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Participant Handbook

Sector
Electronics

Sub - Sector
E-Mobility & Battery

Occupation
Assembly – EM&B

Reference ID: **ELE/Q6604, Version 2.0**
NSQF Level 4

Battery System Assembly Operator

Published by

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

Shri Narendra Modi
Prime Minister of India

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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

"Battery System Assembly Operator" QP No. **"ELE/Q6604, NSQF Level 4"**

Date of Issuance: December 30th, 2021
Valid up to*: December 30th, 2026

*Valid up to the next review date of the Qualification Pack or the 'Valid up to' date mentioned above (whichever is earlier)

Authorized Signatory
Electronics Sector Skills Council of India

Acknowledgments

This participant's handbook meant for Battery System Assembly Operator is a sincere attempt to ensure the availability of all the relevant information to the existing and prospective job holders in this job role. We have compiled the content with inputs from the relevant Subject Matter Experts (SMEs) and industry members to ensure it is the latest and authentic. We express our sincere gratitude to all the SMEs and industry members who have made invaluable contributions to the completion of this participant's handbook.

This handbook will help deliver skill-based training in the field of Battery System Assembly Operator. We hope that it will benefit all the stakeholders, such as participants, trainers, and evaluators. We have made all efforts to ensure the publication meets the current quality standards for the successful delivery of QP/NOS-based training programs. We welcome and appreciate any suggestions for future improvements to this handbook.

About this book

This participant handbook has been designed to serve as a guide for participants who aim to obtain the required knowledge and skills to undertake various activities as a Battery System Assembly Operator. Its content has been aligned with the latest Qualification Pack (QP) prepared for the job role. With a qualified trainer's guidance, the participants will be equipped with the following for working efficiently in the job role:

- **Knowledge and Understanding:** The relevant operational knowledge and understanding to perform the required tasks.
- **Performance Criteria:** The essential skills through hands-on training to perform the required operations to the applicable quality standards.
- **Professional Skills:** The Ability to make appropriate operational decisions about the field of work.

The handbook details the relevant activities to be carried out by a Battery System Assembly Operator. After studying this handbook, job holders will be adequately skilled to carry out their duties efficiently according to the applicable quality standards, with minimum supervision.

The handbook has been divided into an appropriate number of units and sub-units based on the content of the relevant QP. We hope it will facilitate easy and structured learning for the participants. We sincerely hope that participants will obtain enhanced knowledge and skills after studying this handbook and make career progress in the relevant and senior job roles.

The Participant Handbook is designed based on the National Skill Qualification Framework (NSQF) aligned Qualification Pack (QP) and it comprises of the following National Occupation Standrads (NOS)/ topics:

- ELE/N6604: Assemble the Battery System
- ELE/N6605: Test the Battery System assembly
- ELE/N9905: Work effectively at the workplace
- ELE/N1002: Apply health and safety practices at workplace
- DGT/VSQ/N0102: Employability Skills (60 hours)

The handbook has been divided into an appropriate number of units and sub-units based on the content of the relevant QP. We hope it will facilitate easy and structured learning for the participants. We sincerely hope that participants will obtain enhanced knowledge and skills after studying this handbook and make career progress in the relevant and senior job roles.

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It is recommended that all trainings include the appropriate Employability skills Module. Content for the same can be accessed https://www.skillindiadigital.gov.in/content/list

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1. Introduction and Orientation to the Role of a Battery System Assembly Operator

Unit 1.1 - Introduction to the Electronics Sector in India

Unit 1.2 - Introduction to Battery System Assembly

Unit 1.3 - Job Role and Responsibilities of a Battery System Assembly Operator

Key Learning Outcomes

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

1. Describe the role and responsibilities of a Battery System Assembly Operator.

UNIT 1.1: Introduction to the Electronics Sector in India

Unit Objectives

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

1. Describe the size and scope of the Electronics industry.
2. Identify the sub-sectors of the Electronics industry.

1.1.1 Size and Scope of the Electronics Industry and Its Sub-Sectors

The Indian Electronics System Design & Manufacturing (ESDM) industry is one of the vital sectors of the Indian economy. The country has witnessed a substantial spike in demand for electronic products in the last few years. Today, India is positioned as the second-largest mobile phone manufacturer globally, with a surging internet penetration rate.

The ESDM sector is playing a vital role in the Indian government's goal of generating US$ 1 trillion of economic value from the digital economy by 2025. With several government initiatives aiming to boost domestic manufacturing, India is witnessing increased production and assembly activities across products, such as consumer electronics and mobile phones.

Market Size

- The Indian electronics manufacturing industry is projected to reach US$ 520 billion by 2025.
- In FY22 (until October 2021), imports of electronics goods stood at US$ 28.59 billion, whereas exports stood at US$ 7.89 billion.
- The demand for electronic products is expected to rise to US$ 400 billion by 2025 from US$ 33 billion in Fy20.
- The electronics market has witnessed a growth in demand, with market size increasing from US$ 145 billion in FY16 to US$ 215 billion in FY19—the market witnessed a growth of 14% CAGR from 2016-19.
- India's exports of electronic goods were valued at US$ 11.7 billion in FY21.
- Smartphone shipments in India increased by ~82% YoY to reach 33.0 million units in the second quarter of 2021.
- The Electronics System Design & Manufacturing (ESDM) is broadly segregated into—electronics system and electronics design.
- The electronics system market is expected to witness 2.3x demand of its current size (FY19) to reach US$ 160 billion by FY25.

- Electronics design segment, growing at 20.1%, was 22% of the ESDM market size in FY19; it is anticipated to be 27% of the ESDM market size in FY25.
- India's consumer electronics and appliances industry is expected to become the 5th largest globally by 2025.
- According to the Department for Promotion of Industry and Internal Trade, from April 2000 to June 2021, Foreign Direct Investment (FDI) equity inflows stood at US$ 3,176.29 million.

1.1.2 Sub-Sectors of the Electronics System Design & Manufacturing (ESDM) Industry

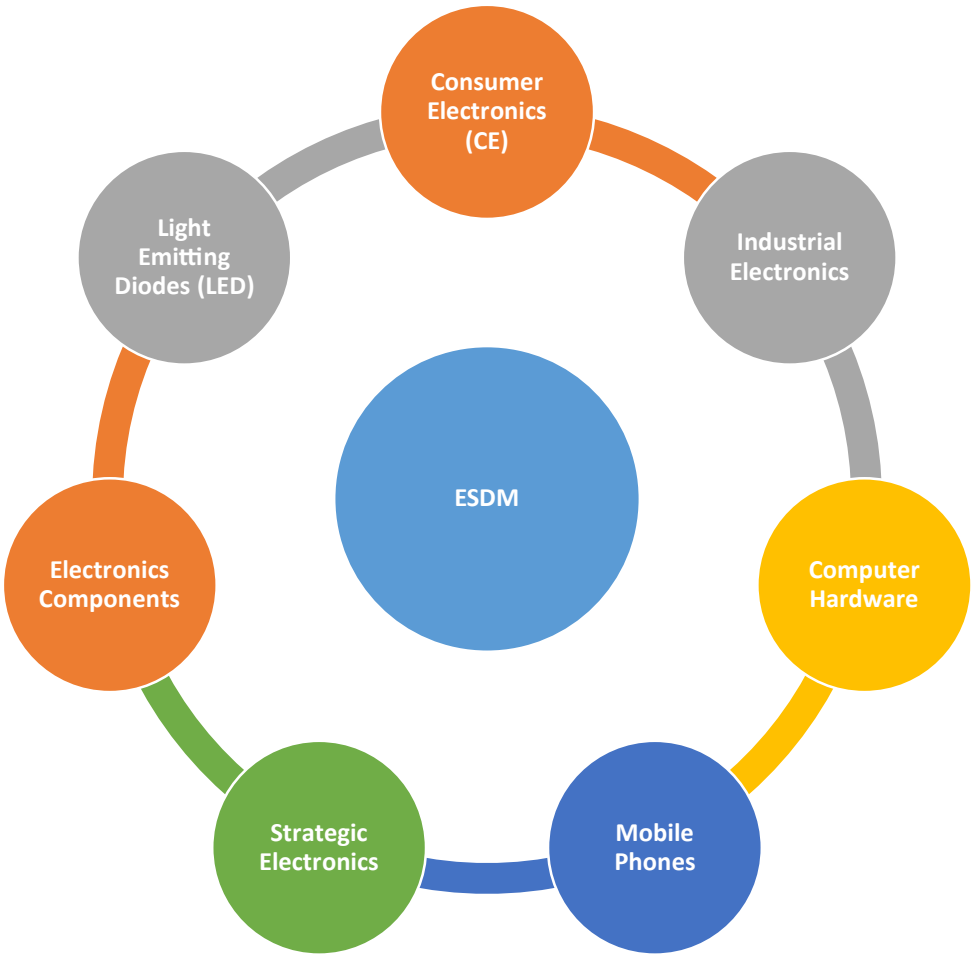

Fig. 1.1.1 Sub-sectors of the Electronics System Design & Manufacturing (ESDM) Industry

1.1.3 Size and Scope of Electric Mobility Market

The global automotive industry is going through a significant transition as a result of climate change. India's announcement of a fundamental transition away from internal combustion engines in favor of fully electric powertrains presents a number of new challenges for the industry, including those related to materials, batteries, and joining technology. As a result, the market for electric vehicles (EVs) has grown significantly. According to the International Energy Agency (IEA), 2.1 million light-duty EVs were sold globally in 2019, a 40% increase from the previous year. Due to the need for light weighting, a key element in the reduction of CO2 emissions, the demand for EVs is growing quickly, posing a number of new challenges for vehicle manufacturers in terms of production in terms of materials, battery systems, and joining technology. Due to the need for light weighting, a crucial component in the reduction of CO2 emissions, the rapid growth in EV demand presents a variety of new challenges for vehicle manufacturers when it comes to production in terms of materials, battery systems, and joining technology. More energy will be used by the car as it becomes heavier. Engineers are tasked with creating new methods to make new electric cars as light as possible while enhancing range because batteries weigh a lot. Increasing the use of lightweight materials like aluminum and carbon fiber composite is necessary to achieve both of these goals. The various battery types used in automotive drivetrains need to be optimized for safety, durability, and performance in addition to weight reduction. Due to these revolutionary changes in the manufacturing of automobiles, joining technologies that support high-performance assembly processes are required.

The Indian market for EV batteries alone could be worth $300 billion between 2017 and 2030. If India achieves its objectives for a swift transition to shared, connected, and electric mobility, the nation could account for more than one-third of global EV battery demand by 2030. Driving down battery costs through quickly scaling production and standardizing battery components could be a key component of India's automotive sector's long-term success given that the battery currently makes up about one-third of the total cost of an EV. India's EV initiative may reduce global energy costs by as much as 16%, to $60 per KWh. India might be able to support manufacturing facilities on a global scale and eventually develop into a hub for exporting batteries given the size of its anticipated domestic market.

Notes

Scan the QR Code to watch the related videos

https://www.youtube.com/watch?v=JgLu40JBa-c

Electronic Industry overview

UNIT 1.2: Introduction to Battery System Assembly

Unit Objectives

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

1. Explain the working principle of an Electric Vehicle.
2. Explain the functions of a Battery system in an Electric vehicle.

1.2.1 Future of Transportation: Electric Mobility

The greenhouse gas problem has been getting worse day by day in recent years, and the price of gasoline has increased by nearly 90 rupees per liter. Public transportation is essential for daily life, but because of the cost of gas, some people choose not to use bikes or cars. As a result, many automakers and new businesses are working hard to turn conventional vehicles into reliable electric vehicles. An electric vehicle is one that is powered by onboard electric sources and is propelled by electric motors. Compared to a gasoline vehicle, it is more robust and has simpler mechanics. Because it does not produce emissions like an internal combustion engine, it uses less fuel than gasoline. Because of a built-in issue with current battery technology, the automotive industry is not fully transitioning to all-electric vehicles. The most typical storage device used in electric vehicles for storing electric energy is the battery. It can fit a lot of energy into a small, light package. Recent data indicates that there were more gasoline-powered vehicles in use over the past few years, but that data has since changed due to an increase in the use of hybrid and electric vehicles. Although hybrid vehicles are currently more popular, the future will be entirely powered by electricity.

1.2.2 Construction and Working Principle of Elctric Vehicle

There are three important components in electric vehicle namely, Motor, Motor Controller and Battery.

1. **Motor.** The primary job of a motor is to transform the electric energy current that is supplied into mechanical energy. Many motor manufacturers have concentrated their efforts on brushless DC motors (BLDC). Compared to other motors, these are more efficient in terms of system cost, size, higher efficiency, excellent controllability, and power savings. There are just two fundamental parts to it. Rotors and stators. The stator is stationary and contains the stator winding, while the rotor rotates and carries the permanent magnet. Stator construction resembles that of an induction motor. It is constructed from steel lamination that has been axially cut for winding.

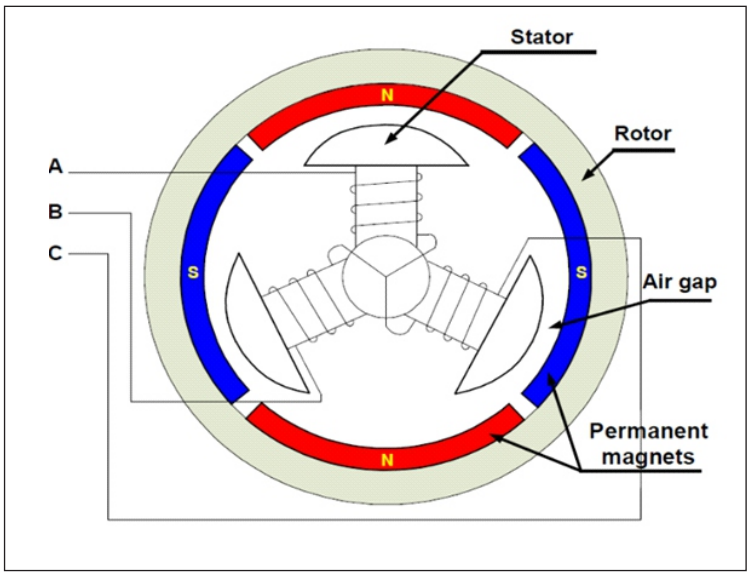

Fig. 1.2.1 BLDC Motor[1]

2. Motor contoroller

Brushless DC motors, which are superior to brushed DC motors and permanent magnet DC motors, are used in the majority of electric vehicles. Electric vehicles that use brushless DC motors must use motor controllers to help control the motor's various properties so that it can accept the necessary current and voltage applied to it. Brushless DC motors do not have brushes or commutators. This linked variable resistor type controller sends a signal to the motor controller when the accelerator pedal is depressed so that the speed can be adjusted to meet our needs. When the vehicle is in the neutral position, the motor controller is not powered.

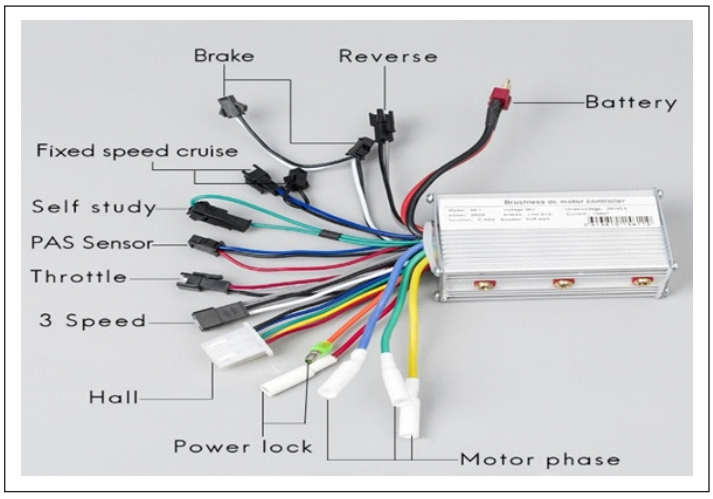

Fig. 1.2.2 BLDC Motor[2]

[1]*Source:https://www.electroschematics.com/wp-content/uploads/2019/10/2-Cross-section-of-a-3-Phase-BLDC-Motor.png*
[2]*Source:https://ae01.alicdn.com/kf/S95d0780f61a94ab29092f85ed232f6daW/24-V-48-V-350W-12-DC-Brushless-MOTOR-CONTROLLER.jpg*

3. **Battery:** The primary purpose of a battery is to store electric power. The majority of hybrid and electric cars used lithium ion batteries. All types of electric vehicles, including plug-in hybrids and hybrid electric vehicles, typically require this storage system. Rechargeable batteries are now used by the majority of automakers as a result of developing technologies. The table below lists the different types of batteries and their traits.

Type	Energy Density (Wh/kg)	Energy Efficiency (%)	Power Density (W/Kg)	Cycle Life (Cycles)	Self Discharge (%/Month)
Lead-Acid	30 - 40	70 - 90	180	200 - 2000	3 - 4
Li-Ion	100 - 250	75 - 90	1800	500 - 2000	5 - 10
Li Polymer	130 - 200	70	3000	>1200	4 - 8
Ni-MH	30 - 80	70	250 - 1000	500 - 100	30
Ni-Cd	40 - 60	60 - 90	140 - 180	500 - 2000	10 - 15
NaS	150	80 - 90	120 - 150	2500	-
VRB	25 - 40	80	100 - 150	>16,000	<1
Zinc Bromide	70	70	-	1000	-

Fig. 1.2.3 Types of Battery

1.2.3 Construction and Working Principle of Electric Vehicle

Basically, electric vehicle is necessary for saving fossil fuel. The illustration depicts an electric vehicle's straightforward construction. It consists of a motor that is connected to the transmission system, a battery, and a motor controller. The energy source in this case is a battery, which is charged by utilizing electric current from the grid (in solar-powered electric vehicles, the battery is charged using a solar PV panel that is mounted on the roof of the vehicle). These batteries can be recharged. The majority of electric vehicles use lead-acid batteries, but newer models of electric vehicles use lithium-ion batteries, which can store more energy than lead-acid batteries in the same amount of physical space. Despite being more efficient and lasting longer than other types of batteries, batteries are more expensive than lead acid batteries. The energy flow from the energy source to the motor is then controlled by the controller. Using a transmission system, the motor transfers power to the car's wheels.

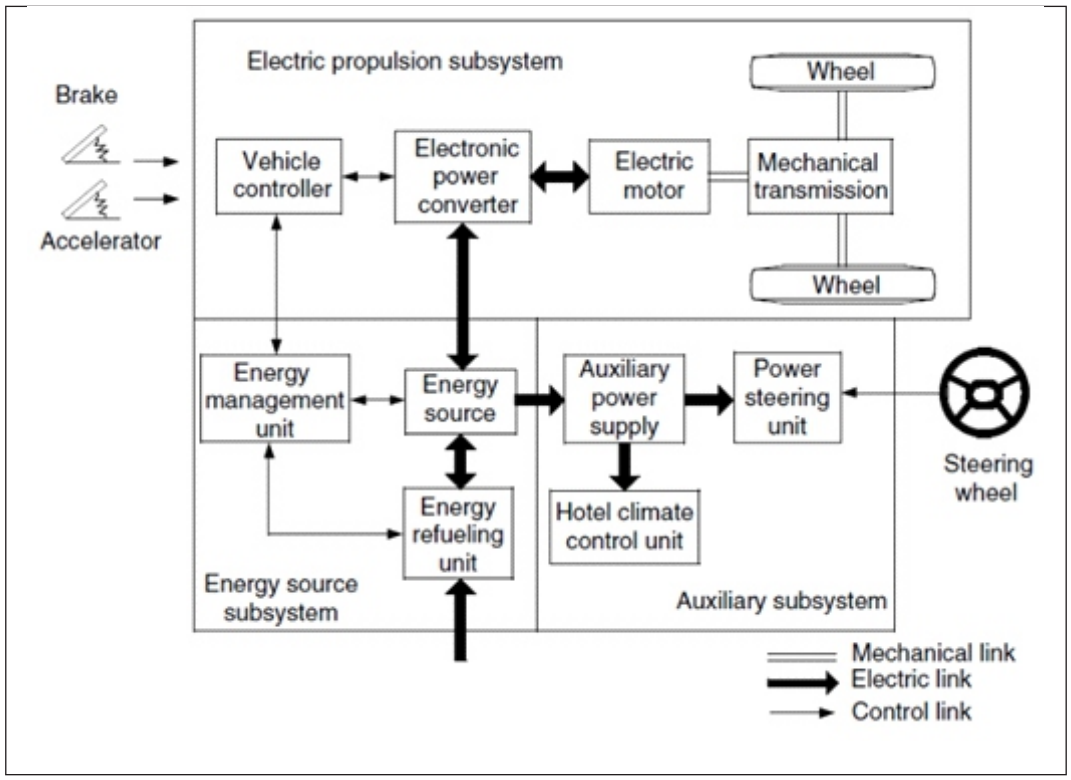

Fig. 1.2.4 Conceptual illustration of general EV Configuration

1.2.4 Types of Electric Vehicle

There are three type of electric vehicle;

1. **Battery Electric Vehicle (BEV):** Battery Electric vehicle consist of an electric motor which is powered by battery connected to it. Electric motor is used for the movement in this type of vehicle. It does not produce emission. In traffic, BEV delivers high torque to the wheels and smoother acceleration than Internal combustion engine. It is noiseless while operating motor. But on other side there are some disadvantages like, high production cost, limited top speed, more recharge time required.

