treat their colleagues the same way one would like to be treated. If the other person is rude, one need not reciprocate. It is possible to stay gracious, firm and assertive without being aggressive. Sometimes, rude people back away when they don't get a reaction from the person they are arguing with.
- **Apologise for any emotional outburst** – Sometimes, one can get overwhelmed by emotions, reacting with an emotional outburst. In such a case, one should accept responsibility and apologise immediately to the affected persons without being defensive.
- **Doing away with negative emotions** - It is recommended to let go of anger, frustration and unhappiness at the end of every workday. Harboring negative emotions affects one emotionally, affecting their job performance also. Engaging in enjoyable activities after work is a good stress reliever.



## UNIT 4.3: Maintaining Social Diversity at Work

### Unit Objectives

**By the end of this unit, participants will be able to:**

1. Explain the concept and importance of gender sensitivity and equality.
2. Discuss ways to create sensitivity for different genders and Persons with Disabilities (PWD).

### 4.3.1 Gender Sensitivity

Gender sensitivity is the act of being sensitive towards people and their thoughts regarding gender. It ensures that people know the accurate meaning of gender equality, and one's gender should not be given priority over their capabilities.



Fig 4.3.1 Gender Equality

Women are an important source of labour in many sectors, yet they have limited access to resources and benefits. Women should receive the same benefits and access to resources as men. A business can improve its productivity and quality of work by providing better support and opportunities to women.

#### Important Terms

- **Gender Sensitivity-** Gender sensitivity is the act of being sensitive to the ways people think about gender.
- **Gender Equality** - It means persons of any gender enjoy equal opportunities, responsibilities, and rights in all areas of life.
- **Gender Discrimination** – It means treating an individual unequally or disadvantageously based on their gender, e.g. paying different wages to men and women for similar or equal job positions.

### **Strategies for Enhancing Gender Equity**

To enhance gender equity, one should:

- Follow gender-neutral practices at all levels at work.
- Participate together in decision-making.
- Help in promoting women's participation in different forums.
- Assist women in getting exposure to relevant skills and practices.
- Assist women in capacity building by mentoring, coaching or motivating them, as appropriate.
- Assist in the formation and operation of women support groups.
- Assist in the implementation of women-centric programmes.
- Combine technical training with reproductive health and nutrition for coffee farming households.
- Assist in making a work environment that is healthy, safe, and free from discrimination.

### **Bridging Gender Differences**

Men and women react and communicate very differently. Thus, there are some work differences as both genders have their style and method of handling a situation.

Although, understanding and maturity vary from person to person, even between these genders, based on their knowledge, education, experience, culture, age, and upbringing, as well as how one's brain functions over a thought or problem.

#### **In order to bridge the gap, one should:**

- Not categorize all men and women in one way.
- Be aware of the verbal and non-verbal styles of communication of every gender to avoid any miscommunication and work better.
- Be aware of partial behaviour and avoid it.
- Encourage co-workers of different genders to make room by providing space to others.

### **Ways to reduce Gender Discrimination**

- Effective steps against sexual harassment by the concerned authorities and general public.
- Gender stereotypes are how society expects people to act based on their gender. This can only be reduced by adopting appropriate behaviour and the right attitude.
- Objectification of females must be abolished.

### Ways to Promote Gender Sensitivity in the Workplace

Practices that promote gender diversity should be adopted and promoted.

- All genders should receive equal responsibilities, rights, and privileges.
- All genders should have equal pay for similar or the same job roles/ positions.
- Strict and effective workplace harassment policies should be developed and implemented.
- An open-minded and stress-free work environment should be available to all the employees, irrespective of their gender.
- Women should be encouraged to go ahead in every field of work and assume leadership roles.
- Follow appropriate measures for women's empowerment.
- Men should be taught to be sensitive to women and mindful of their rights.

## 4.3.2 PwD Sensitivity

Some individuals are born with a disability, while others may become disabled due to an accident, illness or as they get old. People with Disabilities (PwD) may have one or more areas in which their functioning is affected. A disability can affect hearing, sight, communication, breathing, understanding, mobility, balance, and concentration or may include the loss of a limb. A disability may contribute to how a person feels and affect their mental health

### Important Terms

• **Persons with Disabilities (PwD)** – Persons with Disabilities means a person suffering from not less than 40% of any disability as certified by a medical authority.

### •Types of Disability:

- a. Blindness – Visually impaired
- b. Low Vision
- c. Leprosy Cured
- d. Hearing impairment
- e. Locomotor disability
- f. Mental retardation
- g. Mental illness

### PwD Sensitivity

PwD sensitivity promotes empathy, etiquette and equal participation of individuals and organizations while working with individuals with a disability, e.g. sensory, physical or intellectual.