2. **Hybrid Electric Vehicle (HEV):** A hybrid electric car combines an electric motor with a modern internal combustion engine. Both gasoline and electric powered vehicles can use this vehicle. When the electric motor stops producing power, go into fuel mode. Low speed mechanical electric motors, specifically designed for city traffic, are used in HEVs. When vehicle use electric power, there is no emission.

3. **Range Extended Electric Vehicle**: Range extended electric vehicle mostly designed to run by the battery but have gasoline generator to recharge battery when charging is low.

1.2.5 Battery System in an Electric Vehicle

The transition from conventional gasoline-powered vehicles to Electric Vehicles (EVs) was sparked by the need for electric vehicles. Electric traction motors are used in electric vehicles to move them forward. It could also be self-contained with a battery, solar panels, or an electrical generator to turn fuel into electricity, or it could be powered by electricity from sources outside the vehicle through a collector system.

The heart of an electric vehicle is its battery. The battery in an electric vehicle runs everything, as opposed to the batteries in most cars, which are primarily used to start the engine and power accessories like the radio or air conditioner. The most important thing to remember is that it controls the electric motor, or more specifically, it controls a controller that controls the electric motor, so it must be strong and durable enough to get drivers where they need to go with the least amount of recharging. Up until recently, there were no dependable, mass-produced batteries that could make electric cars competitive with gas-powered vehicles. But things are starting to shift.

Batteries for electric vehicles (EVs) are made up of cells, modules, and a pack. These parts assemble in the battery in a sequential order, so a module is made up of a group of cells, and a pack is made up of a group of modules. Although cells are the smallest component, they are the foundation of EV batteries and are crucial to the performance and reliability of the vehicle. For a cell to perform at its peak inside a vehicle, it must have a high capacity per unit volume. The cell must have high reliability and stability to withstand a range of temperatures, as well as the ability to withstand shocks transmitted while driving.

1.2.6 Battery Management System (BMS) for Electric Vehicles

The lithium-ion battery has been identified by makers of electric vehicles as the battery of interest.

since it is light and has a high charge density. These batteries are extremely unstable despite having a lot of power for their size. These batteries must never be overcharged or underdischarged under any circumstances, necessitating the monitoring of their voltage and current. This process becomes a little more challenging because an EV battery pack is made up of numerous cells, each of which needs to be individually monitored for safety and effective operation. This special system is known as the Battery Management System.

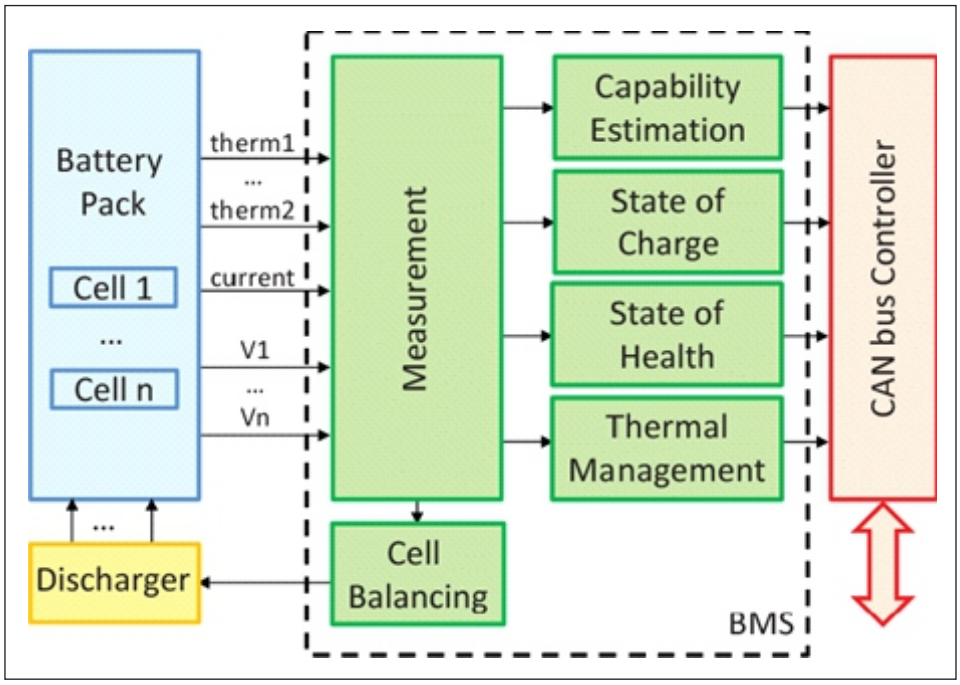

Fig. 1.2.5 Block diagram for battery management systems (BMS) for electric vehicles

The following are the primary duties of the BMS for an EV battery:

1. **Safety:** High voltage Lithium-ion battery packs power electric vehicles. Lithium-ion batteries have a higher energy density than other battery chemistries (between 100 and 265 Wh/kg). There is a chance that these batteries could catch fire in unusual situations. To ensure the safety of the user and the vehicle, it is essential to operate the EV batteries within established safe limits. The Battery Management System continuously checks variables like temperature, voltage, and current flowing into and out of the pack to make sure it is always operating in a secure manner. If necessary, the BMS can change the cooling and activate other safety features to halt operations and reduce the risk. If necessary, the BMS can change the cooling and activate other safety features to halt operations and reduce the risk. For instance, the Hyundai Kona Electric's power output is automatically limited and the vehicle is placed in fail-safe mode if the BMS detects that the battery pack is overheating.

   Lithiumion cell overcharging has the potential to explode and cause thermal runaway. In order to prevent overcharging, BMS continuously measures the voltage of the battery pack as well as the voltage of each battery cell. It also manages the current supply. Depending on the temperature, BMS can enforce the maximum charge or discharge current limits.

2. **Performance Optimisation:** The BMS is in charge of ensuring the battery pack performs to its full potential. When the State of Charge (SOC) of lithium-ion batteries is kept between the minimum and maximum charge limits specified in the battery profile, the batteries operate at their peak efficiency. Both deep discharges and overcharging reduce the battery's capacity, reducing its lifespan. The BMS calculates the maximum amount of current that can be safely injected during charging and notifies the EVSE (Electric Vehicle Supply Equipment or the Charger) of this information. BMS would communicate with the motor controller during battery discharge to prevent too low cell voltages. To remind the user to charge the battery pack, the vehicles can display the appropriate alert. The BMS also manages how the battery pack is recharged using power from regenerative braking.

3. **Health Monitoring and Diagnostics:** The BMS uses the collected data points (temperature, voltage, current etc.) to estimate the State of Charge and State of Health (SOH) of the battery pack. How far a vehicle can travel before recharging is determined by the SoC, which refers to the battery's available energy. How far a vehicle can travel before recharging is determined by the SoC, which refers to the battery's available energy. The battery's suitability for the application is determined by the SOH, which compares the battery's current condition to its original capacity. SOH and SoC are both displayed as percentages. BMS also looks for irregularities in the characteristics and actions of the battery pack's cells. It logs diagnostic data and stores error codes that aid in resolving any battery problems. The BMS can either take necessary corrective actions or trigger failsafe mechanisms to preserve the health of the pack.

4. **Communication:** The BMS is in charge of coordinating communications with other ECUs (Electronic Control Units) in the car. To ensure the smooth operation of the vehicle, it transmits the necessary information about the battery parameters to the motor controller. BMS also looks for irregularities in the characteristics and actions of the battery pack's cells. It logs diagnostic data and stores error codes that aid in resolving any battery problems. To maintain the pack's health, the BMS can either initiate the necessary corrective measures or activate failsafe mechanisms.

VEHICLE SEGMENT	BATTERY CAPACITY	BATTERY VOLTAGE
 E-2W	1.2-3.3 kWh	48-72V
 E-3W (passenger/ goods)	3.6-8 kWh	48-60V
 E-cars (1st generation)	21 kWh	72V
 E-cars (2nd generation)	30-80 kWh	350-500V

Table 1.2.1 Typical battery specifications for different ev segments[3]

[3]*Source: Compiled from market data of available EV models (as of July 2021)*

Notes

Scan the QR Code to watch the related videos

https://www.youtube.com/watch?v=ArSyi1cfMq8

Future of Transportation: Electric Mobility

https://www.youtube.com/watch?v=jM1wTNQERAU

Types of Electric Vehicle

https://www.youtube.com/watch?v=SLGI7W5THhI

Components of an Electric Vehicles

UNIT 1.3: Job Role and Responsibilities of a Battery System Assembly Operator

Unit Objectives

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

1. Explain the role and responsibilities of a Battery System Assembly Operator.
2. Discuss various employment opportunities for a Battery System Assembly Operator in the Electronics industry.
3. Discuss the organisational policies on incentives, personnel management reporting structure, etc.

1.3.1 Job Role and Responsibilities of a Battery System Assembly Operator

A Battery System Assembly Operator has the following primary job responsibilities:

- Assembling various components to make complete storage batteries.
- Assembling negative and positive plates of cell with wood or fibre separators in between each pair of plates to form cell unit.
- Fitting assembled cell-plates in cell and covering each cell with lid.
- Placing cell units in position in battery casing and connecting them by soldering their terminals with lead rod.
- Fitting lead caps over terminals, marking terminals with respective polarity signs and sealing top of assembled battery with molten pitch.
- Filling assembled battery.
- Working at various production stations.
- Working with machines, power tools, and hand tools.
- Taking part in internal trainings, such as those for products or quality.
- Maintaining standards of quality and safety.
- Completing additional tasks as directed by managers.

Key Competencies of a Battery System Assembly Operator

- Knowledge of the negative and positive electrodes of a battery.
- Skilled in separating the two terminals from each other inside a battery.
- Ability to fit cell-plates adequately and efficiently.
- Skilled in marking the correct polarity signs on the terminals of the battery.
- Skilled in filling the battery with acid, once all the parts have been assembled.

Reporting to Supervisor

- Informing the supervisor of the workload and completion status.
- Reporting the work status through proper documentation as per the organizational standards.
- Intimating the problems that cannot be resolved at the field level with reason.
- Reporting on the completion of field repair or hardware part replacement with reference to the agreed target and time or reasons for not meeting the target.
- Preparing the feedback form on customer satisfaction level with respect to the product repair.

In addition, the individual has the following responsibilities:

- Communicating effectively at the workplace.
- Working effectively.
- Maintaining and enhancing professional competence.
- Working in a disciplined and ethical manner.
- Upholding social diversity in the workplace.
- Dealing with workplace hazards.
- Following fire safety practices.
- Following emergencies, rescue and first-aid procedures.
- Following effective waste management/recycling practices.

1.3.2 Personal Attributes of a Battery System Assembly Operator

A Battery System Assembly Operator needs to have some essential personal attributes for performing various activities effectively. The individual should have attention to detail and problem-solving skills to quickly identify any malfunctioning or problems with Battery for their timely resolution. The person should have logical thinking to analyze a situation/problem logically to find an appropriate solution and appropriate technical expertise to perform repair and maintenance activities efficiently. Good decision-making skills are also important for the individual to ensure the correct decision is taken concerning the corrective measures to be taken for battery repair.

The person usually caters to clients who experience issues with their Batteries. For this reason, the individual needs to have good client-dealing skills and the ability to work as per their requirement. It also includes effective communication skills, i.e. talking courteously and listening attentively.

In a dynamic technological environment, it is also vital for the individual to stay updated with the latest developments in the field of work by reading the relevant literature and staying in contact with relevant persons.

1.3.3 Career Progression for a Battery System Assembly Operator

There are different career pathways that a Battery System Assembly Operator can take. Following are some of them:

- Lateral movement in the Electric Mobility industry or even to traditional industry is possible as the uses of Battery is almost available in every industry. The individual can work as an employee with such a company.
- With appropriate knowledge and adequate years of experience, the individual may also become a Senior Assembly Incharge.
- Later, the individual may become a Supervisor and even progress to a manager's level.
- The person can even work as an entrepreneur and start a Battery System Assembly service centre.
- Similarly, with strong technical expertise in Battery Assembling, one can even become a trainer at a training institute or start own Battery Assembling training centre.

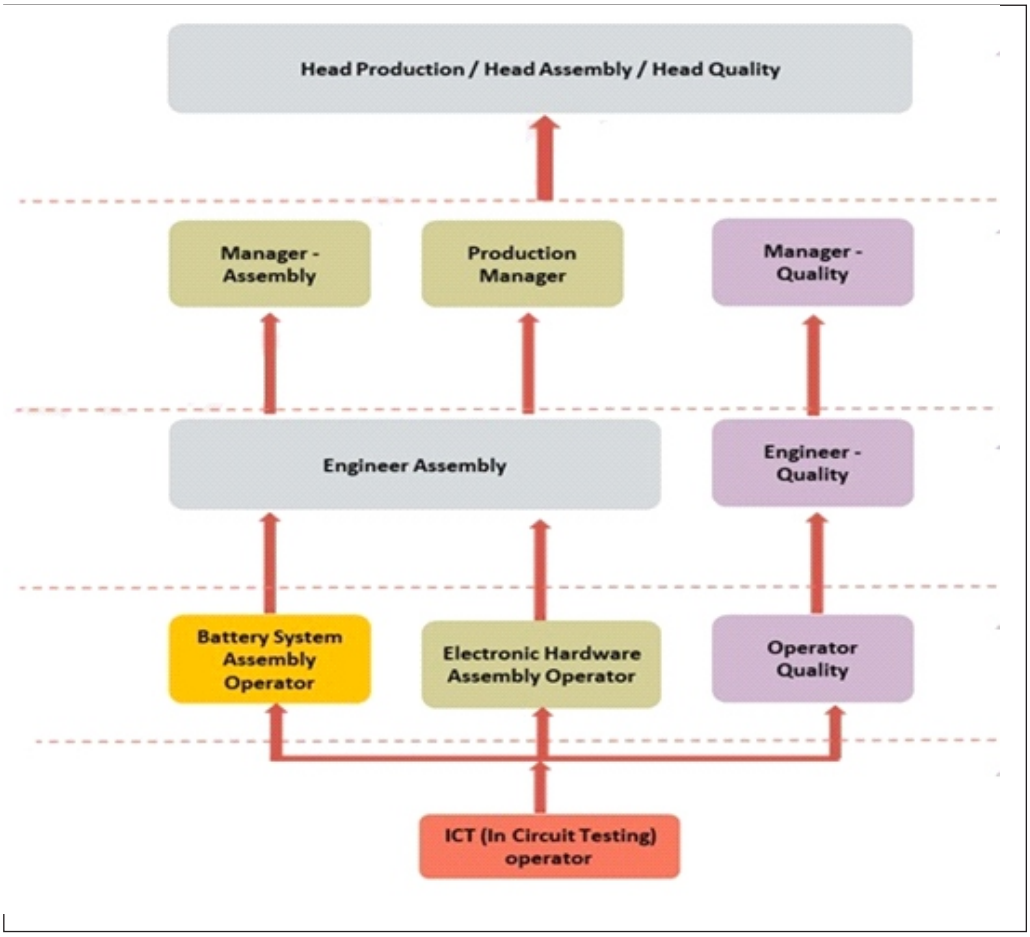

Fig. 1.3.1.Organizational Policies on incentives, Personnel Management and Reporting Structure

The organizational policies on incentives, personnel management, and reporting structure depend on the organization the individual joins. These vary across organizations.

For example, a public sector company may offer different kinds of incentives for work performance as compared to a private company. The same is the case with the reporting structure.

Personnel management policies also tend to differ from organization to organization. The individual should conduct proper research before interviewing for a job at a particular company to ensure that they are satisfied with the company policies on remuneration, human resource management, career progression, etc.

Exercise

1. List down three sub-sectors of the Electronics System Design & Manufacturing (ESDM) Industry.
2. Explain the Construction and Working Principle of Battery.
3. List out the roles and responsibilities of the Battery Operator.
4. Research the popular EVs in the market in LMV segment and list down the battery specifications.
5. List the Types of Electric Vehicle.

Notes

Scan the QR Code to watch the related videos

https://www.youtube.com/watch?v=WcrAFNuGnNY

Job Role and Responsibilities of a Battery System Assembly Operator

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2. Assemble the Battery System

Unit 2.1 - Principles of Battery Asembling

Unit 2.2 - Technical Aspects of Battery Assembling

Unit 2.3 - Quality Standard, Safety and Security while working with Battery

ELE/N6604

Key Learning Outcomes

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

1. Explain the design and connectivity requirement between various components of the assembly.
2. Explain the criteria for selecting Battery system components and functional blocks.
3. Describe the process of planning the assembly as per quality, industry and compliance standards.
4. Explain the precautionary measures to be taken before starting the assembly.
5. Demonstrate the process of assembling various components of the battery.

UNIT 2.1: Principles of Battery Asembling

Unit Objectives

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

1. Explain the basic principles governing Electronics Engineering including ionization and the flow of electricity.
2. Describe the safety and environmental standards that must be followed while assembling a Battery system.
3. Prepare a sample design and connectivity for establishing interoperability between various components of the Battery system.

2.1.1 Basic Principles of Electricity and Electronics

Electricity is a form of energy. You must first comprehend the structure of matter in order to understand electricity. Matter is anything that takes up space and has mass. All gases, liquids, and solids are examples of matter in various states. Atoms are the smallest building blocks that make up matter. Molecules are made up of groups of atoms called compounds.

Atomic theory

The most fundamental component of matter, atoms have unique atomic structures. Similar to how the solar system is described, the structure of an atom can be similarly described. A nucleus stands in place of the Sun in the center. Protons and neutrons are the two fundamental particles that make up this nucleus.

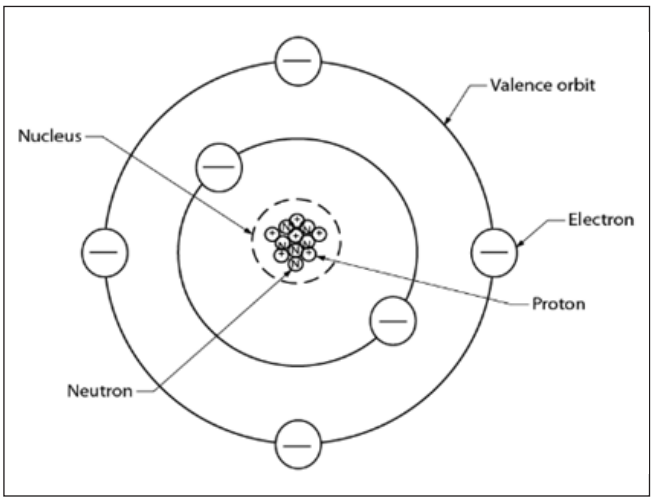


Fig. 2.1.1 Shows a model of a carbon atom

The atom's mass, or weight equivalent, is made up of neutrons, which are thought of as neutral because they have no electrical charge. Protons are inseparable from the nucleus and possess a positive (+) electrical charge. Electrons orbit the nucleus and surround it. These are minute particles with an electrical charge that is negative (-).

Chemical

The chemical reaction that happens between plates and an electrolyte inside a battery makes it a source of electrical power. Positive ions accumulate on one plate as a result of this reaction, while negative ions accumulate on the other plate. The term "potential difference" refers to this electrical difference between the plates.

Electromagnetic induction

A magnetic field can be used to produce electric force. The majority of the electrical energy we use is generated using this method. An alternator or generator are examples.

Friction

Free electrons may move from one body to another as a result of friction and may momentarily accumulate there. When you move across a carpet, electrons are transferred to the atoms in your body, and when you touch a metallic object, you return them to other atoms.

Heat

When two different metals are heated together, an electrical force is produced. The thermocouple in a furnace is an example.

Pressure

When squeezed under great pressure, some crystals will start to emit electricity. A piezoelectric generator, another name for a barbecue starter, is an example.

Light

When exposed to light, some crystals and semiconductors will generate electrical force. The photocell in a calculator serves as an illustration.

The goal is the same for all six of these EMF sources. They separate charge by:

- Supplying the electrons with energy
- Pushing them against an electrostatic field
- Resulting in an excess of negative electrons (negative charge) at one source terminal and an absence of positive electrons (positive charge) at the other terminal

In some ways, the procedure is similar to compressing a spring. The compressed spring's energy can be used later to perform useful tasks. The same is true of the separated charges: they store energy that can be used to do useful work.

Electrical energy always comes from some other form of energy. The device that converts energy from another form into electrical energy is the only thing that can be considered the source of EMF.

2.1.2 Fundamentals of Electricity

Scientists have learned over the years that electricity is a predictable and measurable force. Understanding the fundamentals of electricity will make it easier for you to comprehend how and why electrical circuits function.

Electric Current

Electric current is the term used to describe both the direction and volume of electricity flowing through an electronic circuit. It is measured in amperes (A). The higher the ampere value, the more electricity flows across the circuit. Imagining electricity as the flow of water in a river makes it simple to understand. The quantity of electrons flowing per second is the current. Electrons combine to form particles called electrons.

Voltage is a word that is used in electrical circuits almost as frequently as current. Volts are the unit of measurement for voltage (V). Voltage is connected to the passage of electrons in a circuit, just like the current. The flow of electrons is referred to as current, and the amount of force driving the electrons is referred to as voltage.

The two types of electric current flow are:

Direct Current: The one direction flow of an electric charge is known as direct current. Direct current can flow via conductors like wires, but it can also flow through semiconductors and even a vacuum.

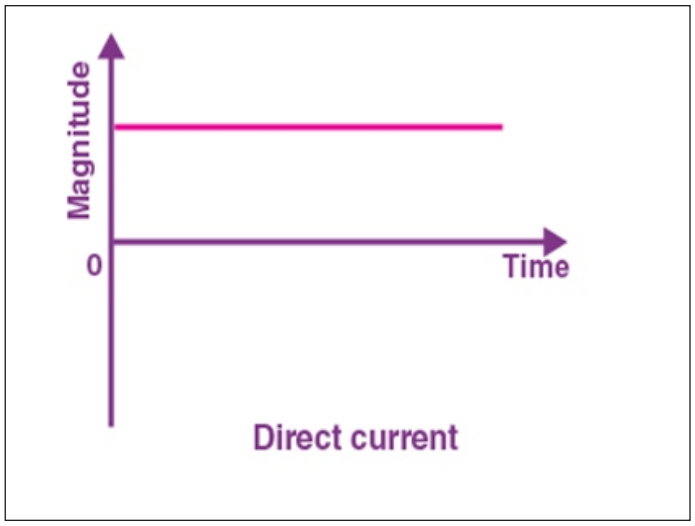


Fig. 2.1.2 Direct Current

Alternating Current: An electrical current that repeatedly changes or reverses its direction is called an alternating current. AC changes its magnitude and polarity at regular intervals of time.

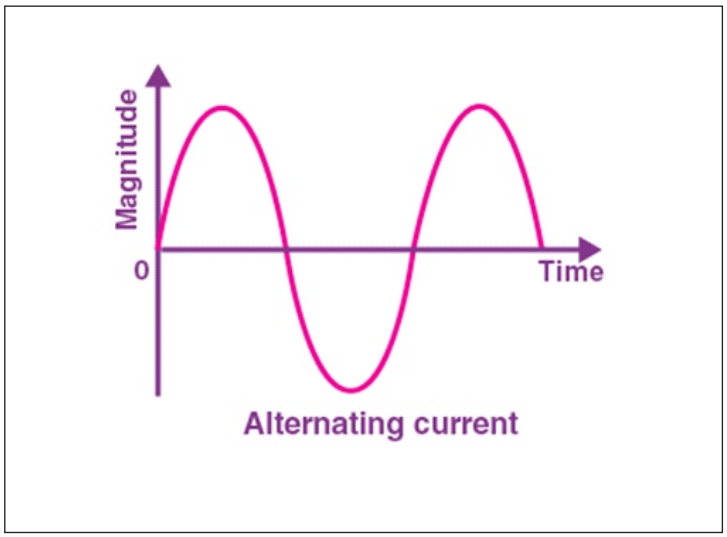


Fig. 2.1.3. Alternating Current

Polarity and direction of current flow

Electricity, magnetism, and electronic signaling are just a few fields where the word "polarity" is used. A body or system is said to be polarized when it exhibits opposing physical characteristics at various points, particularly magnetic poles or electric charge.

One of the poles in an electric current between two points, or poles, will contain more electrons than the other. Negative polarity is defined as having the pole with the most electrons. The pole that contains fewer electrons is said to have positive polarity. Electrons move from the negative pole to the positive pole when the two poles are connected by a wire. This flow is called an electric current.

In a direct current (DC) circuit, the electrons only flow in one direction and one pole is always negative and the other pole is always positive. In an alternating current (AC) circuit, the two poles alternately alternate between positive and negative charges while the electrons flow in the opposite direction.

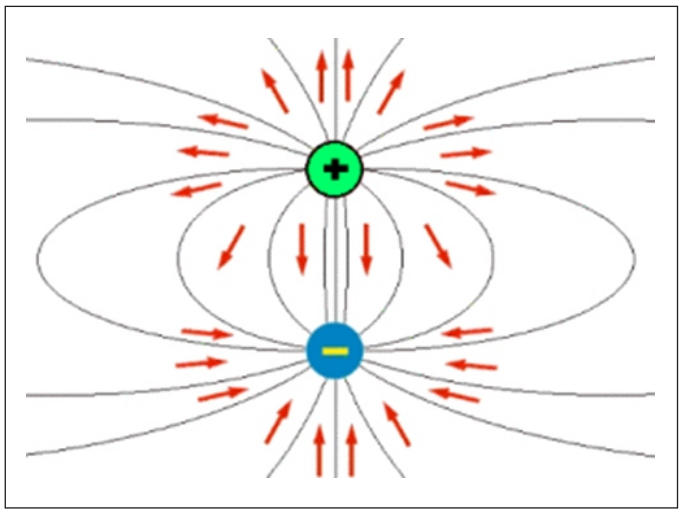


Fig. 2.1.4. Polarity Direction

Polarity Testing

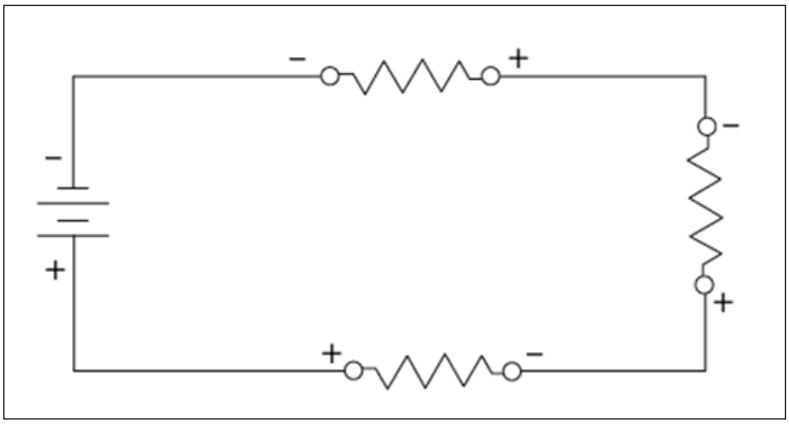
A multimeter or a volt-ohm meter can be used to test the alternating current (AC). In order to test wiring with a multimeter, positive and negative leads from the meter must typically be touched. The polarity is incorrect if there is a flashing negative sign ("-") before the meter's numerical reading.

Reversed Polarity

It is easy to fix polarity problems with wall outlets in your home or with your appliances, but you must exercise caution to prevent electric shock or electrocution. Turning off the electricity supply is a good idea before inspecting the wiring. Positive wires, usually red or black, should be connected to the brass terminal. The chrome terminal with the lighter-colored finish is where neutral wires, which are typically white or gray, should be connected.

If the wires aren't connected correctly, you'll have reversed polarity, which causes the current to flow against its intended direction. Anyone touching the appliance or the outlet may receive an electrical shock as a result, and the appliance itself may even be harmed.

When working with them, the term "polarity" is often used to describe the relationships between various points in an electrical circuit. Connecting the leads of polarity-dependent devices, such as some meters and motors, requires an understanding of polarity. For determining the direction of current flow, polarity is also crucial. In the illustration below, the current travels clockwise around the circuit from the source to the positive terminal before returning to the source at the negative terminal.



The fact that current flows through sources from positive to negative and through loads from negative to positive is crucial to understand. A more accurate way to put it is that while current flows from negative to positive outside the source, it flows from positive to negative inside the source.

2.1.3 Electric Circuit

A channel through which electric current flows is known as an electric circuit. An electric circuit can also be a loop if it is a closed path (both ends are connected). Because of the closed circuit, electric current may flow freely. An open circuit is in which the passage of electrons is interrupted because the circuit is broken. An open circuit does not allow an electric current to flow.

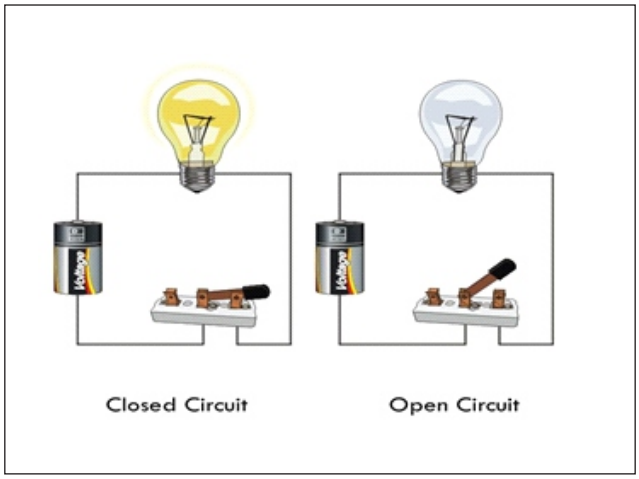


Fig. 2.1.5. Electric Circuit

Parts of Electric Circuit

The functions of parts of an electric circuit are:

- **Cell or electric source:** This is a device that provides electric current.
- **Load:** The load is a resistor. It's just a light bulb that illuminates when the circuit is activated.
- **Conductors:** Copper wires with no insulation are used as conductors. The wire transmits current from the power source to the load and from the load to the power source on one end and from the power source on the other.
- **Switch:** A switch is a component of a circuit that regulates the flow of electricity through it. Its purpose is to open or close a circuit.

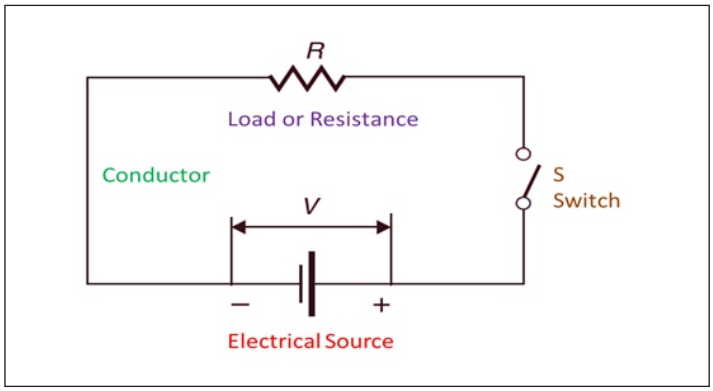


Fig. 2.1.6. Parts of Electric Circuit

Types of Electric Circuit

There are two types of electric circuits;

- Series circuit.
- Parallel circuit.

Series circuit: In a series circuit, electrons can only flow in one direction. At the same moment, the circuit is closed or open. The fundamental drawback of a series circuit is that no current flows in the circuit in the event of a circuit break since the whole circuit is open. If any light bulbs are linked in a series circuit, for example, if one goes out, the others will likewise go out.

- Switch: A switch is a component of a circuit that regulates the flow of electricity through it. Its purpose is to open or close a circuit.

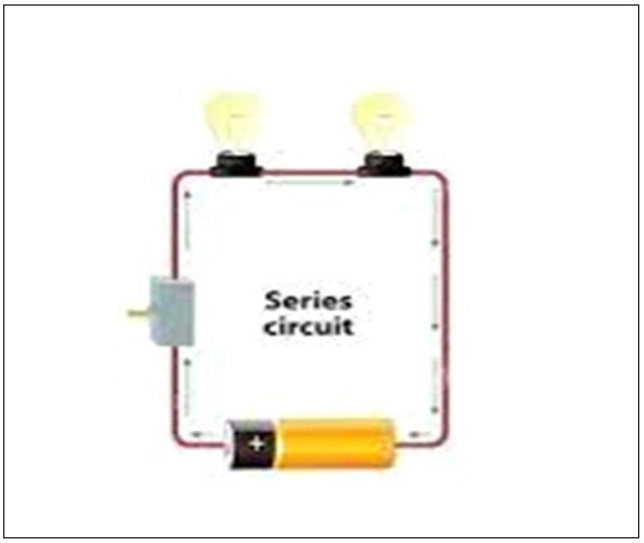


Fig. 2.1.7. Series Circuit

- **Parallel circuit:** Different circuit components are linked across different branches in a parallel electric circuit. As a result, electron flow happens in several stages. If a circuit break occurs in one channel, electric current flows in other paths. In domestic appliance wiring, parallel circuits are utilized to ensure that if one light bulb fails, the other will continue to function.

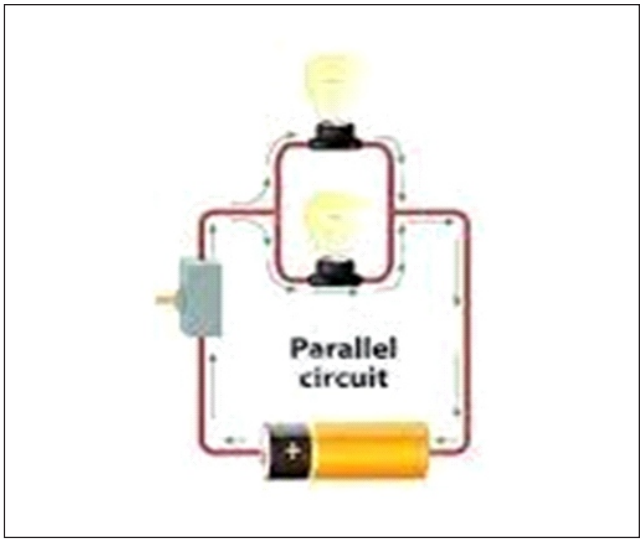


Fig. 2.1.8. Parallel Circuit

2.1.4 Electronic Components

Electronic components are the elements of the circuit that help in its functioning. They can be classified into two types, i.e. Active Components and Passive Components. Active components include transistors, batteries, etc., while passive components include transformers, inductors, resistors, capacitors, etc.

The electronic components and their functions are:

1. **Resistors:** In an integrated circuit, a resistor is one of the components that will be encountered. The gadget, as its name implies, opposes current flow. Power ratings (the amount of power they can withstand without exploding) and resistance values are used to grade resistors (capacity to resist current). Ohms are the units used to measure resistance. The unit's electrical symbol is O.

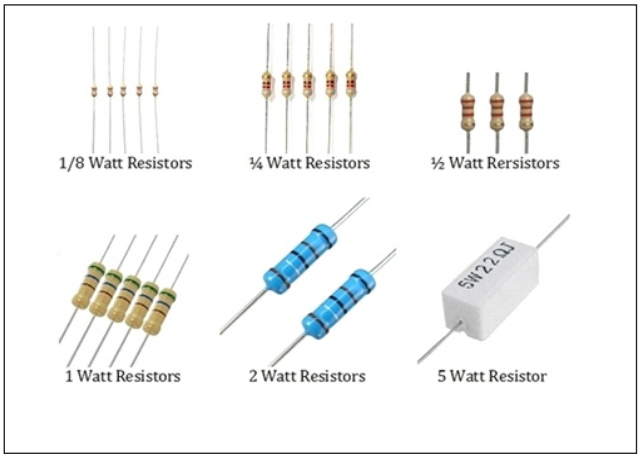


Fig. 2.1.9. Resistors

2. **Capacitors:** These components have the ability to temporarily store electric charge. The components come in a variety of shapes and sizes, with electrolytic and ceramic discs being the most popular. A component's capacity is commonly expressed in microfarads (ÂµF).

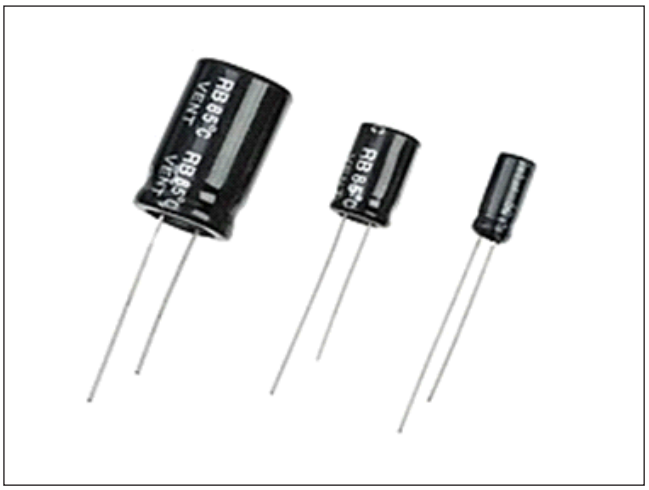


Fig. 2.1.10. Capacitor

3. **Diodes:** Electric current can only travel in one way through diodes. The anode and cathode are the two terminals of each diode. When the anode is charged with a positive voltage and the cathode is charged with a negative voltage, an electric current can flow. The current will not flow if these voltages are reversed.

Fig. 2.1.11. Diode

4. **Transistors:** The three terminals on these components make them easier to spot. Voltage must be provided to one of the components, the base terminal, in order for it to function. The current flow in the two additional terminals can then be controlled by the base (the emitter and collector).

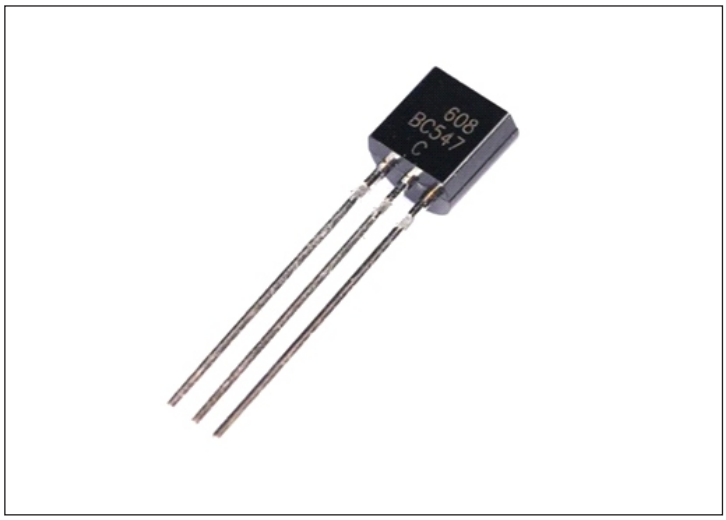


Fig. 2.1.12. Transistors

5. **Inductors:** These are energy-storing components that take the shape of a magnetic field. An inductor is basically a coil of wire coiled around a core of some sort. A magnet or air might be used as the core. A magnetic field is formed around the inductor as electricity passes through it. If a magnet is employed as the core, the magnetic field is greater.

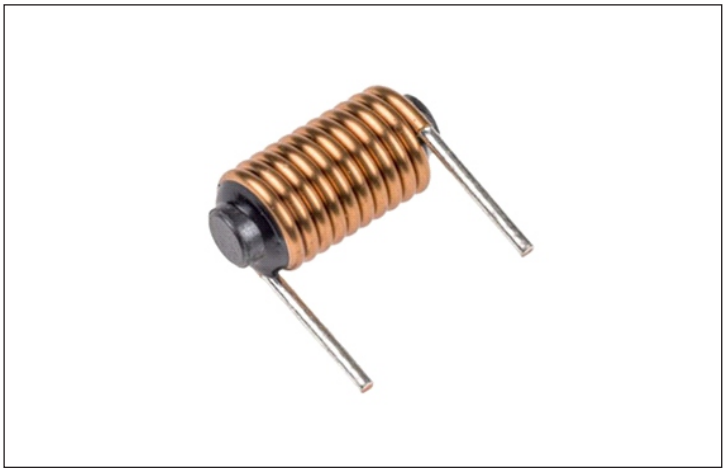


Fig. 2.1.13. Inductors

6. **Integrated Circuits:** An integrated circuit is a particular device containing all electronic circuit components. Diodes, transistors, and other devices are all etched on this component's small piece of silicon. Many electrical gadgets, like watches and computers, employ the components.

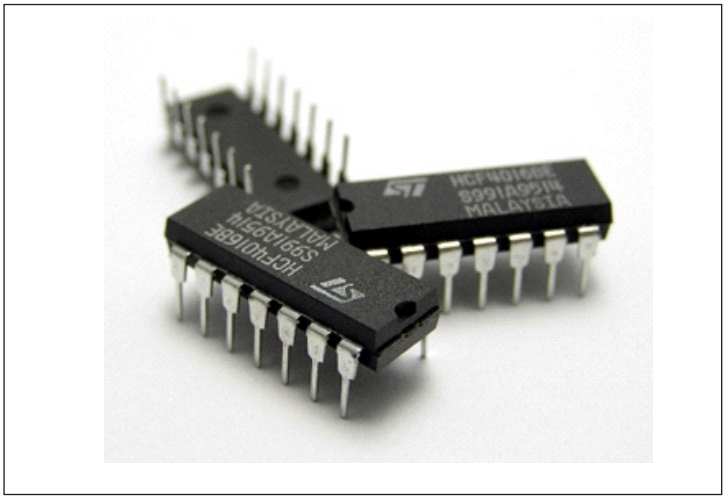


Fig. 2.1.14. Integrated Circuits

7. **Microcontrollers:** Microcontrollers are tiny computers that control a wide range of devices, including power tools, remote controls, medical equipment, and office machinery.