### Ways to be PwD Sensitive

#### To be sensitive to PwD, one should:

- Be respectful to all Persons with Disabilities (PwD) and communicate in a way that reflects PwD sensitivity.
- Always be supportive and kind towards a PwD with their daily chores.
- Be ready to assist a PwD to help them avail of any benefit/ livelihood opportunity/ training or any kind that helps them grow.
- Encourage and try to make things easier and accessible to PwD so that they can work without or with minimum help.
- Protest where feasible and report any wrong act/behaviour against any PwD to the appropriate authority.
- Learn and follow the laws, acts, and policies relevant to PwD.

### Appropriate Verbal Communication

As part of appropriate verbal communication with all genders and PwD, one should:

- Talk to all genders and PwD respectfully, maintaining a normal tone of voice with appropriate politeness. It is important to ensure one's tone of voice does not have hints of sarcasm, anger, or unwelcome affection.
- Avoid being too self-conscious concerning the words to use while also ensuring not to use words that imply one's superiority over the other.
- Make no difference between a PwD and their caretaker. Treat PwD like adults and talk to them directly.
- Ask a PwD if they need any assistance instead of assuming they need it and offering assistance spontaneously.

### Appropriate Non-verbal Communication

Non-verbal communication is essentially the way someone communicates through their body language.

These include:

- **Facial expressions** - The human face is quite expressive, capable of conveying many emotions without using words. Facial expressions must usually be maintained neutral and should change according to the situation, e.g. smile as a gesture of greeting.
- **Body posture and movement** - One should be mindful of how to sit, stand, walk, or hold their head. For example - one should sit and walk straight in a composed manner. The way one moves and carries self, communicates a lot to others. This type of non-verbal communication includes one's posture, bearing, stance, and subtle movements.

- **Gestures** - One should be very careful with their gestures, e.g. waving, pointing, beckoning, or using one's hands while speaking. One should use appropriate and positive gestures to maintain respect for the other person while being aware that a gesture may have different meanings in different cultures.
- **Eye contact** - Eye contact is particularly significant in non-verbal communication. The way someone looks at someone else may communicate many things, such as interest, hostility, affection or attraction. Eye contact is vital for maintaining the flow of conversation and for understanding the other person's interest and response. One should maintain appropriate eye contact, ensuring not to stare or look over the shoulders. To maintain respect, one should sit or stand at the other person's eye level to make eye contact.
- **Touch** - Touch is a very sensitive type of non-verbal communication. Examples are - handshakes, hugs, pat on the back or head, gripping the arm, etc. A firm handshake indicates interest, while a weak handshake indicates the opposite. One should be extra cautious not to touch others inappropriately and avoid touching them inadvertently by maintaining a safe distance.

### **Rights of PwD**

PwD have the right to respect and human dignity. Irrespective of the nature and seriousness of their disabilities, PwD have the same fundamental rights as others, such as:

- Disabled persons have the same civil and political rights as other people
- Disabled persons are entitled to the measures designed to enable them to become as self-dependent as possible
- Disabled persons have the right to economic and social security
- Disabled persons have the right to live with their families or foster parents and participate in all social and creative activities.
- Disabled persons are protected against all exploitation and treatment of discriminatory and abusive nature.

### **Making Workplace PwD Friendly**

- One should not make PwD feel uncomfortable by giving too little or too much attention
- One should use a normal tone while communicating with a PwD and treat them as all others keeping in mind their limitations and type of disability
- Any help should be provided only when asked for by a PwD
- One should help in ensuring the health and well-being of PwD.

**Expected Employer Behaviour**

Some of the common behavioural traits that employees expect from their employers are:

- **Cooperation:** No work is successful without cooperation from the employer's side. Cooperation helps to understand the job role better and complete it within the given timeline.
- **Polite language:** Polite language is always welcomed at work. This is a basic aspect that everybody expects.
- **Positive Attitude:** Employers with a positive attitude can supervise the work of the employees and act as a helping hand to accomplish the given task. A person with a positive attitude looks at the best qualities in others and helps them gain success.
- **Unbiased behaviour:** Employers should always remain fair towards all their employees. One should not adopt practices to favour one employee while neglecting or ignoring the other. This might create animosity among co-workers.
- **Decent behaviour:** The employer should never improperly present oneself before the employee. One should always respect each other's presence and behave accordingly. The employer should not speak or act in a manner that may make the employee feel uneasy, insulted, and insecure.

## Exercise

1. List down three examples of workplace ethics.
2. List down three examples of interpersonal skills.
3. Identify two reasons for workplace conflicts.
4. Identify two ways of resolving interpersonal conflicts
5. List down two ways of dealing with heightened emotions at work.
6. List down two types of non-verbal communication.