Fig. 2.1.15. Microcontrollers

8. **Transformers:** Transformers are regularly used to step up or down power and are made up of two coils of wire.

Fig. 2.1.16. Transformers

9. **Batteries:** Chemical energy is converted to electrical energy by batteries. Anode (+) and cathode (-) are the two types of cells in a battery (-).

Fig. 2.1.17. Batteries

10. Fuses: Fuses protect components from overheating due to excessive current. A fuse comprises a connecting body, support, contacts, and a zinc or copper-based metal fuse material.

Fig. 2.1.18. Fuse

11. **Relays:** These electromechanical switches turn on and off the electricity. An electromagnet, an armature, a set of electrical connections, and a spring make up a relay.

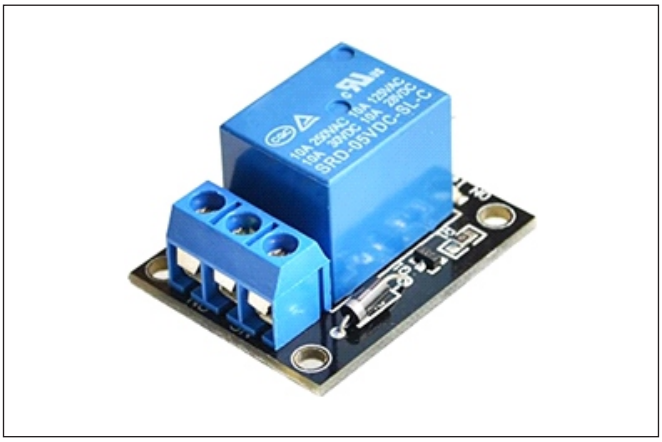


Fig. 2.1.19. Relays

12. **Switches:** The current is interrupted by switches. Single pole single throw (SPST), double pole single throw (DPST), single pole double throw (SPDT), and double pole double throw (DPDT) are the four types of switches (DPDT).

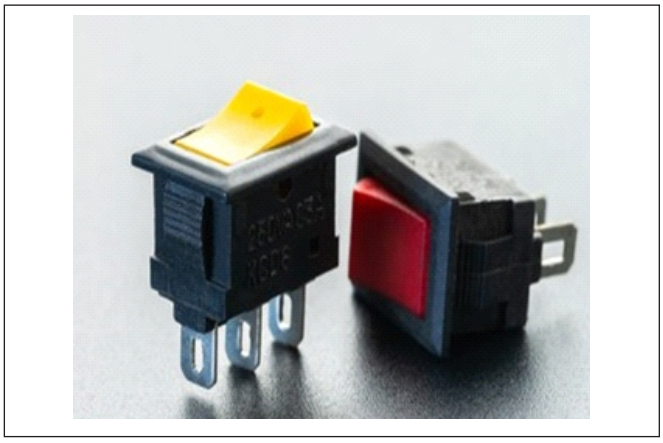


Fig. 2.1.20. Switches

13. **Motors:** Electrical energy is converted into mechanical energy by motors. A rotor, bearings, stator, conduit box, enclosure, and eye bolt are all important components.

Fig. 2.1.21. Motors

14. **Circuit Breakers:** A circuit breaker can be operated using a remote switch as a safety precaution. Its purpose is to prevent the circuit from being overloaded or short-circuited.

Fig. 2.1.22. Circuit Breakers

Semiconductor

A semiconductor is a material with an electrical resistance that is halfway between that of metals and insulators, allowing it to "semi"-conduct electricity. Because we can regulate the flow of electrons in this material, such as with a regulating current, semiconductors are employed in many electrical circuits.

Semiconductors are also employed for a variety of other purposes. In actuality, a solar cell is made up of light-sensitive semiconductors. The quantity of light energy that strikes the semiconductors determines how much electrical current is created by the solar cells' semiconductors.

2.1.5 Electrical Safety

Any kind of safety measure taken to guard against electric currents is referred to as electrical safety.

Serious injuries brought on by electrical contact include:

- Electrical shocks
- Electricity burns
- Electrocution

An electrocution can be fatal if it is severe enough. By requiring employees to adhere to the proper safety precautions when handling electricity, employers are responsible for ensuring workplace safety.

Electric safety fundamentals are as follows:

- It is not advised to work with exposed conductors carrying 50 volts or more.
- Make sure that all electrical equipment is functional, grounded, and properly connected.
- After a single activity or event, extension cables should be discarded because they should not be used as permanent wiring.
- Surge suppressors with built-in circuit breakers are available in chord lengths of three, six, and fifteen feet and can be used for a long time.
- High-amperage appliances like portable air conditioners, space heaters, and others need to be directly plugged into outlets on the wall.
- One should not enter, use, or alter any building's electrical service, including circuit breaker panels, unless they have explicit certification and permission to do so.
- Electrical shocks are more likely in wet situations.

2.1.6 Safety and Environmental Standards While Assembling /Handling Batteries

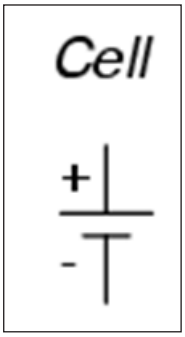
Batteries are bulky, have corrosive acids inside, and generate electricity. When handling batteries, you should take a number of safety precautions because all of these pose a risk to your safety.

- Stay away from touching metal with batteries. This includes personal items like jewelry, watches, and belts as well as metal tools and hoist chain. Anyone touching a metal object as it comes into contact with the battery runs the risk of being electrocuted because metal conducts electricity.
- Never allow both terminals to make simultaneous contact with an object, especially with yourself. Anything touching the engaged terminals will experience an electrical current when they are connected.
- When lifting or moving batteries, avoid hand-guiding them. You would be in danger if the battery fell or shifted because of this. Additionally, touching the battery poses a risk because it might shock the worker with electricity or expose them to corrosive battery acid.
- Use appropriate lifting techniques that are safe. Throughout the moving process, avoid letting unprotected hands come into contact with the battery. Use only the designated lifting equipment that has been approved for the weight of the battery and was created for this purpose. If not, there is a chance that the battery or lifting equipment will be harmed.
- When handling batteries, put on safety gear, such as gloves, goggles, and a hardhat. Gloves and safety glasses protect against battery acid, and a hard hat is necessary when lifting batteries in case it swings or falls.

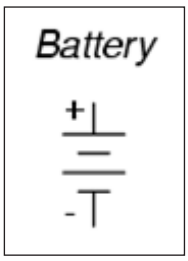
- All personnel handling batteries should receive initial training in safe lifting and handling techniques. In order to keep a workplace safe, it's also a good idea to frequently remind employees of proper battery handling techniques.
- The scheduled maintenance programs from Industrial Battery & Charger Inc. give you the option to proactively manage your fleet maintenance on a schedule as opposed to a purely corrective basis. The foundation of any effective and well-run facility is a preventive maintenance program, which will ultimately save you time and money while extending the life of your batteries.

2.1.17 Connection and Designing a Battery

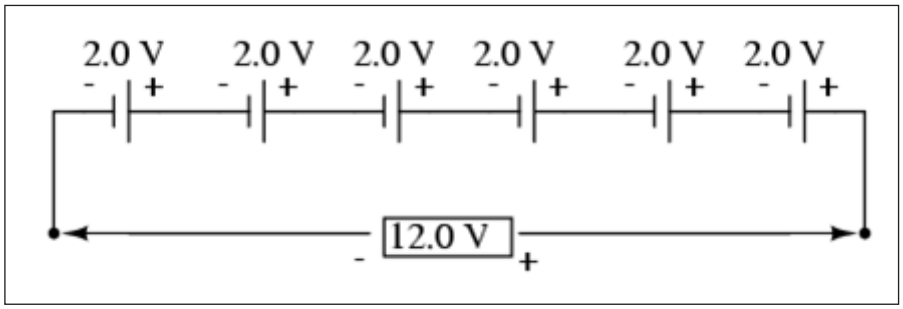
A cell is represented by a very straightforward symbol made up of two parallel, long and short lines connected by wires:



A few cell symbols stacked vertically form the battery symbol:

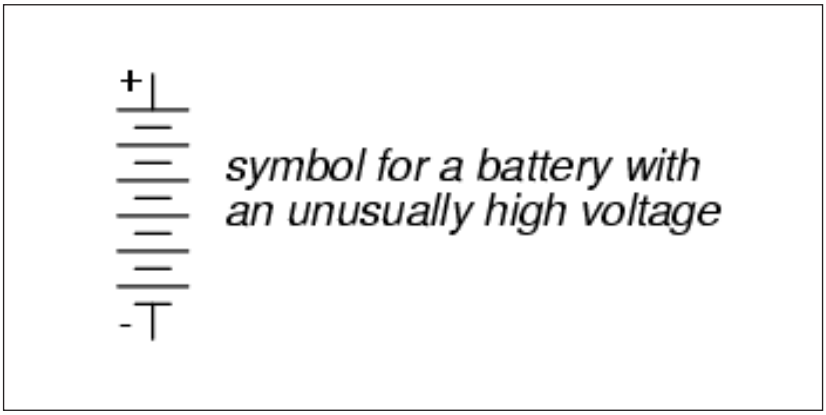


As previously stated, the chemistry of a given type of cell solely determines the voltage that type of cell can produce. The voltage of the cell is independent of its size. More than one cell must be connected in series to produce a voltage higher than the output of a single cell. The sum of all cell voltages makes up the battery's overall voltage. Six cells make up a typical automotive lead-acid battery, which produces a nominal voltage of 6 x 2.0 or 12.0 volts:



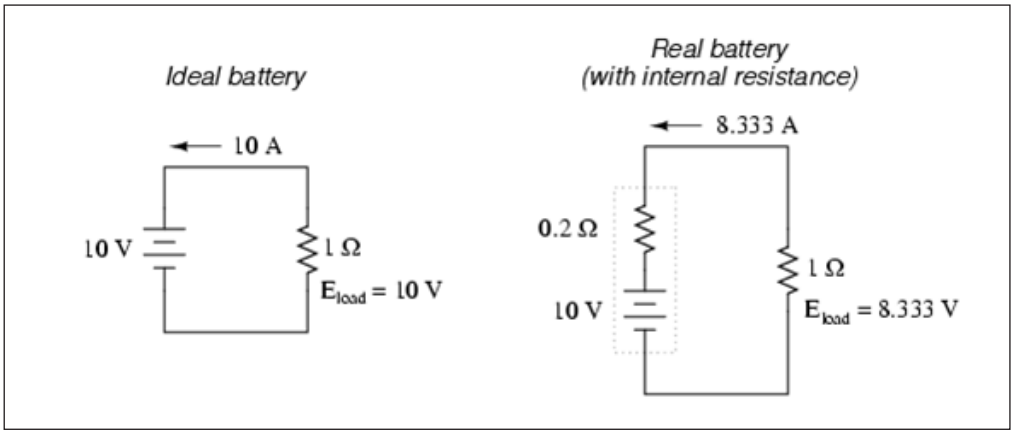
An automotive battery's cells are housed in a single hard rubber housing and are connected to one another using thick lead bars rather than wires. Each cell's electrodes and electrolyte solutions are kept separate and compartmentalized within the battery case. The electrodes in large batteries typically take the form of thin metal grids or plates, and are frequently referred to as plates rather than electrodes.

Battery symbols are typically limited to four lines, alternating long and short, for convenience's sake, even though the actual battery they represent may have many more cells. The symbol for a battery with an unusually high voltage may occasionally be drawn with extra lines on purpose. Of course, the lines represent the different cell plates:



What does a cell's physical size affect if it doesn't affect its voltage? The maximum current a cell can produce is impacted by resistance, which is the answer. All voltaic cells have some internal resistance because of the electrodes and electrolyte. Every voltaic cell contains some amount of internal resistance due to the electrodes and the electrolyte. The greater the contact area between the electrode and the electrolyte, the lower the internal resistance of the cell will be.

In a circuit, a cell or battery is typically thought of as an ideal source of voltage (absolutely constant), with the circuit's external resistance controlling the current through it. However, this is not entirely accurate in real life. Every cell and battery has some internal resistance, so any given circuit's current must be impacted by that resistance:

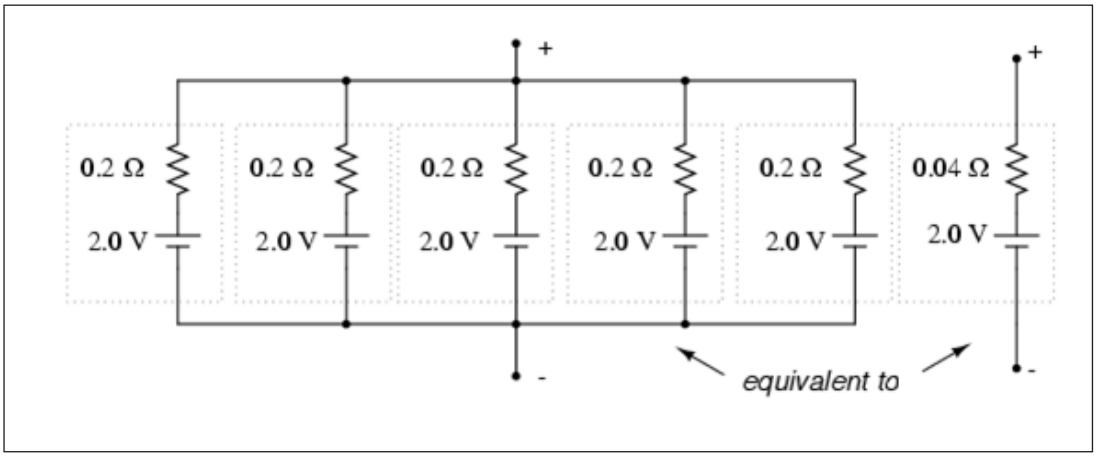


The actual battery, which is enclosed by the dotted lines in the image above, has an internal resistance of 0.2, which reduces its ability to deliver current to the 1 load resistance. Our calculations using Ohm's Law for current (I=E/R) result in a perfect value of 10 amps for current with the 1 ohm load and 10 volt supply because the ideal battery on the left has no internal resistance. The real battery can only provide 8.333 amps to the same resistance load due to its inherent resistance, which further restricts the flow of electrons.

The ideal battery would be able to provide an infinite amount of current in a short circuit with zero resistance. The internal resistance of the real battery, on the other hand, limits its ability to supply more than 50 amps (10 volts / 0.2) to a short circuit with 0 resistance. Even though the internal resistance in the battery drops voltage as electrons move through it, the chemical reaction inside the cell may still be producing exactly 10 volts, but this decreases the voltage available at the battery terminals to the load.

We must understand the effects of factors like internal resistance because our world and batteries are imperfect. Battery performance is typically very close to that of an ideal voltage source because batteries are typically used in situations where their internal resistance is negligible in comparison to the circuit load (and their short-circuit current far exceeds their typical load current).

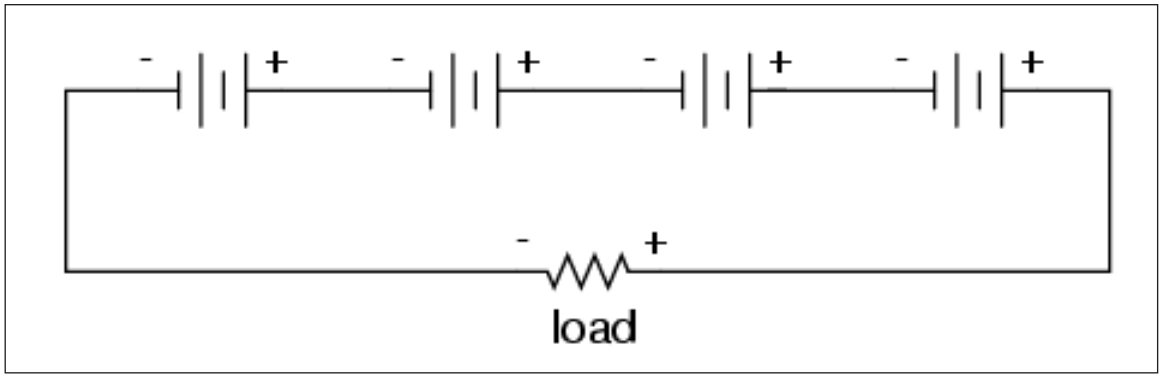
The cells must be connected in parallel if we want to build a battery with less resistance than one cell can provide (for a higher current capacity):



We have essentially calculated the Thevenin equivalent of the five parallel cells, which is a network consisting of a voltage source and a series resistance. Although the source voltage in the equivalent network is the same, each individual cell's resistance in the original network is much lower. Similar to how parallel resistors reduce their combined resistance, connecting cells in parallel reduces the equivalent internal resistance. This five-cell battery has an equivalent internal resistance that is one-fifth that of each individual cell. 2.0 volts is the constant value of the system's voltage. Due to the equal distribution of current through parallel branches with equal resistance, if this battery of cells were powering a circuit, the current flowing through each cell would be 1/5 of the overall circuit current.

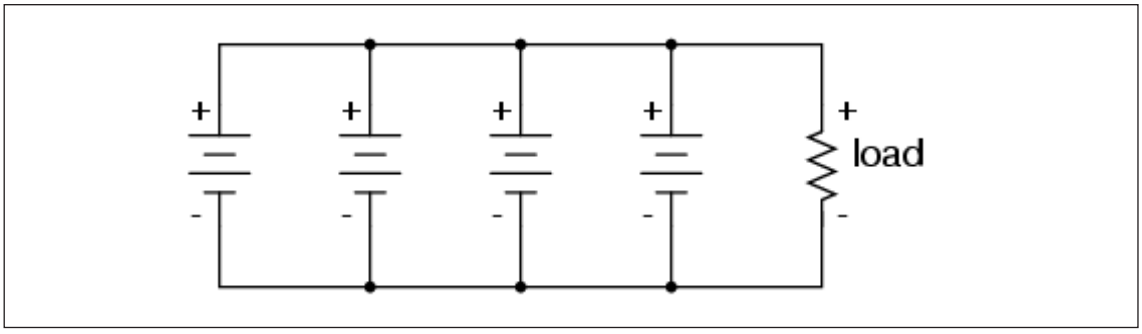
Practical Considerations – Batteries

Batteries must be matched to one another in order to avoid issues when connecting smaller "banks" (a battery of batteries?) of batteries together. We'll first think about series wiring batteries together for higher voltage:



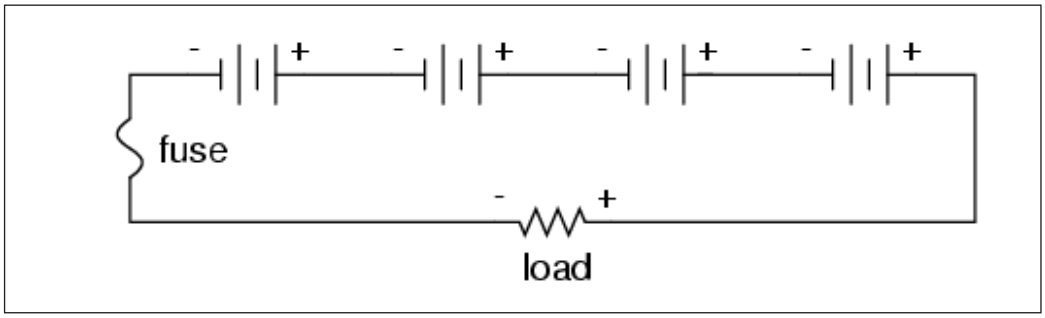
The amount of current flowing through any one of the series-connected batteries must be the same for all the others since we know that current in a series circuit is equal at all points. Because of this, each battery needs to have the same amp-hour rating. Otherwise, some batteries will run out of power faster than others, reducing the bank's overall capacity. Please be aware that the number of batteries has no bearing on the total amp-hour capacity of this series battery bank.

To increase current capacity (lower internal resistance) or amp-hour capacity, we can connect batteries in parallel as follows:

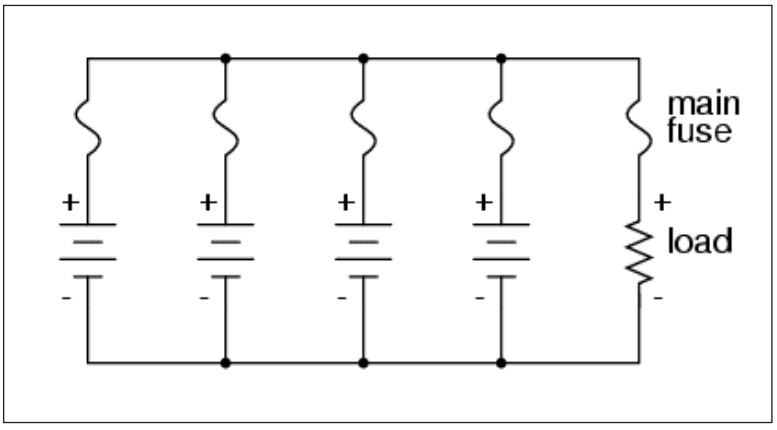


We need to confirm that the voltage of these batteries is equal because we know that in a parallel circuit, the voltage is equal across all branches. In the event that this does not occur, relatively large currents will flow from one battery to the next, with the higher-voltage batteries outperforming the lower-voltage batteries. This is not good.

In keeping with this theme, we need to make sure that any overcurrent protection (circuit breakers or fuses) is installed properly to ensure its effectiveness. One fuse will be sufficient to safeguard the wiring in our series battery bank from excessive current flow because any break in a series circuit prevents current flow through the entire circuit:



One fuse is enough to safeguard the wiring in a parallel battery bank against load overcurrent (between the parallel-connected batteries and the load), but there are other risks we need to guard against. Batteries have been known to internally short circuit as a result of electrode separator failure, creating a problem similar to that experienced when batteries of different voltages are connected in parallel: the good batteries will outweigh the failed (lower voltage) battery, resulting in relatively high currents flowing through the batteries' connecting wires. We should protect each and every battery against overcurrent with individual battery fuses in addition to the load fuse to prevent this eventuality:



The process and timing of charging must be carefully considered when working with secondary-cell batteries. The manufacturer's recommendations are probably the best rule to follow when designing or maintaining a system because different types and constructions of batteries have different charging needs. Cycling and overcharging are two distinct issues with battery charging. The term "cycling" describes the process of first "fulling up" a battery and then "discharging" it to a lower state. All batteries have a finite (limited) cycle life, and each design has a different maximum "depth" of cycle (how far it should be discharged at any given time). The process of overcharging refers to the process of forcing current through a secondary cell after it has reached its full charge. Particularly with lead-acid cells, overcharging causes electrolysis of the water (also known as "boiling" the water out of the battery) and reduces life.

Electrolysis will result in the production of hydrogen gas in any battery that has water in the electrolyte. This is especially true for overcharged lead-acid cells, but not exclusive to that type.In the presence of free oxygen produced during the same electrolysis process, hydrogen is an odorless, colorless gas that is extremely flammable. Hydrogen is an odorless, colorless gas that is incredibly flammable (especially in the presence of free oxygen produced during the same electrolysis process). Even when used normally, these batteries pose an explosion risk, so they must be handled carefully. Always make the final connection (or initial disconnection) to a battery when connecting or disconnecting charging equipment so that any spark that may result has little to no chance of igniting hydrogen gas (for example, at a point on one of the battery cables, at least a foot away from the battery).

In large, permanently installed battery banks, batteries have vent caps above each cell, and hoods are immediately over the batteries to allow hydrogen gas to be vented outside of the battery room. In large, permanently installed battery banks, batteries have vent caps above each cell, and hoods are immediately over the batteries to allow hydrogen gas to be vented outside of the battery room. Hydrogen gas is very light and rises quickly. The greatest danger is when it is allowed to accumulate in an area, awaiting ignition.

In more recent lead-acid battery designs, the electrolyzed hydrogen and oxygen are recombined into water inside the battery case. In case a battery were to leak, adequate ventilation might still be advised.

Notes

Scan the QR Code to watch the related videos

https://www.youtube.com/watch?v=mc979OhitAg

Basic principles of Electricity and Electronics

https://www.youtube.com/watch?v=_1xjkl5MCIA

Fundamentals of Electricity

https://www.youtube.com/watch?v=ouOJW_ozx6Q

Electric Circuit

https://www.youtube.com/watch?v=VBZ-3Ma7Ohc

Electronic Components

https://www.youtube.com/watch?v=GFFkeQ5dIgU

Electrical Safety

UNIT 2.2: Technology Associated with Battery

Unit Objectives

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

1. Explain the terminologies, graphical representations, signs and symbols related to Battery assembly
2. List the tools and equipment required for assembling a Battery system
3. Explain the use of various Battery systems software
4. Explain the functions of Integrated Circuits (IC), Micro-Controller Unit (MCU), circuit diagram, ampere-hours and cell balancing
5. Demonstrate the standard process of designing the Battery system using the components such as circuit, busbar, ICs, temperature monitoring sensor, functional block etc.

2.2.1 Terminologies, Graphical Representations, Signs and Symbols

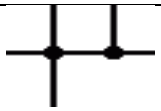
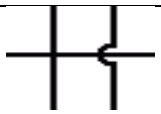
Circuit diagrams, schematics, and computer-aided drawing software frequently employ basic electrical and electronic graphical symbols called schematic symbols to indicate the locations of individual components and circuit elements.

Graphical symbols are used to represent a component's position as well as the type of electrical element it contains, such as a mechanical, inductive, capacitive, or resistive one. As a result, graphical symbols are used in circuit diagrams and schematics to identify and represent electrical and electronic devices as well as to show how they are electrically connected to one another. The wires or component leads are represented by the connecting lines. In a schematic diagram, letters or abbreviations can be used to denote connecting leads or pins of a component. For instance, the emitter, base, and collector connecting leads of a bipolar junction transistor (BJT) are designated as E, B, and C, respectively. Additionally, arrows are used in schematic symbols to show the direction in which converted current flows through a circuit or through a component. They are also used as a part of the graphical representation of a component to indicate that its value is variable or adjustable. Rheostats or potentiometers are two examples.

Although there are a number of alternate symbols and variants used globally to represent the same electrical component or device, electrical components are represented by universally recognized schematic symbols. For instance, for the same component, the IEEE (Institute of Electrical and Electronics Engineers) has a different set of symbols than the IEC (International Electrotechnical Commission).

Because they are used frequently across a variety of electrical and electronic fields, the basic electrical and electronic graphical symbols that are presented here are the ones that are more widely accepted. The individual graphical symbols below are given along with a brief description and explanation.

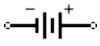
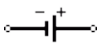
Electrical Wiring Symbols for Wire

Name	Meaning / Function	Symbol
Electrical Wire	Conduct Electricity	
Connected Wires	Wires are Connected	
Not Connected Wires	Wires are not Connected	

Electrical Wiring Symbols for Ground

Name	Meaning / Function	Symbol
Earth Ground	Protection against Electrical Shock	
Chassis Ground	Connected to Chassis of a Circuit	
Common Ground	For Analog and Digital Grounding	

Power Supply Symbols

Name	Meaning / Function	Symbol
Voltage Source	Constant Voltage Source	
Current Source	Constant Current Source	
AC Voltage Source	Source of AC Voltage	
Battery	Constant Voltage Source	
Battery Cell	Constant Voltage Source	
Generator	Mechanical Voltage Source	

Lamp and Light Bulb Symbols

Name	Meaning / Function	Symbol
Lamp or Light Bulb	Generates Light with Flow of Current	
Lamp or Light Bulb	Generates Light with Flow of Current	
Lamp or Light Bulb	Generates Light with Flow of Current	

Switch and Relay Symbols

Name	Meaning / Function	Symbol
SPST Toggle Switch	Disconnect Current when Open	
SPDT Toggle Switch	Select Between 2 Connections	
Push Button Switch (N.O)	Switch Momentary – Generally Open	
Push Button Switch (N.C)	Switch Momentary – Generally Closed	
DIP Switch	Onboard Configuration	
SPST Relay	Single Pole Single Throw	
SPDT Relay	Single Pole Double Throw	
Jumper	Jumper to Close Connection	
Solder Bridge	Solder Connection	

2.2.2 Various Important Terminology

Terminology	Defination/Description
Active Material	the substance that participates in the electrochemical reactions of charge or discharge in the electrodes of a cell or battery.
Ambient Temperature	The average temperature of the surroundings.
Anode	the negative electrode in a battery cell.
Battery (Pack)	A cell or cells electrically connected in a suitable configuration to supply the necessary operating voltage and current levels
Cathode	The positive electrode in a (battery) cell.
Bobbin Cell	In one of the most fundamental cell designs, one electrode is typically made up of a solid cylindrical core, and the other electrode is made up of an annular layer surrounding the first. Such a cell produces less power than other cell designs because it has an electrode surface area that is relatively small.
Boost Charge	Battery charging during storage is done to keep the batteries' capacity up and to combat self-discharge.
Capacity	Measured in amp-hours. the amount of electrical energy that a cell or battery is capable of storing. The capacity is proportional to the size of the battery for a given chemistry.
Charging	The process of giving a rechargeable battery (or cell) external electrical power so that it can be used repeatedly. During charging, ions move through the electrolyte from the cathode to the anode.
Cell	The basic electrochemical unit providing a source of electrical energy by direct conversion of chemical energy. A cell consists of an assembly of electrodes, separators, electrolyte, a container and electrical terminals.
Chemistry	Based on the unique chemistry of the components inside, cells are categorized. Common chemistries include variations of Lead, Nickel and Lithium metal. The chemistry dictates the cell voltage and the performance characteristics and each chemistry has its optimum charging algorithm; traditionally different battery chemistries are not interchangeable in the same charger. Each chemistry also possesses its own shipping, handling and disposal regulatory requirements.
Constant Current Charge	A method of charging a battery using a fixed current.

Constant Voltage Charge	Also known as constant potential charge, this technique involves applying a fixed voltage to the battery while allowing variations in the current.
Current	Measured in amps. This is consistent with the battery's ability to discharge electrons at a certain rate. A battery's capacity for current depends on the chemistry and cell design.
Cycle Life	The maximum number of charges and discharges a battery can withstand before it reaches the end of its useful life (EOL); typically, a battery is considered EOL when its nominal capacity drops below 60% to 80% of its initial capacity. Usage, temperature, aging, maintenance history, internal resistance, and depth of discharge are some of the elements that affect a battery's cycle life.
CCV	Closed circuit voltage is the voltage that is measured when a battery or cell is being loaded by an external source.
C-Rate	A battery's rate of discharge (or current) in relation to its maximum capacity is measured by its C-rate. Example: If a battery is discharged at a rate of 1C, it will deliver 1A for an hour.
Discharge	A loss or release of energy from cell or battery. The conversion of chemical energy into electrical energy and withdrawal of the energy into a load. During discharge, ions travel from the negative electrode to the positive electrode through the electrolyte.
Duty Cycle	The operating regime of a cell or battery including factors such as charge and discharge rate, depth of discharge, cycle length, and length of time in the standby mode.
Electrode	The key, energy delivering active material that makes up a cell. This is the site or location where the fundamental electrochemical processes take place.
Electrolyte	The medium (i.e. aqueous solution, gel, organic, inorganic, etc.) which provides ion transport between the cathode and anode of a cell.
Energy	Measured in watt-hours or Ampere-hours. This is the product of the Voltage and the cell Capacity.
Energy Density	The energy of a cell or battery is scaled to its size (in terms of weight or volume). Can be measured gravimetrically (watt-hours per kilogram) or volumetrically (watt- hours per liter).
Gassing	The electrodes of a cell release gas into the surrounding area. Gassing frequently happens as a result of local action (self-

	discharging) or during charging when the electrolyte is electrolyzed.
Impedance	The resistance to the flow of an Alternating Current (AC) through a cell is referred to as the impedance of a cell, which is a complicated quantity. Along with capacitance and inductance, which fluctuate with frequency, it also contains DC resistance.
Internal Resistance	This idea is frequently applied to DC (Direct Current). It is the total of all the ionic, electronic, and kinetic resistances of the cell's constituent parts, and it describes the resistance to the flow of an electric current within a cell or battery. A battery with low internal resistance delivers all available energy with minimal voltage drop and excellent current flow.
Load	A term used to define the current drain on a battery based on the resistance of any device connected to it. The voltage decreases as a result of internal battery resistance and a declining state of charge.
Memory Effect	In order to maintain their discharge capacities, some cell chemistries (like Ni/Cd) demand that the cell be fully discharged before being recharged. If this is not done, the capacity decreases fairly quickly from cycle to cycle.
Negative Electrode	The electrode acting as an anode when a cell or battery is discharging.
Nominal Voltage	The battery voltage that falls in the middle of the discharge curve, halfway between the fully charged state and the end voltage where a battery spends the majority of its time.
Open Circuit Voltage (OCV)	Voltage measurement when the battery or cell has no external load.
Operating Temperature	The temperature at which a battery operates. Depending on the battery's function and intended use, a specific temperature range is required for it to function properly. If the battery is used outside of this range, the application may fail prematurely.
Overcharge	Charging beyond the maximum, safe capacity limit of a cell or battery. This typically has very negative consequences depending on the cell chemistry, hence must be avoided.
Over Discharge	Discharge after the cell battery's maximum available capacity has been reached. This can also lead to undesirable situations.

Parallel Pack	A battery pack's capacity is increased by connecting cells in parallel. The positive terminals of all cells are connected together (or to a common conductor), while the negative terminals of all cells are connected in a similar fashion. The battery pack capacity will be the sum of all cell capacities combined, while the pack voltage will be the voltage of one cell.
Passivation	When an electrode first makes contact with the electrolyte after assembly, a protective layer develops on its surface. The process significantly slows down and stops further reaction from occurring on the electrode surface after an initial passivation layer is formed, extending the battery's (cell's) shelf life. This is a crucial quality of lithium cells.
Positive Electrode	The electrode acting as a cathode when a cell or battery is discharging. When a cell or battery is discharging, the electrode that serves as the cathode. The ratio of the power available from a battery to its volume (W/L).
Power Density	The ratio of the power available from a battery to its volume (W/L).
Primary Battery	Also known as a non-rechargeable or single use battery. Typically a primary battery provides higher energy density in the same package compared to a rechargeable battery. This provides a longer run time in applications.
Protection Circuit	A battery pack's internal electrical circuit ensures safety under all operational and environmental conditions by guarding against abuses like excessive current usage, operation in extremely hot or cold temperatures, and overcharging and overdischarging.
Rated Capacity	The maximum amount of amp-hours a battery is capable of producing under particular circumstances (rate of discharge, end voltage, temperature); this is typically the manufacturer's rating.
Secondary Battery	Rechargeable battery is another name for it.
Self-Discharge Rate	Cells will gradually lose some of their capacity (energy) over the course of prolonged storage as a result of internal chemical reactions to the chemistry. During extended storage, cells will slowly lose some of their capacity (energy) due to internal chemical reactions to the chemistry. This affects shelf-life.
Separator	An insulator that prevents electrical contact (or a short) between the positive and negative electrodes of a cell by separating them and allowing ions to pass through it. The separator is a crucial component of a cell that must function properly for the electrochemical reactions to take place as intended.

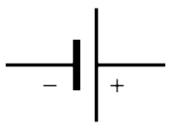
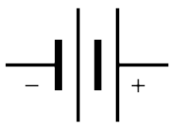
Series Pack Configuration	In order to raise the voltage of the battery pack, cells are connected in series. The positive terminal of the first cell in the series is connected to the negative terminal of the second, and so on. While the capacity of the battery pack will be equal to the lowest capacity cell in the series, the voltage of the battery pack is equal to the sum of all cell voltages.
Shelf Life	The length of time a cell or battery can be stored under specified conditions before being used in a device. The chemistry, initial charge level, ambient temperature, and any leakage current in the electrical circuit (in the case of a battery pack) will all affect how long the battery will last.
Smart Battery	A Smart Battery is a rechargeable battery pack incorporating a Battery Management System (BMS) with an external communication data bus (usually a 2-wire system called SMBus).By keeping an eye on important cell parameters (current, voltage, temperature, cycle count, state of charge, etc.) in a single or multi-cell pack, performing cell balancing to ensure optimum performance, performing battery authentication, and externally communicating the battery health data with a smart charger and/or host device through the SMBus, the BMS safeguards the battery from operating outside of its safe limits.
Spirally Wound Cell	In order to increase the electrode surface area and provide a higher rate cell compared to a bobbin cell, a cylindrical cell with an electrode structure made by winding electrode sheets or ribbons separated by a separator into a cylindrical "jelly roll" construction is used.
State of Charge (SOC)	Battery capacity expressed as a percentage of rated capacity at any given time.
State of Health (SOH)	Despite the lack of a standard definition, this usually refers to how a cell or battery is performing in contrast to what was anticipated by design. The impedance can be used to report the health status.
Sulfation	Process occurring in lead batteries that have been stored and allowed to self- discharge for extended periods of time. Lead sulfate crystals grow to be quite large and obstruct the action of the active ingredients.

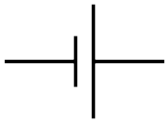
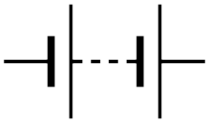
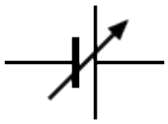
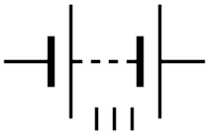
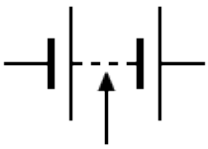
Temperature Effects	Battery life is significantly reduced when used in incredibly hot or cold environments. High temperatures can result in high internal cell pressure, which can lead to leaks or other issues with cell integrity. Low temperatures may increase internal resistance, which produces heat. This heat may cause the electrolyte to evaporate in a non-hermetic system, lowering capacity.
Thermal Runaway	When a battery is being charged or discharged, this condition can occur. It is caused by internal chemical reactions that start when the battery reaches a certain threshold as a result of overcharging, overdischarging, or other electrical or mechanical abuse.
Voltage Delay	Time delay for a battery to deliver the required operating voltage after it is placed under load. Typically a voltage depression followed by a recovery will be observed when this phenomenon is present.
Voltage Depression	An abnormally low voltage, below the expected value, during the discharge of a battery. Sometimes seen in extremely low temperatures (typically < - 20°C).
Voltage (potential)	Measured in volts. The cell voltage is defined by its chemistry (i.e. active materials). This is independent of the size of the battery.
Working Voltage	The typical voltage or range of voltages of a battery during discharge.

2.2.3 Electrical and Electronics Symbols Used in Battery Assembly

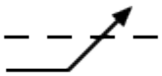
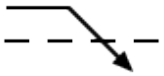
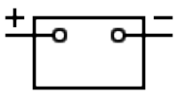
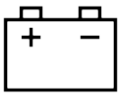
The symbols used for drawing schematic diagrams are electrical and electronic symbols. Here are a few electrical symbols that are frequently used when working on battery assembly.

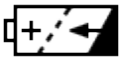
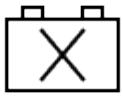
Symbols of Cells & Batteries

	Cell - Electric battery Generic symbol		Battery pack

	Cell - Battery		Connected batteries
	Electric cell with adjustable voltage		Adjustable multi-battery in three steps
	Multi-adjustable battery		Battery with connection of mobile voltage

Symbols on devices with batteries

	Pole, electrode or terminals positive of battery		Pole, electrode or terminals negative of battery
	Overvoltage indication + Info		Indication of undervoltage
	Battery representation		Battery representation

	Charge level of the battery + Info		Battery charge indication
	Battery failure		Overload indication of battery

2.2.4 Tools and Equipment Required for Assembling a Battery System

Any man who enters the battery repair industry will eventually discover through experience what tools he finds essential for his job. While some men will be able to produce quality work with relatively little equipment, others will need a slightly complex layout.

However, there are some things that are essential, and the lists below can help you choose the tools you'll need. A man with limited resources won't be able to purchase all of his equipment at once, but he should add to it as quickly as his income will allow. When his business is very small, the repairman might be able to "get-by" with subpar equipment, but if he wants to see his business expand, he must have high-quality equipment.

The various articles are listed below in order of their significance.

Required Key Equipments

Sr. No.	Item	Purpose	Picture
1	**Measuring Tape**	All types of field measurements are made using a standard tape measure.	

2	**Flashlight**	Many dim areas, including attics, basements, wall and ceiling cavities, and electrical boxes' interiors, are involved in electrical repair and improvement work.	
3	**Utility Knife**	A utility knife, also known as a box cutter, is useful for opening cardboard boxes, severing electrical tape, and sheathing non-metallic (Romex) cable.	
4	**Screwdrivers**	Electricians keep screwdrivers with them at all times, for removing and installing cover plates, outlets, switches, and many other devices. It's best to have a few different lengths of screwdrivers	
5	**Straight-Blade Screwdrivers**	The non-slip fit of the hardened tips on these screwdrivers allows them to remove even the most hopelessly stripped screws.	
6	**Wrench Set (Hex Set)**	Wrenches are used to tighten hex-head screws.	