# 5. Basic Health and Safety Practices

Unit 5.1 - Workplace Hazards

Unit 5.2 - Fire Safety

Unit 5.3 - First Aid

Unit 5.4 - Waste Management



## Key Learning Outcomes



**By the end of this module, participants will be able to:**

1. Discuss job-site hazards, risks and accidents
2. Explain the organizational safety procedures for maintaining electrical safety, handling tools and hazardous materials
3. Describe how to interpret warning signs while accessing sensitive work areas
4. Explain the importance of good housekeeping
5. Describe the importance of maintaining appropriate postures while lifting heavy objects
6. List the types of fire and fire extinguishers
7. Describe the concept of waste management and methods of disposing of hazardous waste
8. List the common sources of pollution and ways to minimize them
9. Elaborate on electronic waste disposal procedures
10. Explain how to administer appropriate first aid to victims in case of bleeding, burns, choking, electric shock, poisoning and also administer first aid to victims in case of a heart attack or cardiac arrest due to electric shock

## UNIT 5.1: Workplace Hazards

### Unit Objectives

**By the end of this unit, participants will be able to:**

- Discuss job-site hazards, risks and accidents
- Explain the organizational safety procedures for maintaining electrical safety, handling tools and hazardous materials
- Describe how to interpret warning signs while accessing sensitive work areas
- Explain the importance of good housekeeping
- Describe the importance of maintaining appropriate postures while lifting heavy objects
- Explain safe handling of tools and Personal Protective Equipment to be used.

### 5.1.1 Workplace Safety

Workplace safety is important to be established for creating a safe and secure working for the workers. The workplace has to be administered as per the rules of the Occupational Safety and Health Administration (OSHA). It refers to monitoring the working environment and all hazardous factors that impact employees' safety, health, and well-being. It is important to provide a safe working environment to the employees to increase their productivity, wellness, skills, etc.

**The benefits of workplace safety are:**

- Employee retention increases if they are provided with a safe working environment.
- Failure to follow OSHA's laws and guidelines can result in significant legal and financial consequences.
- A safe environment enables employees to stay invested in their work and increases productivity.
- Employer branding and company reputation can both benefit from a safe working environment.

### 5.1.2 Workplace Hazards

#### 5.1.2. Workplace Hazards

A workplace is a situation that has the potential to cause harm or injury to the workers and damage the tools or property of the workplace. Hazards exist in every workplace and can come from a variety of sources. Finding and removing them is an important component of making a safe workplace.

#### **Common Workplace Hazards**

The common workplace hazards are:

• **Biological:** The threats caused by biological agents like viruses, bacteria, animals, plants, insects and also humans, are known as biological hazards.

- **Chemical:** Chemical hazard is the hazard of inhaling various chemicals, liquids and solvents. Skin irritation, respiratory system irritation, blindness, corrosion, and explosions are all possible health and physical consequences of these dangers.
- **Mechanical:** Mechanical Hazards comprise the injuries that can be caused by the moving parts of machinery, plant or equipment.
- **Psychological:** Psychological hazards are occupational hazards caused by stress, harassment, and violence.
- **Physical:** The threats that can cause physical damage to people is called physical hazard. These include unsafe conditions that can cause injury, illness and death.
- **Ergonomic:** Ergonomic Hazards are the hazards of the workplace caused due to awkward posture, forceful motion, stationary position, direct pressure, vibration, extreme temperature, noise, work stress, etc.

### Workplace Hazards Analysis

A workplace hazard analysis is a method of identifying risks before they occur by focusing on occupational tasks. It focuses on the worker's relationship with the task, the tools, and the work environment. After identifying the hazards of the workplace, organisations shall try to eliminate or minimize them to an acceptable level of risk.

### Control Measures of Workplace Hazards

Control measures are actions that can be taken to reduce the risk of being exposed to the hazard. Elimination, Substitution, Engineering Controls, Administrative Controls, and Personal Protective Equipment are the five general categories of control measures.

- **Elimination:** The most successful control technique is to eliminate a specific hazard or hazardous work procedure or prevent it from entering the workplace.
- **Substitution:** Substitution is the process of replacing something harmful with something less hazardous. While substituting the hazard may not eliminate all of the risks associated with the process or activity, it will reduce the overall harm or health impacts.
- **Engineering Controls:** Engineered controls protect workers by eliminating hazardous situations or creating a barrier between the worker and the hazard, or removing the hazard from the person.
- **Administrative Controls:** To reduce exposure to hazards, administrative controls limit the length of time spent working on a hazardous task that might be used in combination with other measures of control.
- **Personal Protective Equipment:** Personal protective equipment protects users from health and safety hazards at work. It includes items like safety helmets, gloves, eye protection, etc.

### 5.1.3 Risk for a Drone Technician

A drone technician may require to repair the propeller, motor and its mount, battery, mainboards, processor, booms, avionics, camera, sensors, chassis, wiring and landing gear. A technician may face some risks while repairing the drones' equipment.

- The technician is susceptible to being physically harmed by propellers.
- Direct contact with exposed electrical circuits can injure the person.
- If the skin gets in touch with the heat generated from electric arcs, it burns the internal tissues.
- Major electrical injuries can occur due to poorly installed electrical equipment, faulty wiring, overloaded or overheated outlets, use of extension cables, incorrect use of replacement fuses, use of equipment with wet hands, etc.