7	**Tongue-and-Groove Pliers**	Tongue-and-groove pliers are known by many names, including channel-lock, groove joint, tongue-and-groove, and straight-jaw pliers.	
8	**Non-Contact Voltage Tester**	A voltage tester is used for a quick safety check to make sure there's no voltage in an electrical wire or device before you start working on it. Non-contact voltage testers, powered by batteries, are the simplest and safest types of testers because they can detect electricity just by being near an outlet slot or wire.	
9	**Wire Strippers**	Wire strippers are used to cut and remove the insulation from electrical wires.	
10	**Needle-Nose Pliers**	When connecting screw terminals, it will be used for wire bending and twisting.	
11	**Linesman Pliers**	Lineman's pliers are used by electricians to straighten, cut, grip, twist, push, and pull wire. They are used to cut and bend light gauge metal and pull staples and nails.	

12	**Voltmeter or Multimeter**	A voltmeter is used to read voltage levels and verify that circuits are “live” or off. Unlike a circuit tester, this tool gives you reading on how much voltage is being carried. More sophisticated forms of the tool are known as multimeters, and they can not only read voltage levels but also amperage, resistance, and DC voltage and amperage.	

2.2.5 Equipment Which is Absolutely Necessary

1. Where direct current is available, a charging outfit such as a motor-generator set, rectifier, or charging resistance should be used.
2. Charging Bench and Accessories. With the charging bench must go the following:
   - A syringe-hydrometer for adding water to cells, drawing out electrolyte, and determining the specific gravity of the electrolyte.
   - A specific battery thermometer for electrolyte temperature measurement.
   - A voltmeter for measuring the voltages of cadmium, batteries, and cells.
   - A meter to measure the current flow during charging.
   - A glass bottle for distilled water. Also one for electrolyte.
   - A few 18-inch lengths of flexible No. 12 wire with lead-coated test clips are needed to connect batteries in series while they are being charged.
3. Work bench with vise.
4. Sink or wash tank and water supply.
5. Lead-burning outfit. Since it is used to melt lead components so that they can be welded together, this should actually be called a lead welding outfit.

6. For handling sealing compound, the following are necessary.
    - Stove.
    - Pot in which compound is melted.
    - An iron ladle for dipping up the melted compound.
    - One or two old coffee pots for pouring compound.
7. Batteries that have been repaired, are being repaired, are being rented out, are new batteries, are in battery boxes, jars, plates, etc., can all be stored on shelves or racks.
8. Bins for battery parts, such as covers, inter-cell connectors, plate straps, terminals, handles, vent plugs, hold down bolts, separator hold-downs, and so on.

2.2.6 Equipment Needed In Opening Batteries

- Battery steamers are used for a variety of purposes, including softening sealing compound and making covers limp, softening compound around damaged jars that need to be removed, softening jars that need to be placed in battery boxes, and more.
- To remove softer scaling compound, use a putty knife.
- One ratchet brace with a set of 3/8, 5/8, 3/4, 13/16, and 7/8 inch square shank drill bits or wood bits for drilling off terminals and inter-cell connectors. Drilling off the terminals and connectors will take less time and work if you use a power drill press or a portable electric drill.
- Before drilling, mark the center of the connectors and terminals with a punch.
- For prying off drilled connectors and terminals, use a ten inch screwdriver. Of course, the screwdriver can be used for a variety of other tasks as well.
- To protect the upper edge of the case when prying off the connectors and terminals that have been drilled, a ten-inch length of 3/4-inch angle iron is needed.
- Two pairs of common combination pliers for removing objects from jars. For this task, a set of six- or eight-inch gas pliers will work as well.
- Machinist hammer. Of course, there are other uses for this as well.
- Using terminal tongs to remove the taper lugs from the terminals
- A set of long, flat-nosed pliers for opening jars and separators.
- Open-end wrench for use in removing taper lugs from terminals.

2.2.7 Equipment for Lead Burning (Welding)

In addition to the lead burning- outfit, the following tools are needed:

- A plate burning rack is used to arrange plates on a plate strap before burning them.
- a triangular scraper used by plumbers or tinners to clean surfaces before welding.
- A pocketknife will do in a pinch.
- Steel wire brush for cleaning surfaces before joining them with welding. Additionally, it can be used to clean lead parts generally.
- Vixen, round, and coarse files are used to file lead parts.
- An assortment of burning collars for attaching intercellular connectors to posts.
- Moulds for casting sticks of burning lead. Mold compound and a pot for melting lead are both required along with the mold.
- A set of post builders-molds is used to rebuild posts that have had terminals and intercell connectors removed after a short drilling.
- Pair of blue or smoked glasses to be worn when using lead burning outfit.

Equipment for General Work on Cell Connectors and Terminals

- Set of moulds for casting inter-cell connectors, terminals, terminal screws, taper lugs, plate straps and posts, etc.Set of molds for casting plate straps, posts, taper lugs, terminals, inter-cell connectors, and other parts.
- Terminal and connector holes can be reamed with this set of reamers.
- Set of hollow reamers for reducing posts.

2.2.8 Battery Systems Software

In the area of e-mobility, batteries are regarded as a key technology. In BEVs, the battery not only powers the electric motor but also various other electrical components. Another alternative drive technology for electric mobility is the hydrogen fuel cell. To meet the steadily rising demand, the various battery types, including lithium-ion battery cells, must be produced effectively. In order to optimize end-to-end production processes in battery manufacturing plants, an intelligent production control solution and reliable software must be implemented.

Implementing an intelligent IT solution is crucial for streamlining the manufacturing process and meeting the demands of the market as well as the most crucial battery requirements (range, charging speed, reliability, safety, lifetime). An integrated solution can be used to create the entire production process, which includes additional process flows that go beyond specific areas as well as the individual Li-Ion battery production steps, such as electrode manufacturing, cell assembly, and cell finishing. Producers rely on ongoing tests and quality checks throughout the battery manufacturing process. In the process, data is recorded and evaluated and tested for errors.

Benefits

- Optimized production planning (APS) based on actual and limited capacitiesBased on actual and limited capacities, optimized production planning (APS)
- Production process mapping and process control
- All production steps are continuously traceable
- Adherence to standards for quality and performance
- Production transparency using real-time dash boarding and business intelligence
- Complete adherence to all requirements and standards (production compliance)
- Utilizing optimization's potential to boost productivity through improved production methods
- Using data analytics tools to control production processes in a proactive manner
- Managing performance

Notes

Scan the QR Code to watch the related videos

https://www.youtube.com/watch?v=DOBBwx3Cbbk

Technology Associated with Battery

UNIT 2.3: Maintaining Quality & Safety In Assembling Process

Unit Objectives

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

1. Explain the importance of following quality standards during the assembly process.
2. Explain the factors that may cause short circuits in the battery pack assembly.
3. Explain the precautionary measures to be taken to protect against electrostatic discharge.
4. Demonstrate the use of relevant Personal Protective Equipment (PPE) to avoid shock, heat, deformation, short circuit etc. during the assembly process.

2.3.1 Importance of Quality Assurance in Battery Assembly

The different types and variations of parts that need to be assembled, such as cells, cooling components, and housings, as well as the various assembling technologies that must be taken into consideration, are always a factor in quality assurance during battery assembly. In actuality, each unique application has a significant impact on the use of measurement tools for quality assurance that can be integrated into the assembly line (the so-called inline quality assurance the approach focuses on). In general, optical measuring systems like camera systems or laser scanners are required to identify various types of cells and components, which are typically marked by various types of barcodes. Similar systems are employed to address problems involving the precise positioning of different components, such as cells during cell stacking or cells and contact bars during welding connections. Checking for completeness is another typical task for camera systems. Electric measurement tools are used to check the characteristics of the entire battery system as well as electrical properties like voltage, charge level, and internal resistance of cells and modules. The main task for quality assurance systems during battery assembly is the inspection of joining points. When screwing together parts, process parameters like the torque or the turning angle are checked in addition to camera systems for position recognition and completeness checks. The parameters of welding processes must be controlled in order to identify failures. There are various optical measurement systems that can be used to check for failures on the weld seam's surface. By choosing the proper welding process parameters that were previously defined with the aid of destructive laboratory tests (for example, tensile tests), different volumetric defects like inclusions or pores that cannot be detected by observing the weld seam surface must be excluded. The quality of the joining is not always controlled by electrical measurement devices that control the transition resistance. For use in battery assembly, non-destructive test techniques like thermography and acoustic systems must first be certified. The location and geometric shape of the bead can be determined by camera systems, laser triangulation, or a combination of the two during the application of glue for glue joints or during the application of heat transfer media. Pressure and leakage tests are performed to examine the tightness of the cooling components and their attachments. Software systems must be checked and electrical characteristics must be controlled once more as part of the end-of-line test at the conclusion of the assembly process. Additionally, the housing's potential coating needs to be visually inspected. To ensure electric isolation, it is also necessary to check the battery system's dielectric strength. The entire process is accompanied by visual checks and weight checks for various module and battery components.

2.3.2 Electrical Short Circuit

A short circuit is an abnormal situation in which an electrical circuit's intended, longer path is taken by the current instead of continuing along it.

What Causes Short Circuits

Short circuits can be caused by:

- Wires being chewed through by animals or pests
- Electrical wiring coming into contact with water or other fluids
- In an electrical box, there are loose connections.
- Outlets, switches, lights, appliances, or other electrical devices that are outdated or damaged
- A wall being punctured by screws or nails and having wires come into contact with them
- Sheathing on electrical cables deteriorating
- Electricity accumulating or spiking

2.3.3 Explain the Factors that May Cause Short Circuits in the Battery Pack Assembly

Lithium-ion batteries are commonly used as sources of power for electric vehicles (Evs). Due to a significant number of accidents, short circuit has been identified as one of the primary causes, battery safety is a major concern. Due to a significant number of accidents, short circuit has been identified as one of the primary causes, battery safety is a major concern. In order to increase EV safety, diagnosing and forecasting short circuits is crucial. This article reviews the state of the art in short circuit diagnosis and prognosis, covering the technique and key indicators. The findings provide important insights regarding how to improve the battery safety.

As the transportation industry develops more environmentally friendly and sustainable technologies, electric vehicles (EVs) are becoming more popular. With advantages of high power density, high energy density, low self-discharge rate, prolonged cycle life, and no memory effect, lithium-ion batteries are frequently used in EVs. The risk of thermal instability, which can lead to a chain exothermic reaction, is typically higher with higher energy densities. Short circuits (SC) are one of the main failure mechanisms because internal short circuits (ISC) account for the majority of accident probabilities while external short circuits (ESC) account for a lesser percentage of accident probabilities. It starts when electronic conductors pierce the separator. This can increase the local temperature and cause the separator to shrink or even melt.

Example of EV Short Circuit/Fire:

- The first fire incident was discovered on March 26 as a result of a social media video going viral showing an Ola EV on fire. In Vellore, Tamil Nadu, on the same day, an explosion involving an Okinawa electric scooter claimed the lives of a father and daughter. On March 30, a Pure EV electric scooter caught fire. A container truck carrying 20 EVs owned by Jitendra Electric Vehicles caught fire in Nashik on April 11 in a separate incident.
- Due to a possible short circuit, an Okinawa Autotech dealership in Tamil Nadu was completely destroyed by fire on April 18. Notably, the Gurugram-based company recalled 3,215 units of its 'Praise Pro' scooters. According to the company, the recall has been initiated to fix "any issue" related to batteries.

It is difficult to prevent battery abuse in EVs, such as mechanical damage from collisions and electrical abuse from battery leaks, overcharges, and discharges. All of these have the potential to cause SC, which is characterized as an abrupt and sudden decrease in electrical resistance that causes batteries to overheat. It is widely acknowledged that thermal runaway (TR), which can result in fire and even explosions, is primarily caused by SC. A mechanical abuse-related ISC, for instance, can cause TR right away. The use of high-thermal-resistant battery materials, crashworthy car body design, and high-quality cables can reduce the likelihood of fire but cannot satisfy the needs of cost and lightweight for EVs. Therefore, it is crucial to diagnose and predict SC using diagnostics and prognostics. An effort has been made to comprehend the fundamental mechanisms of SC. It is essential to identify ISC before the final stage because the TR occurs right away once ISC progresses from the middle to the final stages.

ESC is typically brought on by car accidents, battery leaks, submersion in water, and improper battery assembly or disassembly techniques. ISC's root causes are more intricate. The three problems listed below are attributed to ISC:

- Mechanical abuse, the deformation and damage of a separator due to nail penetration or crushing, mechanical mistreatment, a separator's deformation and harm brought on by the crushing or penetration of nails,
- Thermal abuse, a separator collapsing from an excessively hot environment, and
- Due to electrical abuse, an overcharged or over discharged separator may become pierced by dendrite growth.

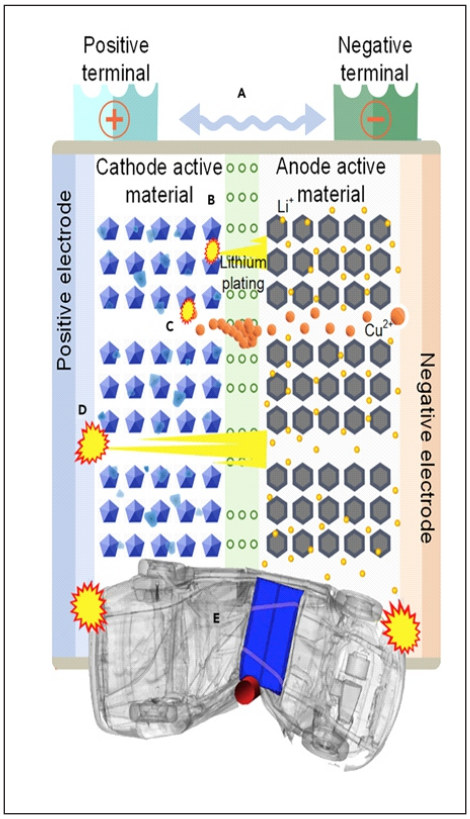


Fig. 2.3.1 Types of Short

2.3.4 Electrostatic Discharge

No matter how a material is categorized based on its electrical conductivity, electrostatic discharge (ESD) can occur with any material. Either positive or negative charges are stored by materials. Plastics and other synthetic materials store negative charges, whereas human skin and animal fur accumulate positive charges.

Any material that can store charge must do so to the best of its ability; this action is more akin to a capacitor. The human body can be compared to a 250pF capacitor that can store charges of up to 25000V in terms of how it works.

The Effects of Electrostatic Discharge on Electronics

Current flows through objects as a result of electrostatic discharge. To balance potentials, ESD currents typically follow low impedance routes to the ground. Any other means of transportation, such as the device's metal body, could be used to get to the ground. Subsequently, repeated electrostatic discharge and current flow impair a device's functionality. Electrostatic discharge causes internal parts of a device to frequently cross threshold values, deteriorate over time, and eventually fail.

Fortunately, there are ways to stop electrostatic discharge before it causes a device to malfunction.

Electrostatic Discharge Prevention Methods

Unfortunately, electrostatic discharge is everywhere, and in the electronics manufacturing sector, it is costly to deal with. Electronics—and semiconductors in particular—contain stored charges. Electrostatic discharge happens when these accumulated charges come into contact with a person or object, such as a tool. Even though this discharge cannot be seen by humans, it still causes harm.

Electrostatic discharge can be caused by handling printed circuit boards with bare hands, using synthetic materials close to electronic equipment, and sudden air movements in the vicinity of the equipment. Electrostatic discharge prevention techniques can stop this damaging discharge from harming circuits when producing and assembling electronics.

Here are three techniques that are frequently used to prevent electrostatic discharge: grounding, antistatic bags, and antistatic sprays.

Grounding

The best way to prevent ESD for people handling printed circuit boards is to ground them. The path with the lowest impedance for the ESD current flow is created by providing a ground. The user working on the circuits is typically grounded using an ESD wrist strap. Electrostatically sensitive equipment is also placed on grounding mats or antistatic mats to lessen the risk of ESD. Another defense is to ground the workbench.

Antistatic Bags

Electronic and electrical components that are electrostatically sensitive are covered by antistatic bags. These packaging materials avoid interactions with static electricity. Antistatic bags typically come in semi-reflective or clear varieties and are made of polyethylene terephthalate. These bags, which are available in many different sizes and hues, are frequently used to pack hard drives, motherboards, sound cards, graphic cards, etc.

Antistatic Sprays

Antistatic sprays can be used to stop charges from adhering to a surface. Electrostatic electricity is eliminated when this liquid is sprayed because it stops charges from building up. Equipment moving at high speeds or surfaces with strong static charges, which are challenging to control or block, require the use of antistatic sprays.

Static electricity's negative effects can be eliminated using prevention techniques for electrostatic discharge.

2.3.5 Precautionary Measures

Here are few important precautionary measures:

Avoid Friction

Try avoiding as much friction as possible. Certain clothes can cause more friction than others, for instance; sweaters and corduroy materials tend to create more static through friction. Also, try to keep the foot dragging and floor rubbing to a minimum while moving.

Turn off Electronics

Be sure to power down and unplug any electronics before you work on them. This is a good practice while working or repairing on electronics and electronic equipment to avoid damaging it in the process and to ensure safety.

Wear Safe Apparel

Soft synthetic fibers and are designed to protect the user while preventing static discharge that can do damage to the electronic components. The gloves are worn with the purpose of keeping damaging oils from the skin off the circuit boards while working in electronics assembly. While wearing ESD gloves greatly reduces the risk of static discharge, to achieve the most beneficial results one should also employ additional anti-static practices in conjunction.

Safe Garments - Lab Coats, Jackets and Smocks

For a little extra protection ESD lab coats, jackets and smocks can be worn for neutralizing static discharge. These garments are anti-static and designed for electrostatic fields in mind and greatly reduce static damage from the user's clothing. They are low tribocharging because they are constructed with cotton or polyester or sometimes even both to create a woven grid of conductive fibers that creates a shield. It's like having your very own personal Faraday Cage at your disposal.

Fig. 2.3.2. Safe Garments-Lab Coats/Jackets

Use Anti-Static Equipment and Supplies

Another way to help prevent ESD is to store your electronics parts and components in anti-static bags. The static safe bags are used to transport and store electronic components, they typically contain metalized polyester, and cross linked urethane resin and a Low Density Polyethylene film (LDPE) to create an extra strong static barrier for greater protection.

Safe Mats

ESD mats are also a great way to help prevent a static surge. ESD mats are insulated and non conductive. Ones with wrist straps will transfer the static charge from the user to the mat and it disperses it to the ground. The mat is essentially transferring the charge slowly to itself and the ground by acting as a large resistor. Because the charge is transferred to the mat it prevents it from making contact to critical electronic components and damaging them. Good ESD mats are comprised of three layers. The top layer is made up from vinyl that discharges the conductive matter. The middle layer provides a discharge path to the ground and made up of a conductive metal sheet. The bottom layer is typically used to keep it in place and usually consists of some sort of non-skid foam.

Wrist Wraps

An anti-static wrist strap is typically used with an anti-static mat or other types of work place ESD equipment. The wrist strap contains conductive threads on the strap that lead to a ground conductor in order to discharge static electricity safely. The anti-static wrist strap is an effective piece of safety gear that aids and prevents the buildup of static electricity near highly sensitive electronics or other components where static charge could cause safety issues and helps prevent electronics equipment from being damaged.

Fig. 2.3.3. Wrist Wraps

2.3.6 Personal Protective Equipment (PPE) to Avoid Shock, Heat, Deformation, Short Circuit Etc. During the Assembly Process

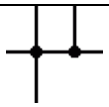
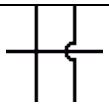
PPE is equipment that will protect the user against the risk of accidents or of adverse effects on health. It can include items such as safety helmets, gloves, eye protection, high-visibility clothing, safety footwear, safety harnesses and respiratory protective equipment (RPE).

In a standard industrial battery room, employers should choose battery PPE that is specifically designed to resist acids and alkali. Rubber and nitrile provides sufficient protection by preventing skin exposure, so look for equipment that uses these materials.

- **Goggles:** Goggles cover the eye sockets completely, protecting the worker's vision from chemical exposure. Safety glasses serve a similar function, but do not create a seal on the face.
- **Recommendation:** Safety goggles include venting, which prevents the goggles from fogging up during normal use. This can help to ensure that workers wear their PPE as intended. Solus Group also offers safety glasses with side shields, which may be more comfortable for some workers.
- **Face Shields:** Face shields are intended to shield the entire face from battery acid and other chemicals. They are intended as secondary protection for the face — that means that face shield should be worn in addition to goggles.
- **Recommendation:** A Splash Shield is an affordable, disposable face shield that provides additional protection from chemicals in the battery room.
- **Gloves and Boots:** Gloves protect the worker's hands, which have a relatively high chance of exposure to battery chemicals during routine maintenance (such as watering or charging). Overboots are intended to help a worker maintain traction while cleaning up spills. Latex overboots can also limit exposure to chemicals.
- **Recommendation:** When battery room PPE is designed to prevent skin contact, look for rubber or nitrile materials. Nitrile Chemical Gloves provide excellent protection for battery room workers. Latex Boots provide slip protection during clean-up.
- **Chemical Aprons:** Chemical aprons protect the clothing and skin, though all workers should wear loose-fitting, long-sleeved shirts at all times when working with batteries. While aprons can protect against splashes, workers should still remove exposed clothing and follow appropriate safety protocols.
- **Recommendation:** Chemical/Acid Apron can be worn comfortably to limit exposure resulting from spills or sprays.
- **PPE Kits for the Battery Room:** To ensure that workers have access to high-quality PPE, consider purchasing complete kits. The PPE Kit includes a disposable face shield, safety glasses, nitrile gloves, a chemical coverall, a disposable apron, and latex overboots.