### 5.1.4 Workplace Warning Signs

A Hazard sign is defined as 'information or instruction about health and safety at work on a signboard, an illuminated sign or sound signal, a verbal communication or hand signal.'

There are four different types of safety signs:

- Prohibition / Danger Alarm Signs
- Mandatory Signs
- Warning Signs
- And Emergency

**1. Prohibition Signs:** A "prohibition sign" is a safety sign that prohibits behaviour that is likely to endanger one's health or safety. The colour red is necessary for these health and safety signs. Only what or who is forbidden should be displayed on a restriction sign.



Fig. 5.1.1. Prohibition Warning Signs

## 2. Mandatory Signs:

Mandatory signs give clear directions that must be followed. The icons are white circles that have been reversed out of a blue circle. On a white background, the text is black.



Fig. 5.1.2. Mandatory Signs

## 3. Warning Signs

Warning signs are the safety information communication signs. They are shown as a 'yellow colour triangle'.



Fig. 5.1.3. Warning Signs

#### 4. Emergency Signs

The location or routes to emergency facilities are indicated by emergency signs. These signs have a green backdrop with a white emblem or writing. These signs convey basic information and frequently refer to housekeeping, company procedures, or logistics.



Fig. 5.1.4. Emergency Signs

### 5.1.5 Cleanliness in the Workplace

Workplace cleanliness maintenance creates a healthy, efficient and productive environment for the employees. Cleanliness at the workplace is hindered by some elements like cluttered desks, leftover food, waste paper, etc. A tidy workplace is said to improve employee professionalism and enthusiasm while also encouraging a healthy working environment.

#### Benefits of cleanliness in the workplace:

1. **Productivity:** Cleanliness in the workplace can bring a sense of belonging to the employees, also motivating and boosting the morale of the employees. This results in increasing their productivity.
2. **Employee Well-being:** Employee well-being can be improved by providing a clean work environment. Employees use fewer sick days in a workplace where litter and waste are properly disposed of, and surfaces are cleaned regularly, resulting in increased overall productivity.
3. **Positive Impression:** Cleanliness and orderliness in the workplace provide a positive impression on both employees and visitors.
4. **Cost saving:** By maintaining acceptable levels of cleanliness in the workplace, businesses can save money on cleaning bills and renovations, which may become necessary if the premises are not properly kept.

### Reasons for Cleaning the Workplace

- Cleaning of dry floors, mostly to prevent workplace slips and falls.
- Disinfectants stop bacteria in their tracks, preventing the spread of infections and illness.
- Proper air filtration decreases hazardous substance exposures such as dust and fumes.
- Light fixture cleaning improves lighting efficiency.
- Using environmentally friendly cleaning chemicals that are safer for both personnel and the environment.
- Work environments are kept clean by properly disposing of garbage and recyclable items.

## 5.1.6 Lifting and Handling of Heavy Loads

Musculoskeletal Injuries (MSIs), such as sprains and strains, can occur while lifting, handling, or carrying objects at work. When bending, twisting, uncomfortable postures and lifting heavy objects are involved, the risk of injury increases. Ergonomic controls can help to lower the risk of injury and potentially prevent it.

Types of injuries caused while lifting heavy objects:

- Cuts and abrasions are caused by rough surfaces.
- Crushing of feet or hands.
- Strain to muscles and joints

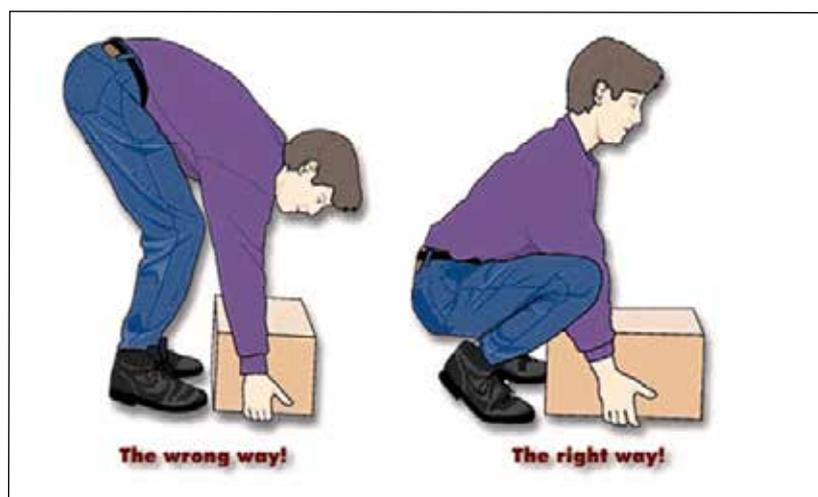


Fig. 5.1.5. Lifting loads technique

**Preparing to lift**

A load that appears light enough to bear at first will grow increasingly heavier as one carries it further. The person carrying the weight should be able to see over or around it at all times.

The amount of weight a person can lift, depends on their age, physique, and health. It also depends on whether or not the person is used to lifting and moving hefty objects.

**Common Causes of Back Injuries**

The Most Common Causes of Back Injuries are:

- 1) **Inadequate Training:** The individual raising the load receives no sufficient training or guidance.
- 2) **Lack of awareness of technique:** The most common cause of back pain is incorrect twisting and posture, which causes back strain.
- 3) **Load size:** The load size to consider before lifting. If the burden is too much for one's capacity or handling, their back may be strained and damaged.
- 4) **Physical Strength:** Depending on their muscle power, various persons have varied physical strengths. One must be aware of their limitations.
- 5) **Teamwork:** The operation of a workplace is all about working together. When opposed to a single person lifting a load, two people can lift it more easily and without difficulty. If one of two people isn't lifting it properly, the other or both of them will suffer back injuries as a result of the extra strain.

**Techniques for Lifting Heavy Objects**

Technique	Demonstraton
<p>1. Ensure one has a wide base of support before lifting the heavy object. Ensure one's feet are shoulder-width apart, and one foot is slightly ahead of the other at all times. This will help one maintain a good balance during the lifting of heavy objects. This is known as the Karate Stance.</p>	
<p>2. Squat down as near to the object as possible when one is ready to lift it, bending at the hips and knees with the buttocks out. If the object is really heavy, one may wish to place one leg on the floor and the other bent at a straight angle in front of them.</p>	

3. Maintain proper posture as one begin to lift upward. To do so, one should keep their back straight, chest out, and shoulders back while gazing straight ahead.



4. By straightening one's hips and knees, slowly elevate the thing (not the back). As one rises, they should extend their legs and exhale. Lift the heavy object without twisting the body or bending forward.



5. Do not lift bending forward.



6. Hold the load close to the body.



7. Never lift heavy objects above the shoulder	
8. Use the feet (not the body) to change direction, taking slow, small steps.	
9. Set down the heavy object carefully, squatting with the knees and hips only.	

**Table 5.1.1 Techniques for lifting heavy objects**

<sup>3</sup>Source:<https://www.braceability.com/blogs/articles/7-prop-heavy-lift-techniques>

### 5.1.7 Safe Handling of Tools

Workers should be trained on how to use tools safely. When tools are misplaced or handled incorrectly by workers, they can be dangerous. The following are some suggestions from the National Safety Council for safe tool handling when they are not in use:

- Never carry tools up or down a ladder in a way that makes it difficult to grip them. Instead of being carried by the worker, tools should be lifted up and down using a bucket or strong bag.
- Tools should never be tossed but should be properly passed from one employee to the next. Pointed tools should be passed with the handles facing the receiver or in their carrier.
- When turning and moving around the workplace, workers carrying large tools or equipment on their shoulders should pay particular attention to clearances.
- Pointed tools such as chisels and screwdrivers should never be kept in a worker's pocket. They can be carried in a toolbox, pointing down in a tool belt or pocket tool bag, or in hand with the tip always held away from the body.
- Tools should always be stored while not in use. People below are put in danger when tools are left sitting around on an elevated structure, such as a scaffold. In situations when there is a lot of vibration, this risk increases.

## 5.1.8 Personal Protective Equipment

Personal protective equipment, or "PPE," is equipment worn to reduce exposure to risks that might result in significant occupational injuries or illnesses. Chemical, radiological, physical, electrical, mechanical, and other job dangers may cause these injuries and diseases.

**PPE used for protection from the following injuries are:**

Injury Protection	Protection	PPE
Head Injury Protection	Falling or flying objects, stationary objects, or contact with electrical wires can cause impact, penetration, and electrical injuries. Hard hats can protect one's head from these injuries. A common electrician's hard hat is shown in the figure below. This hard hat is made of nonconductive plastic and comes with a set of safety goggles.	
Foot and Leg Injury Protection	In addition to foot protection and safety shoes, leggings (e.g., leather) can guard against risks such as falling or rolling objects, sharp objects, wet and slippery surfaces, molten metals, hot surfaces, and electrical hazards.	
Eye and Face Injury Protection	Spectacles, goggles, special helmets or shields, and spectacles with side shields can protect against the hazards of flying fragments, large chips, hot sparks, radiation, and splashes from molten metals. They also offer protection from particles, sand, dirt, mists, dust, and glare.	