Exercise

1. Explain in brief the direct current, alternating current, and electric circuit.
2. Write few Safety and environmental standards while Assembling/Handling Batteries.
3. Match with the correct symbol.

Name	Symbol
Not Connected Wires	
Earth Ground	
Connected Wires	
Current Source	
Voltage Source	
Electrical Wire	
AC Voltage Source	
Chassis Ground	
Common Ground	

Fill In the Blanks with the tool name:

Sr. No.	Name	Picture
1.	.....	

2.	.....	
3.	.....	
4.	.....	

Notes

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https://www.youtube.com/watch?v=3Fnwabe9Ps8

Maintaining Quality & Safety Assembling in Process

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

ESSCI
Skilling India in Electronics

3. Testing the Battery System After Assembly

Unit 3.1 - Testing the Battery System After Assembly

ELE/N6605

Key Learning Outcomes

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

1. Explain the globally accepted regulatory standards to be followed during testing.
2. Demonstrate the process of testing the battery cells and modules for various performance parameters.
3. Explain how to find the cause of the problem if the test results diverge from specifications.
4. Demonstrate the use of relevant techniques to rectify malfunctions as per the SOP.

UNIT 3.1: Testing the Battery System After Assembly

Unit Objectives

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

1. Describe the globally accepted standards for testing BE systems
2. Explain the standard performance parameters for battery cells, modules and Battery systems
3. Demonstrate the process of inspecting the battery cells, modules and systems against various performance parameters
4. Explain the usage mechanism of various testing equipment such as hydrometer, multimeter etc.
5. Describe the process of carrying out various battery cell tests such as thermal performance test, cold start test, capacity test, pulse power test, self-discharge test, energy efficiency test, cycle life test, etc.
6. Demonstrate the use of appropriate techniques to rectify malfunctions with the Battery system
7. Describe the process of carrying out various battery pack tests such as impedance spectroscopy test, thermal test, vibration test, etc.
8. Explain how to evaluate the test results to find the root cause of the problem

3.1.1 Globally Accepted Standards for Testing BE Systems

The global population of Electric Vehicle have been significantly increased within the latest few years and it is forecasted that the sales of new Electric Vehicle will reach around 35% of total new car sales in 2025.The number of electric vehicles has significantly increased over the past few years, and in 2025, it is predicted that sales of new electric vehicles will account for about 35% of all sales of new automobiles.

The most crucial component of an electric vehicle, the battery, has undergone extensive development in order to meet the demands of the electric vehicle manufacturer. Additionally, the testing protocols and standards are continually reviewed.

Vibration and shock testing must be performed on batteries in order to verify their reliability and safety. There are currently three international test standards that are frequently used for battery vibration and shock testing. The three are SA J2380, ISO 12405-1, and UN 38.3. Despite the fact that some automakers have their own testing requirements.

The battery system and the electronic system are the two categories into which the test sequences are divided by the ISO 12405.

3.1.2 Battery Testing Comparison

Battery testing standards comparison				
Standards	UN 38.3 Section 38.3.4.3 Section 38.3.4.4	ISO 12405-1 Section 8.3 & Section 8.4	SAE J2380 Section 4.4	GMW16390 Section 7.3 & Section 8.3 & Section 9.3
Freq. range	7-200 Hz	5-200 Hz	10-190 Hz	8~1000 Hz
Sine or random G level	Small batteries 0.5~12kg, 8G Large batteries >12kg, 2G	X: 0.96Grms Y1: 1.23Grms Y2: 0.95 Grms (below the passenger compartment) Z: 1.44Grms	Z: 1.9 & 0.75(N) / 0.95(A)Grms Y: 1.5 & 0.4(N) / 0.75(A)Grms X: 1.5 & 0.4(N) / 0.75(A)Grms	Z: 1.4Grms X & Y: 1.1Grms
Test time	Z: 3 h Y: 3 h X: 3 h	Z: 21/15/12 h Y: 21/15/12 h Z: 21/15/12 h	Z: 16.2/10.95 h Y: 38.18/13.58 h Z: 38.18/13.58 h	Z: 24 h Y: 24 h X: 24 h
Mechanical shock	Small batteries 150G@6ms Large batteries 50G@11ms	51G@6ms	NA	Pothole: 10G@16ms Minor collision: 100G@11ms (<50kg); 70G@11ms (50~100kg); 40G@11ms (>100kg)
Shocks qty.	±X/±Y/±Z: 3	X/Y/Z: 10	NA	Pothole: ±X/±Y/±Z, 3 Minor collision: ±X/±Y, 3

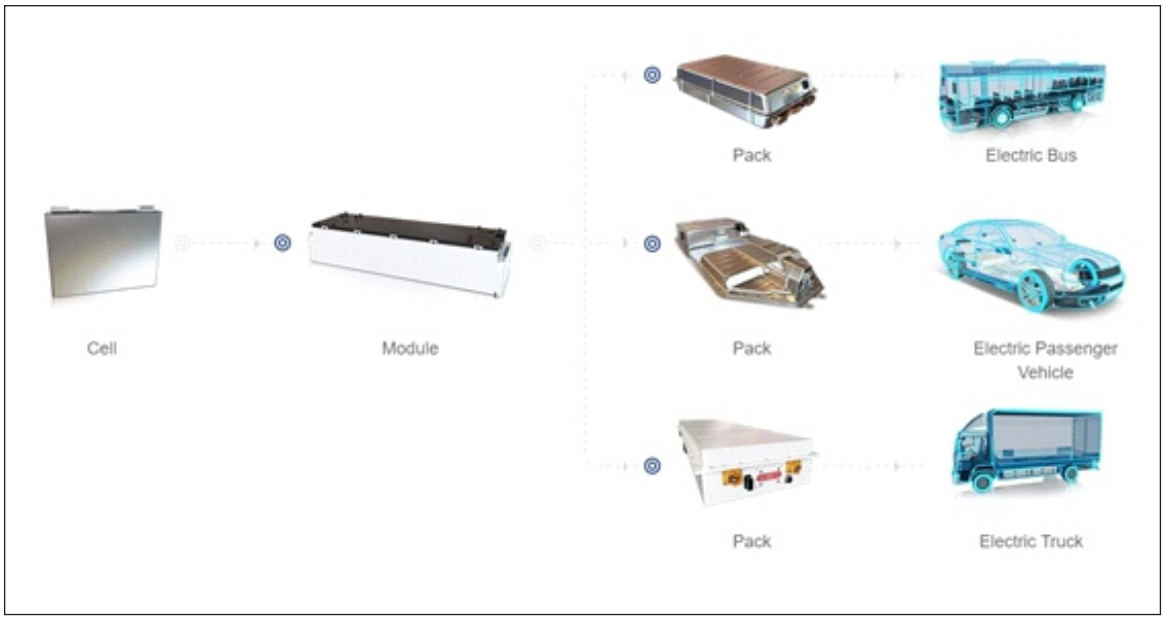
Table 3.1.1 Battery Testing Comaprison

Name	**ISO 12405-1**	
Headline	*Electrically propelled road vehicles – Test specification for lithium-ion traction battery systems Part 1- High power applications*	
Object *Cell/Module/Pack/ Electronics*	Electronic devices on the batteries Same as **IEC 62660-2**	Pack (including electronics)
Directions	Three directions	Three directions
Vibration mode *Sinus/Random*	Random	Random
Frequencies *(Hz)*	10-2000	5-200
Acceleration *(g)*	3 (rms)	1.44 (rms)
Time/axis *(hour)*	8	21
State of Charge (SOC) before test	N/A	50 % after two standard cycles

Table 3.1.2 ISO 12405 for Battery Testing Standards

Type of Battery product system in which the standards to be followed:

- Cell
- Module
- Pack
- Entire Vehicle Battery System



3.1.3 Automotive Industry Standards (AIS)-India

The L category of vehicles, which includes two- and three-wheeled electrics, is the focus of the AIS-156 testing standard. Given that electric two-wheelers are currently the only vehicles using incendiary batteries, a closer examination of the AIS-156 testing standard is warranted. The Rechargeable Electric Energy Storage System (or REESS, as it is referred to in the document published by ARAI outlining the AIS-156 procedures) or the battery is put through a variety of torture tests as part of the AIS-156 testing standards established by the Ministry of Road Transport and Highways.

The MoRTH claims that the UN ECE R136 procedure has provided "considerable assistance," indicating that the tests adhere to global norms. A closer examination of the MoRTH and UN publications reveals that the majority of the test descriptions in AIS-156 are identical to and have been copied verbatim from the UN ECE R136. The AIS-156 currently available includes tests for vibration, thermal shock and cycling, mechanical drops, over-temperature protection, and hydrogen emission.

1. **Fire Resistance**

The fire resistance test, which is conducted in accordance with AIS-156, involves pre-heating, direct heating, and two stages of indirect heating. It is arguably the most important part of the standard. The battery or REESS is positioned on a steel grating table during each stage, with a pan of commercial fuel placed underneath it and lit. In the indirect heating stage, a screen is placed between the pan and the testing-device. The battery is then monitored for a further three hours while it cools to room temperature.

2. **Vibration Test**

Vibration tests are a crucial component of the AIS testing process because of the adverse road conditions that batteries and battery management systems, specifically in India, must withstand. In the course of 15 minutes, the vehicle is subjected to shocks ranging from 7Hz to 200Hz and back to 7Hz. The procedure is then carried out 12 more times, and then there is a period of observation.

3. **Mechanical Shock and Drop Test**

A suitable mechanical shock test for vehicles with non-removable batteries has been developed. A brief created by the MoRTH states that the testing apparatus is subject to mechanical shock with a peak acceleration of 1500 m/s 2. The testing apparatus is then shocked 18 times at various angles and positions. This test, like others, has been borrowed, nearly verbatim from the UN R136 standard.

For removable batteries, a mechanical drop test has been developed where the battery is dropped onto a hard floor, typically made of concrete, simulating real-life conditions. This is carried out six times from angles chosen by the testing organization. The manufacturer can choose to use a different battery for every drop, though.

4. **Thermal Shock and Cycling**

The goal of this test, according to the MoRTH paper, is to expose the battery to quickly varying temperatures. The battery is kept at 60 degrees Celsius for six hours straight (or higher if the manufacturer insists), then is kept at -40 degrees Celsius for another six hours. The maximum time interval between these two stages is 30 minutes only. The battery is then monitored for 24 hours at room temperature after these test cycles are repeated five times.

The AIS-156 test may, however, be better suited to European conditions in several key areas, including thermal testing, which is one of them. The thermal load on a battery is significant in a nation where some areas experience ambient temperatures as high as 50 degrees Celsius.

3.1.4 Standard Performance Parameters for Battery Cells, Modules and Battery Systems

Several important metrics and considerations are important when evaluating battery performance:

- **Cell, module, and pack level:** When comparing energy and power densities, it's crucial to take into account whether the data applies to a single cell or a full battery pack. Cells will always have the highest energy and power for a given size or weight. This is due to the fact that the additional structure, cooling system, electrical connections, and pack of the modules only increase size and weight without increasing energy or power. The performance loss when switching from the cell or pack level will depend on elements like the pack's size, the cells' heat tolerance, the charge and discharge rates, and the degree of expensive light-weighting. Despite using the same cells, a battery pack for a car will be much heavier than one for an aircraft. The battery life and cost of the car pack will be optimized, whereas the weight of the aircraft pack will.

  The maximum amount of power a battery can store per cubic liter, typically expressed in Wh/L. Lithium-ion batteries, for instance, have a storage capacity of about 690 Wh/L, compared to gasoline's 9,500 Wh/L.

- **Power density:** The amount of power a battery can deliver per unit volume, typically measured in W/L. Since the power flow into or out of a battery is influenced by elements like internal resistance and the capacity to dissipate or withstand heat, this is closely related to the charging speed (C-Rate). It can be misleading to express power density as a single number because the same battery may produce a peak power for brief periods that is significantly higher than its sustained power output. High power usage may also shorten the battery's cycle life or necessitate additional cooling. Therefore, the actual operating power density is a compromise between several considerations.

- **Specific Energy (or gravimetric energy density):** The amount of energy a battery stores per unit mass. Commercial EV cells have a storage capacity of about 260 Wh/kg, but this drops to 220 Wh/kg for high-performance aerospace packs or about 150 Wh/kg at the pack level.

- **Specific Power (or gravimetric power density):** The amount of power a battery can deliver per unit mass, typically measured in W/kg. The same factors that affect power density also apply to this. Modern aluminum-ion batteries, also known as aluminum-graphene batteries, have demonstrated 7,000 W/kg in the lab, while commercial lithium-ion EV cells only manage about 340 W/kg.

- **C-Rate:** The charge per hour rate is calculated by dividing the number of hours necessary to fully charge the battery by one. Current lithium-ion batteries can charge at a rate of 4C, which equates to a 15 minute charge time, whereas a rate of 0.1C would take 10 hours to fully charge. C-rates are sometimes also used to refer to the current required to discharge a battery at this rate. Although the maximum C-rate is a property of the battery, the actual C-rate achieved also depends on the power of the charger available.

- **Cycle Life:** The number of charge-discharge cycles a battery can perform before its performance has degraded beyond its useful level. It is oversimplified to define cycle life as a single number because batteries gradually lose capacity. Application-specific and somewhat arbitrary criteria determine when something is no longer usable. Additionally, the rate of degradation depends on how the battery is used, which deeper charge-discharge cycles, high C-rates, and overheating — all reducing the life of a battery. A lithium-ion battery should last for at least 1,000 cycles in typical use. .Modern aluminum-ion batteries have shown in the lab that they can last up to 250,000 cycles.

- **Charge/Discharge Efficiency:** This measures the battery's energy effectiveness. It is calculated by dividing the energy you put into charging the battery by the energy you extract. Li-ion batteries have efficiencies of over 99 percent when used properly. At very high C-rates and/or operating temperatures, it can drop as low as 90%, though. If enough time passes between charging and discharging for significant self-discharge to take place, additional losses may also happen. 95 percent is a conservative estimate for the average battery's charge/discharge efficiency.
- **Self-Discharge Rate:** How quickly a fully charged battery loses power when left unused. When fully charged or kept at higher temperatures, batteries self-discharge more rapidly. Typically lithium-ion batteries self-discharge at between two and three percent per month.
- **Operating Temperature:** The range of temperatures within which a cell can function effectively. Higher-temperature cells require less cooling, which makes battery packs lighter and extends cycle life. Low-temperature operation can remove the need for cold-start heating.

3.1.5 Automotive Battery Inspection

It is now much simpler than ever to find anomalies in battery parts, battery cells, and ESS & EV modules. Battery manufacturers and users can inspect known sources of defects as well as gain insights into new areas of potential concern or product design improvement with the help of automated defect recognition for lithium-ion batteries.

This includes everything from the traditional anode/cathode overhang inspection for prismatic and pouch cells to new spot checks for things like foreign body materials, gas bubbles, welding errors in the electrodes, electrode cracks, and electrolyte filling. The requirement to inspect complete modules for resin filling, connections, cell alignment, or dimensional accuracy becomes even more critical with the prevalence of ever-larger ESS & EV modules.

3.1.6 Mechanism of Various Testing Equipment

1. How to Use A Battery Hydrometer

Car batteries are bulky and mysterious in terms of how they work. For many people, a battery either functions properly or eventually stops functioning altogether. It's a good idea to become familiar with this evolving technology by learning how a battery works and how to check it. Learn how to operate a battery hydrometer for testing purposes. When charging and discharging, these tools can provide you with more information than just trial and error.

- **First, Gear Up**

  In order to use a hydrometer, you must have access to the battery's sulfuric acid. Wearing the proper safety equipment is important because it is highly corrosive.

Put on these items, including:

- Protective eyewear
- Thick gloves
- Closed-toe shoes

All battery store even suggests wearing a rubber apron. Any electrolyte solution that's spilled can quickly burn through cotton clothing.

- **Prep the Car and Battery**

Move the car to a well-ventilated area. Shut it off, and pop the hood. Remove the covers on the battery that give you access to the electrolyte solution below, suggests It Still Runs. Make sure to carefully remove all of the covers because you want to test every cell. You don't want to perform this task midway through your measurement process. Drops of sulfuric acid might spring up from the battery.

- **Insert the Hydrometer**

The battery hydrometer should be carefully inserted into the cell. Press on the bulb that acts as a syringe. You should see fluid filling the hydrometer.

When the battery electrolyte solution has completely filled the device, squeeze the bulb one more time. This device tests each cell by measuring the specific gravity of the fluid. This value tells you if the cell is properly working or on its last legs. Batteries need all six cells in good working order to operate at peak levels, reports How it Works.

- **Read and Test All Cells**

Read the measured value from the device while the bulb is filled with battery electrolyte fluid. Write this value down. Continue onto the next cell. It's important to take a reading of every cell at the same time before you perform any calculations. The electrolyte temperature plays a role in determining the overall battery life.

- **Calculate Your Results**

Make a note of the electrolyte temperature. It's normally somewhere around 80 degrees Fahrenheit. If the temperature varies, you must account for that change in the calculations.

If you measure the specific gravity and get a reading of 1.250, it will only stay that way if the temperature is 80 degrees Fahrenheit. For every 10-degree difference, add or subtract 0.004.

A specific gravity value of 1.250 at 100 degrees F. would be adjusted to 1.258, for instance. The battery life results use the adjusted numbers as follows, including:

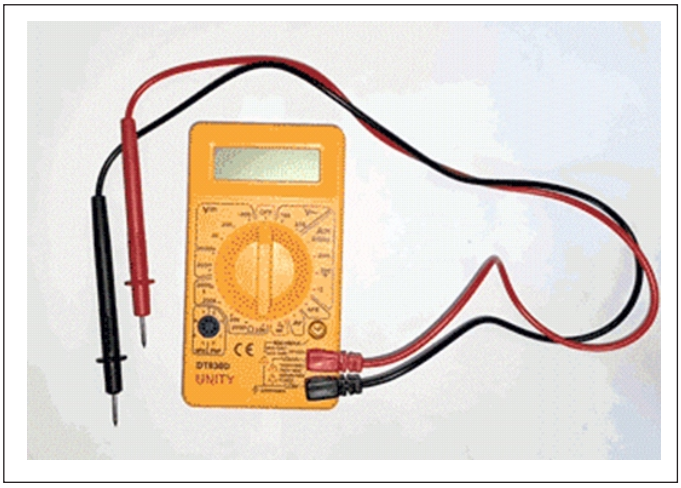
  - Between 1.274 and 1.239 is 100- to 75-percent charged
  - Between 1.238 to 1.201 is 74- to 25-percent charged
  - Values under 1.200 indicate a discharged cell

- **Avoid Watering the Battery**

Battery maintenance involves many different tasks, including watering the battery. If you've just performed this task, don't use a hydrometer just yet. Before taking the battery's electrolyte fluid measurement, let the battery be discharged and then recharged at least once. Before you can measure a precise number, the water and battery solution must be mixed evenly. All of the cells might test poorly with fresh water in the reservoir.

2. Multimeter Testing

Multimeters are a very useful piece of electrical test equipment that, as their name implies, can measure a wide range of parameters, including voltage, resistance, current, and many others. Apart from this, it can also be used to test batteries, learn about other people's electronic designs, and debug broken circuits.



Step1: Check the Battery. Try turning on the electronic multimeter.

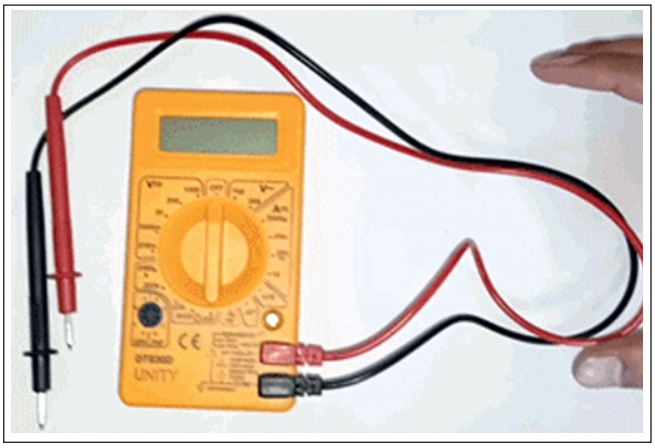
Therefore, turning the dial from off to any other position and looking for a display there is the simplest way to check if your multimeter is working. First, make sure your multimeter is powered by checking whether the display works.