<p>Protecton against Hearing Loss</p>	<p>Hearing protection can be obtained by wearing earplugs or earmuffs. High noise levels can result in permanent hearing loss or damage, as well as physical and mental stress. Self-forming earplugs composed of foam, waxed cotton, or fibreglass wool usually fit well. Workers should be fitted for moulded or prefabricated earplugs by a specialist.</p>	
<p>Hand Injury Protecton</p>	<p>Hand protection will aid workers who are exposed to dangerous substances by skin absorption, serious wounds, or thermal burns. Gloves are a frequent protective clothing item. When working on electrified circuits, electricians frequently use leather gloves with rubber inserts. When stripping cable with a sharp blade, Kevlar gloves are used to prevent cuts.</p>	
<p>Whole Body Protecton</p>	<p>Workers must protect their entire bodies from risks such as heat and radiation. Rubber, leather, synthetics, and plastic are among the materials used in whole-body PPE, in addition to fire-retardant wool and cotton. Maintenance staff who operate with high-power sources such as transformer installations and motor-control centres are frequently obliged to wear fire-resistant clothes.</p>	

**Table 5.1.2. Personal protective equipment**



## UNIT 5.2: Fire Safety

### Unit Objectives

**By the end of this unit, participants will be able to:**

1. List the types of fire and fire e extinguiss.

### 5.2.1 Fire Safety

Fire safety is a set of actions aimed at reducing the amount of damage caused by fire. Fire safety procedures include both those that are used to prevent an uncontrolled fire from starting and those that are used to minimise the spread and impact of a fire after it has started. Developing and implementing fire safety measures in the workplace is not only mandated by law but is also essential for the protection of everyone who may be present in the building during a fire emergency.

The basic Fire Safety Responsibilities are:

- To identify risks on the premises, a fire risk assessment must be carried out.
- Ascertain that fire safety measures are properly installed.
- Prepare for unexpected events.
- Fire safety instructions and training should be provided to the employees.

### 5.2.2 Respond to a Workplace Fire

- Workplace fire drills should be conducted on a regular basis.
- If one has a manual alarm, they should raise it.
- Close the doors and leave the fire-stricken area as soon as possible. Ensure that the evacuation is quick and painless.
- Turn off dangerous machines and don't stop to get personal items.
- Assemble at a central location. Ascertain that the assembly point is easily accessible to the employees.
- If one's clothing catches fire, one shouldn't rush about it. They should stop and descend on the ground and roll to smother the flames if their clothes catch fire.

### 5.2.3 Fire Extinguisher

Fire extinguishers are portable devices used to put out small flames or minimise their damage until fire-fighters arrive. These are maintained on hand in locations such as fire stations, buildings, workplaces, public transit, and so on. The types and quantity of extinguishers that are legally necessary for a given region are determined by the applicable safety standards.

Types of fire extinguishers are:

**There are five main types of fire extinguishers:**

1. Water.
2. Powder.
3. Foam.
4. Carbon Dioxide (CO<sub>2</sub>).
5. Wet chemical.

**1. Water:** Water fire extinguishers are one of the most common commercial and residential fire extinguishers on the market. They're meant to be used on class-A flames.



**2. Powder:** The L2 powder fire extinguisher is the most commonly recommended fire extinguisher in the Class D Specialist Powder category, and is designed to put out burning lithium metal fires.



**3. Foam:** Foam extinguishers are identified by a cream rectangle with the word "foam" printed on it. They're mostly water-based, but they also contain a foaming component that provides a quick knock-down and blanketing effect on flames. It suffocates the flames and seals the vapours, preventing re-ignition.



**4. Carbon Dioxide (CO<sub>2</sub>):** Class B and electrical fires are extinguished with carbon dioxide extinguishers, which suffocate the flames by removing oxygen from the air. They are particularly beneficial for workplaces and workshops where electrical fires may occur since, unlike conventional extinguishers, they do not leave any toxins behind and hence minimise equipment damage.



**5. Wet Chemical:** Wet chemical extinguishers are designed to put out fires that are classified as class F. They are successful because they can put out extremely high-temperature fires, such as those caused by cooking oils and fats.





## UNIT 5.3: First Aid

### Unit Objectives

**By the end of this unit, participants will be able to:**

1. Explain how to administer appropriate first aid to victims in case of bleeding, burns, choking, electric shock, poisoning
2. Explain how to administer first aid to victims in case of a heart attack or cardiac arrest due to electric shock.

### 5.3.1 First Aid

First aid is the treatment or care given to someone who has sustained an injury or disease until more advanced care can be obtained or the person recovers.

The aim of first aid is to:

- Preserve life
- Prevent the worsening of a sickness or injury
- If at all possible, relieve pain
- Encourage recovery
- Keep the unconscious safe.

First aid can help to lessen the severity of an injury or disease, and in some situations, it can even save a person's life.

### 5.3.2 Need for First Aid at the Workplace

- In the workplace, first aid refers to providing immediate care and life support to persons who have been injured or become unwell at work.
- Many times, first aid can help to lessen the severity of an accident or disease.
- It can also help an injured or sick person relax. In life-or-death situations, prompt and appropriate first aid can make all the difference.

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### 5.3.3 Treating Minor Cuts and Scapes

**Steps to keep cuts clean and prevent infections and scars:**

- **Wash Hands:** Wash hands first with soap and water to avoid introducing bacteria into the cut and causing an infection. One should use the hand sanitiser if one is on the go.
- **Stop the bleeding:** Using a gauze pad or a clean towel, apply pressure to the wound. For a few minutes, keep the pressure on.
- **Clean Wounds:** Once the bleeding has stopped, clean the wound by rinsing it under cool running water or using a saline wound wash. Use soap and a moist washcloth to clean the area around the wound. Soap should not be used on the cut since it may irritate the skin. Also, avoid using hydrogen peroxide or iodine, as these may aggravate the wound.
- **Remove Dirt:** Remove any dirt or debris from the area. Pick out any dirt, gravel, glass, or other material in the cut with a pair of tweezers cleaned with alcohol.

### 5.3.4 Heart Attack

When the blood flow carrying oxygen to the heart is blocked, a heart attack occurs. The heart muscle runs out of oxygen and starts to die.

Symptoms of a heart attack can vary from person to person. They may be mild or severe. Women, older adults, and people with diabetes are more likely to have subtle or unusual symptoms.

**Symptoms in adults may include:**

- Changes in mental status, especially in older adults.
- Chest pain that feels like pressure, squeezing, or fullness. The pain is most often in the centre of the chest. It may also be felt in the jaw, shoulder, arms, back, and stomach. It can last for more than a few minutes or come and go.
- Cold sweat.
- Light-headedness.
- Nausea (more common in women).
- Indigestion.

- Vomiting.
- Numbness, aching or tingling in the arm (usually the left arm, but the right arm may be affected alone, or along with the left).
- Shortness of breath
- Weakness or fatigue, especially in older adults and in women.

**First Aid for Heart Attack**

If one thinks someone is experiencing a heart attack, they should:

- Have the person sit down, rest, and try to keep calm.
- Loosen any tight clothing.
- Ask if the person takes any chest pain medicine, such as nitro-glycerine for a known heart condition, and help them take it.
- If the pain does not go away promptly with rest or within 3 minutes of taking nitro-glycerine, call for emergency medical help.
- If the person is unconscious and unresponsive, call 911 or the local emergency number, then begin CPR.
- If an infant or child is unconscious and unresponsive, perform 1 minute of CPR, then call 911 or the local emergency number.



## UNIT 5.4: Waste Management

### Unit Objectives

**By the end of this unit, participants will be able to:**

1. Describe the concept of waste management and methods of disposing of hazardous waste.
2. List the common sources of pollution and ways to minimize them.
3. Elaborate on electronic waste disposal procedures.

### 5.4.1. Waste Management and Methods of Waste Disposal

The collection, disposal, monitoring, and processing of waste materials is known as waste management. These wastes affect living beings' health and the environment. For reducing their effects, they have to be managed properly. The waste is usually in solid, liquid or gaseous form.

The importance of waste management is:

Waste management is important because it decreases waste's impact on the environment, health, and other factors. It can also assist in the reuse or recycling of resources like paper, cans, and glass. The disposal of solid, liquid, gaseous, or dangerous substances is the example of waste management.

When it comes to trash management, there are numerous factors to consider, including waste disposal, recycling, waste avoidance and reduction, and garbage transportation. Treatment of solid and liquid wastes is part of the waste management process. It also provides a number of recycling options for goods that aren't classified as garbage during the process.

### 5.4.2 Methods of Waste Management

Non-biodegradable and toxic wastes, such as radioactive remains, can cause irreversible damage to the environment and human health if they are not properly disposed of. Waste disposal has long been a source of worry, with population increase and industrialisation being the primary causes. Here are a few garbage disposal options.

1. **Landfills:** The most common way of trash disposal today is to throw daily waste/garbage into landfills. This garbage disposal method relies on burying the material in the ground.
2. **Recycling:** Recycling is the process of transforming waste items into new products in order to reduce energy consumption and the use of fresh raw materials. Recycling reduces energy consumption, landfill volume, air and water pollution, greenhouse gas emissions, and the preservation of natural resources for future use.

3. **Composting:** Composting is a simple and natural bio-degradation process that converts organic wastes, such as plant remnants, garden garbage, and kitchen waste, into nutrient-rich food for plants.
4. **Incineration:** Incineration is the process of combusting garbage. The waste material is cooked to extremely high temperatures and turned into materials such as heat, gas, steam, and ash using this technology.

### 5.4.3 Recyclable, Non-Recyclable and Hazardous Waste

1. **Recyclable Waste:** The waste which can be reused or recycled further is known as recyclable waste.
2. **Non-recyclable Waste:** The waste which cannot be reused or recycled is known as non-recyclable waste. Polythene bags are a great example of non-recyclable waste.
3. **Hazardous Waste:** The waste which can create serious harm to the people and the environment is known as hazardous waste.

### 5.4.4 Sources of Pollution

Pollution is defined as the harm caused by the presence of a material or substances in places where they would not normally be found or at levels greater than normal. Polluting substances might be in the form of a solid, a liquid, or a gas.

- **Point source of pollution:** Pollution from a point source enters a water body at a precise location and can usually be identified. Effluent discharges from sewage treatment plants and industrial sites, power plants, landfill sites, fish farms, and oil leakage via a pipeline from industrial sites are all potential point sources of contamination.

Point source pollution is often easy to prevent since it is feasible to identify where it originates, and once identified, individuals responsible for the pollution can take rapid corrective action or invest in longer-term treatment and control facilities.

- **Diffuse source of pollution:** As a result of land-use activities such as urban development, amenity, farming, and forestry, diffuse pollution occurs when pollutants are widely used and diffused over a large region. These activities could have occurred recently or in the past. It might be difficult to pinpoint specific sources of pollution and, as a result, take rapid action to prevent it because prevention often necessitates significant changes in land use and management methods.

#### Pollution Prevention

Pollution prevention entails acting at the source of pollutants to prevent or minimise their production. It saves natural resources, like water, by using materials and energy more efficiently.

**Pollution prevention includes any practice that:**

- Reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal;
- Reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants (these practices are known as "source reduction");
- Improved efficiency in the use of raw materials, energy, water, or other resources, or Conservation is a method of safeguarding natural resources.
- Improvements in housekeeping, maintenance, training, or inventory management; equipment or technology adjustments; process or method modifications; product reformulation or redesign; raw material substitution; or improvements in housekeeping, maintenance, training, or inventory control.

### 5.4.5 Electronic Waste

Lead, cadmium, beryllium, mercury, and brominated flame retardants are found in every piece of electronic waste. When gadgets and devices are disposed of illegally, these hazardous compounds are more likely to contaminate the earth, pollute the air, and leak into water bodies.

When e-waste is dumped in a landfill, it tends to leach trace metals as water runs through it. The contaminated landfill water then reaches natural groundwater with elevated toxic levels, which can be dangerous if it reaches any drinking water bodies. Despite having an environmentally benign approach, recycling generally results in international shipment and dumping of the gadgets in pits.

**Some eco-friendly ways of disposing of e-waste are:**

- Giving back the e-waste to the electronic companies and drop-off points
- Following guidelines issued by the government
- Selling or donating the outdated technology-based equipment
- Giving e-waste to a certified e-waste recycler

## Exercise

1. Name all five types of fire extinguishers.
2. Explain PPE in brief.
3. List the common workplace hazards.
4. Fill in the blanks:
  - i. A "\_\_\_\_\_ sign" is a safety sign that prohibits behaviour that is likely to endanger one's health or safety.
  - ii. \_\_\_\_\_ entails acting at the source of pollutants to prevent or minimise their production.
  - iii. \_\_\_\_\_ is the treatment or care given to someone who has sustained an injury or disease until more advanced care can be obtained or the person recovers.
  - iv. The threats caused by biological agents like viruses, bacteria, animals, plants, insects and also humans, are known as \_\_\_\_\_.
  - v. The workplace has to be administered as per the rules of the \_\_\_\_\_.







## 6. Employability and Entrepreneurship Skills



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## 7. Annexure



## Annexure - QR Code

Chapter No.	Unit No.	Topic Name	Page No.	QR Code(s)	URL
1. Basics of Uninterrupted Power Supply (UPS) and Inverter	1.1 Basics of Electronics and Electronic Components	1.1 Basics Of Electronics and Electronics Components	54		<a href="https://www.youtube.com/watch?v=VBZ-3Ma7Ohc">https://www.youtube.com/watch?v=VBZ-3Ma7Ohc</a>
	1.2 Fundamentals of Electricity	1.2 Fundamentals of Electricity			<a href="https://www.youtube.com/watch?v=mc979OhitAg">https://www.youtube.com/watch?v=mc979OhitAg</a>
	1.3 Introduction to UPS and Inverters	1.3 Introduction to UPS & Inverters			<a href="https://www.youtube.com/watch?v=6Q0t0iQINw4">https://www.youtube.com/watch?v=6Q0t0iQINw4</a>
		1.3.3 Basic differences and similarities between UPS & Inverters			<a href="https://www.youtube.com/watch?v=tc0u8GYxBus">https://www.youtube.com/watch?v=tc0u8GYxBus</a>
		1.3.5 Wiring procedure of UPS/inverter			<a href="https://www.youtube.com/watch?v=htf0ftt3ddk">https://www.youtube.com/watch?v=htf0ftt3ddk</a>
	1.4 Tools and Equipment	1.4.2 Equipment-Oscilloscope			<a href="https://www.youtube.com/watch?v=jzAQ9Yx9EfM">https://www.youtube.com/watch?v=jzAQ9Yx9EfM</a>
		1.4.2 Equipment-Voltmeter/Ammeter			<a href="https://www.youtube.com/watch?v=yE3eQ6q39f4">https://www.youtube.com/watch?v=yE3eQ6q39f4</a>
		1.4.2 Equipment-Wattmeter			<a href="https://www.youtube.com/watch?v=uS4ltXu3wQ8">https://www.youtube.com/watch?v=uS4ltXu3wQ8</a>
		1.4.2 Equipment-Megger			<a href="https://www.youtube.com/watch?v=CnjV86pLaJE">https://www.youtube.com/watch?v=CnjV86pLaJE</a>
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