Now, if nothing is visible on your display, there are two options. Open the casing to replace the battery if necessary if it has been discharged. Your fuse might have blown, which brings us to the second problem. Therefore, you must change your fuse and open the casing once more. After examining the battery, you might then check the efficiency of your leads.

Step2: Test the Probe Leads

Put your multimeter in continuity mode to accomplish that. Every multimeter has a continuity mode, and you can tell which one it is by looking for the continuity symbol (which looks like a sound wave) over there. Take these two probes and connect them together once the multimeter is in continuity mode. When you do that, you ought to continuously hear beeping. This indicates that the leads are properly connected and that your multimeter is operational. Following that, you can almost certainly verify that your meter is in good working order and proceed to measure your voltage, current, resistor, or whatever else you need to.

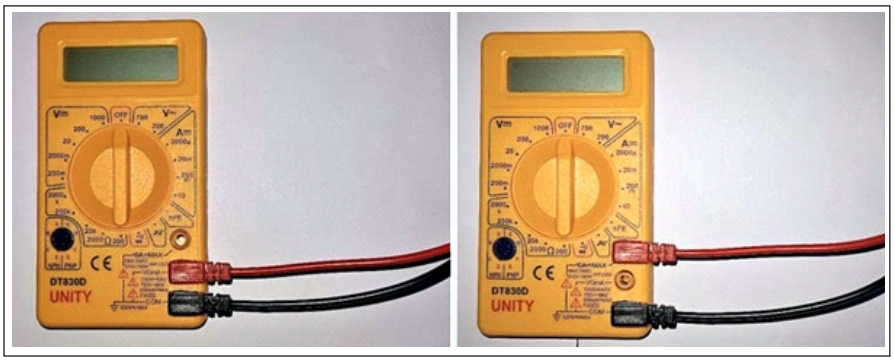
if the display is functional. Additionally, if you cannot hear the continuity sound, there is a problem with your leads, and you must replace them. Now that we've established that your multimeter is functional, here are a few pointers you can use to guarantee that you're always using this tool safely.



How to Use a Multimeter Safely?

In this section, we will discuss how to use a multimeter for different applications safely.

- When measuring AC voltage, keep your hands away from the probe tips while they are still attached to the appropriate points on the circuit. This is done to avoid a short in the circuit, which might cause a spark or a ball of fire that could hurt you.
- If the protective insulation on your test leads or probes is broken or damaged, do not use them. The probe conductor may come into contact with your fingers, which could shock you.
- Be aware that not all multimeters can measure AC current. Therefore, you must never, ever measure AC current with a multimeter that does not support AC current measurement because doing so will harm the meter.



- When measuring current, you should always be cautious about where you place your probes. Always insert the black probe into the com port. Now for the red probe, you can use it in these two places. In milliamp amps, one can be used to measure voltage and current. Additionally, you must use your probe on a different port as depicted in the image if you're measuring current in amps rather than milliamps.

3.1.7 Process of Carrying Out Various Battery Cell Tests

The purpose of battery testing is generally twofold:

1. Determine whether the battery can satisfy the requirements (beginning with the application scenario): This type of test can be thought of as beginning with the application requirements, rewinding the characteristics that the battery should meet, and then using testing to confirm whether the battery under test complies with the standards. For instance, the entire automobile factory will design the battery cold start test based on the scenario of driving in a cold environment, the energy efficiency test based on the power consumption index, and the power performance test based on the scenario of vehicle climbing or accelerating. In addition, tests like overcharge and discharge, short circuit, overtemperature, extrusion, and puncture will be planned with vehicle safety in mind.

2. Understanding the characteristics of the battery (beginning with the battery itself) is essential. We must pass the test to determine the battery's capacity, internal resistance, voltage characteristic, ratio, temperature characteristic, cycle life, energy density, and other crucial parameters. We also need to pass these parameters when using the battery to achieve better results.

   For the purposes of electric vehicle (EV) applications, tests are used to characterize certain aspects of the performance or life behavior of batteries. It is anticipated that the tests may be generally useful for testing energy storage devices created for this purpose. The tests are defined based on the Vehicle Technologies Office targets for electric vehicles.

   - **Thermal performance test**

     The ability to achieve a portion of the Peak Power target at various temperatures is one of the main goals of the thermal performance testing. By performing the Static Capacity Test and Hybrid Pulse Power Characterization Test (either the low or high HPPC)16 at various temperatures within the operating temperature target range (-30 to +52°C), the effects of environment (ambient temperature) on device performance will be evaluated as needed. The thermal performance test is typically conducted at 52, 0, -10, -20, and -30°C. Such testing at the laboratory cell level aims to characterize the technology's performance as a function of temperature and to limit the likely thermal management constraints on full-size cells or batteries. Thermal performance testing increasingly focuses on the design and behavior of thermal management systems at the module and system levels. Initial charging during thermal performance testing should be done at 30°C unless otherwise specified in a device-specific test plan. This suggests a test procedure that goes as follows:

     - Fully charge the device to Vmaxop at 30°C;
     - Increase or decrease the device ambient temperature to the target value;
     - Wait a suitable soak period for thermal equalization, typically 4 to 16 hr depending on size and mass; and
     - Carry out the desired performance test.

The device can be clamped at a voltage during the soak period if self-discharge is a major concern; however, this requires knowledge of the device's OCV versus temperature behavior to ensure that the SOC is not unintentionally changed. To make sure that thermal stability and voltage equilibrium are achieved before each repetition of the pulse power characterization profile, it might be necessary to modify the rest intervals in the HPPC Test. If possible, full thermal performance testing is done at BOL and EOL. A thermal performance test at -20°C could be carried out in the middle of the lifespan.

- **Capacity test**

The static capacity testing method (SCT), which measures the battery's available capacity (including energy) at various environmental temperatures, is required for capacity testing. SCT testing procedures vary between businesses and standards, but the basic concept is the same. Example: Use the battery manufacturer's recommended charging procedure at room temperature (25°C), followed by a 1C rate of discharge to the cut-off voltage (2.5V), followed by a measurement of the released capacity (energy). To increase accuracy in the actual experiment, the mean value can be repeated continuously for three times.

Capacity test Output: Relationship table between temperature and capacity (energy).

Assign the X-axis to capacity C and the Y-axis to voltage V. The relationship between capacity and temperature is represented by the point at which 1C discharge stops on the X-axis at various temperatures. The ratio of the available energy at various temperatures is represented by the area formed by each discharge curve in relation to the X and Y axes.

- **Self-discharge test**

The battery's capacity loss after a specific amount of shelf life can be assessed using the self-discharge test. Specific testing techniques come in a wide variety of forms. One technique to test self-discharge, for instance, is capacity recovery, which is mentioned in GBT 31486. In this test, the fully charged battery was set aside at room temperature for 28 days, and then emptied and recorded the holding capacity Cr. The current actual capacity Ct was then once more measured at room temperature SCT.

In order to determine the self-discharge characteristics, the capacity retention rate (Cr/Ct) was calculated. The method of high temperature acceleration and OCV determination can be used to shorten the self-discharge test cycle. The self-discharge rate, for instance, can be calculated using the OCV voltage change if the battery is kept at 55°C for 7 days.

- **HPPC testing**

A technique called HPPC testing is used to evaluate a battery's dynamic performance characteristics. This testing establishes the battery's power capacity over the range of the cell's usable voltage. It is a test profile that includes both regeneration and discharge pulses that happen at different states of charge (SOC), and that can be carried out under a variety of temperature stressors and current loads. A regeneration pulse is a relatively brief charge applied to the battery, and a discharge pulse is a relatively brief load applied to the battery. This profile simulates the discharge and charge that can take place on hybrid electric vehicles (EVs) during acceleration and regenerative braking.

The test profile itself is divided into two sections:

1. Static capacity test
2. HPPC test

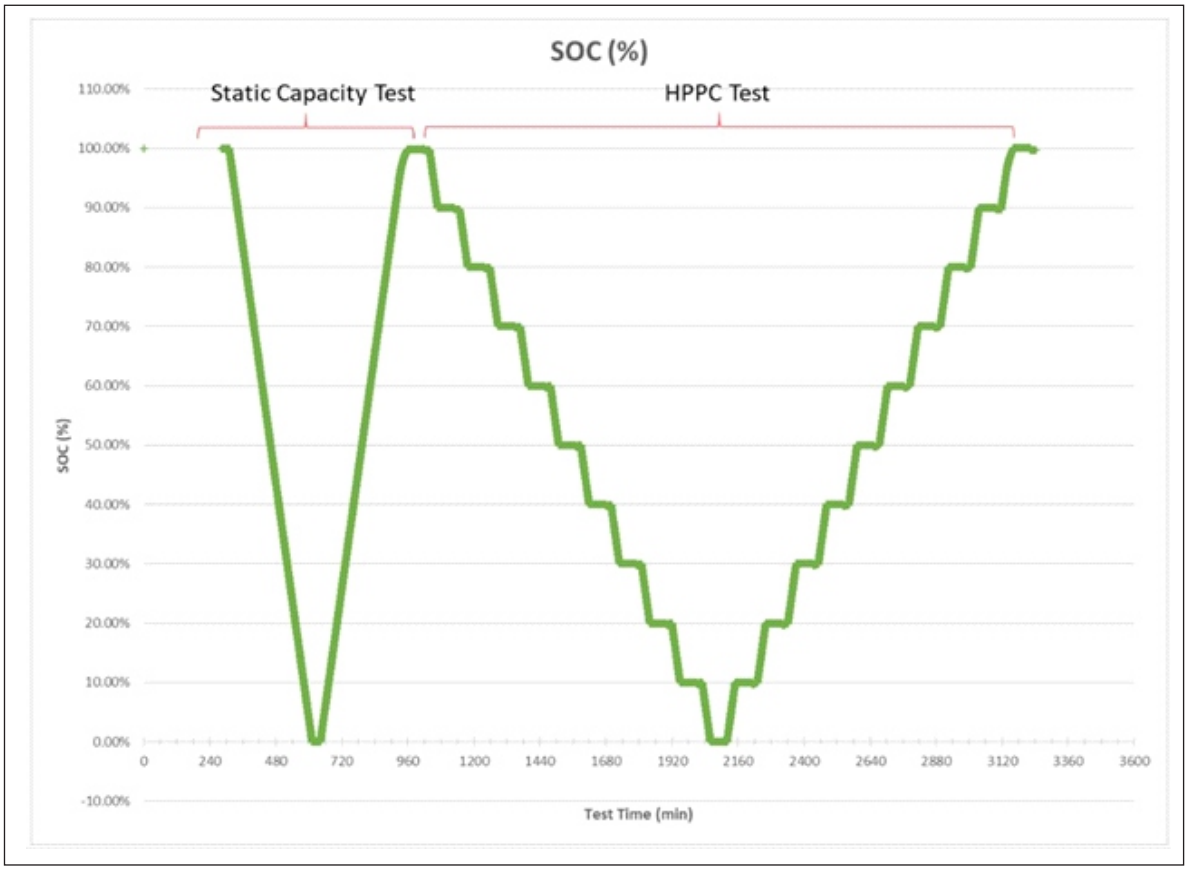


Fig. 3.1.1. Test profile comprised of static capacity and HPPC tests.

- **Static capacity test**

  In order to perform the static capacity test, a battery must be charged according to the manufacturer's recommendations from an unknown SOC to 100% SOC. This is often done at a predetermined C-rate, which is the rate at which current is provided (charged) or removed (discharged) from a device in relation to its maximum capacity. The theoretical current under which the battery would supply its nominal rated capacity in an hour is equal to the current in use, and this is known as the C-rate. The current in use, for instance, would be 3 A if a cell's nominal rated capacity was 2000 mA-hr and a C-rate of 1.5 was utilised to deplete the battery.

  Before switching to constant voltage charging until a minimum current is obtained, the battery is first charged at a constant current until the charge voltage (the voltage at full capacity) is reached. A constant-current, constant-voltage (CCCV) charging scheme is what this is. A sufficient rest interval is used once the battery has attained 100% SOC to allow the cell to reach equilibrium.

  The battery is then drained to a minimum voltage cutoff at a set C-rate. 0% SOC results in this. The capacity to discharge a battery can be evaluated directly using a special battery tester or estimated from the current used between 100% SOC and 0% SOC. Before employing the CCCV technique to recharge back to 100% SOC, another rest period is used.

  The battery capacity is determined by the rate of discharge from 100% SOC to 0% SOC. You should typically find that it agrees with the charge capacity that was tested. The discharge capacity is typically used for consistency, particularly if simply running the discharge portion of the HPPC test, which is the following element of the test profile.

- **HPPC test**

  Based on the battery capacity discovered from the aforementioned static capacity test, 10% SOC steps are used for the HPPC test. For the second half of the test profile, the steps are made from 100% to 0% SOC and may continue back to 100% SOC.

  Each step consists of:

  - Rest for 60 minuntes.
  - Pulse, discharge: 1C for 10 seconds
  - Rest for 10 minutes (relaxation period)
  - Pulse, regeneration: 1C or 0.75C for 10 seconds
  - Rest for 10 minutes (relaxation period)
  - Discharge/charge to next step at prescribed discharge/charge C-rate (per manufacturer's data sheet)

  Each cell type can be evaluated at each SOC, including under different temperatures and with different pulse C-rates (discharge and charge).

- **Battery efficiency test (Life Test)**

  Efficiency testing is a catch-all term for electrical assessments of a battery's condition. It can be divided into internal resistance derived from a DC signal technique or impedance or conductance derived from an AC signal approach.

  The diagnostic pitfalls for batteries are in the widest variety. It might be caused by an intricate and non-linear electrochemical component, as well as other elements that affect the reading, such as frequency, test signal amplitude, and test metre resolution.

  This means that the measurements obtained with one technique stimulus may not match the information recorded using a different technique.

  Consistency in both equipment and testing depends on the battery life.

  Internal impedance, which is not a direct capacity measure, showed a good association with capacity when data were collected accurately and regularly. It can be used to forecast battery performance during a discharge as an indicator of the battery's state of health.

  With typical replacement planning, a 25–35% increase in internal impedance will be acceptable because a 25% increase signifies a performance decline from 100% to roughly 80%.

  We have a clear physical evidence on the degradation of the battery capacity with an increase in internal impedance of between 35 and 50%. As a result, that is getting close to the conclusion of its life cycle.

3.1.8 Battery Pack Tests

- **Electrochemical impedance spectroscopy (EIS)**

  EIS, or electrochemical impedance spectroscopy, is a potent method for analysing electrochemical system processes. The dynamics of bound or mobile charge in the bulk or interfacial areas of any liquid or solid media, including ionic, semiconducting, mixed electronic-ionic, and even insulators, are typically involved in such processes (dielectrics). The key advantage of EIS is its ability to efficiently break down complicated electrochemical processes into a number of fundamental processes based on various relaxation durations. The system must, however, remain in a steady state for the duration of the EIS measurement. Both properties can be obtained by stimulating the electrochemical system at various frequencies with a small-amplitude periodic disturbance of potential or current. The related transfer function, or the system's impedance, can be computed by measuring the system's reaction (current or potential) to this perturbation2. An ideal impedance spectrum would have a distinct feature for each fundamental electrochemical action that makes up the whole mechanism.

  It is already possible for a basic EIS measurement of a typical electrochemical energy storage cell to yield a spectrum in which the reaction(s) that take place on the positive and negative electrodes are seen as (well) separated features (e.g. semi-circles in the complex impedance plots). Additionally, a high-frequency intercept along the x-axis of the complex impedance plot is seen as the migration of ions across the liquid electrolyte contained in a separator (also called the Nyquist plot). A given cell's other fundamental processes, such as I surface layer generation on electrode materials, (ii) poor interphase contacts, and (iii) carry depletion in the active phase or electrolyte, may be identified with the aid of more thorough EIS research. The advantages and disadvantages of this in situ approach are briefly discussed here, taking into account the most well-known contemporary electrochemical energy storage system: the lithium-ion battery.

- **Vibration test**

  Test procedure:

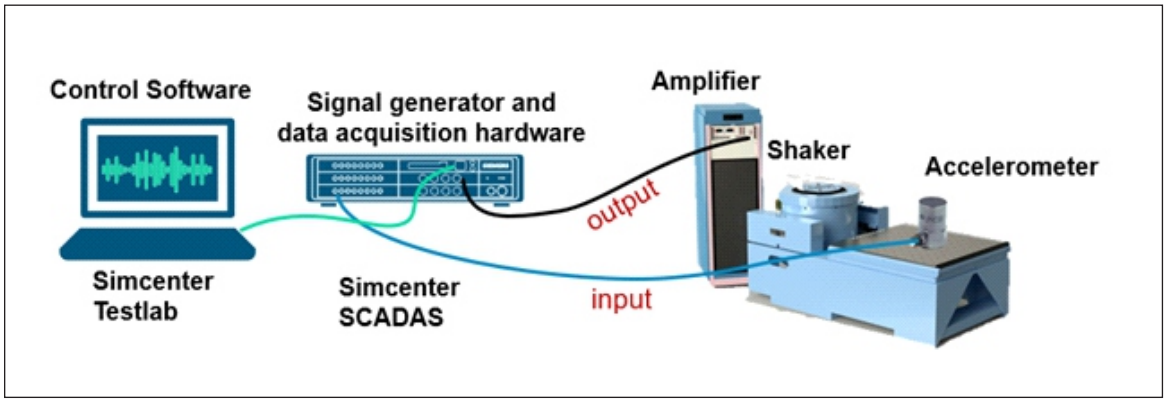


Fig. 3.1.2. Battery vibration test setup[4]

[4]*Source:https://blogs.sw.siemens.com/simcenter/why-battery-vibration-test-is-the-name-of-the-game/)*

- Batteries and cells are securely fastened to the vibration machine's platform without causing the cells to deform in a way that interferes with the vibration's faithful transmission.
- The vibration must have a sinusoidal waveform with a 15-minute logarithmic sweep between 7 Hz and 200 Hz, then returning to 7 Hz. For each of the three perpendicular mounting positions for the cell, this cycle must be repeated 12 times in a row for a total of three hours. Vibration must occur in at least one direction that is parallel to the terminal face.
- The vibration must have a sinusoidal waveform and move through a logarithmic range of 7 Hz to 200 Hz and back in 15 minutes. For each of the cell's three mutually perpendicular mounting configurations, this cycle must be repeated 12 times for a total of 3 hours. The terminal face must be perpendicular to one of the vibration directions.

  a. The extreme temperature exposure test is broadened to stress connections within cells and battery packs;

  b. The vibration test's frequency range is expanded to be typical of conditions in all modes of transportation; and

  c. The vibration test's frequency range is increased.

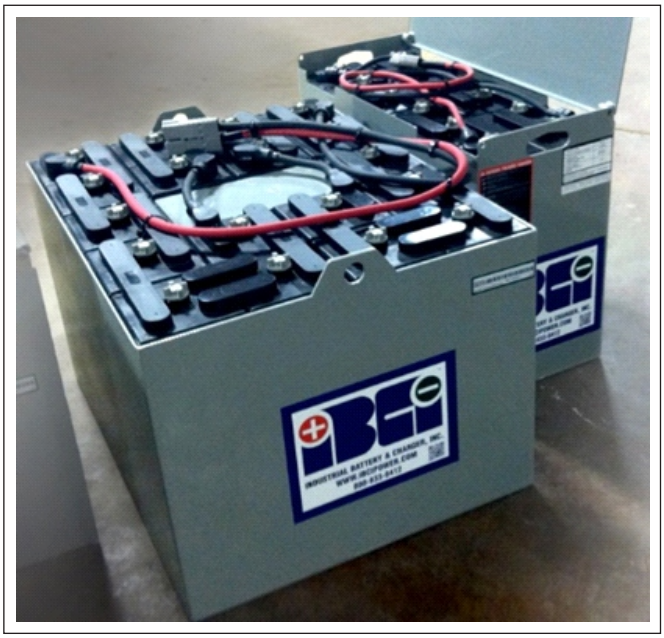
Vibration Test Methods for Large Format Battery Packs

- ✓ Large, heavy, and complex battery packs (DUT) are very difficult to test for mechanical vibration (T.3) and shock (T.4), and they also require testing facilities with sufficient capacity.
- ✓ In accordance with the current test protocol, "Cells and batteries are firmly fastened to the platform of the vibration machine without distorting the cells in such a manner to authentically transfer the vibration."
- ✓ The DUT must be clamped by screw rather than by belts in a typical transport manner in order to be secured to the platform during vibration tests in 3D orthogonal axes.

3.1.9 Getting to the Root of the Problem

Understanding the root cause of a battery-powered gadget failure may take specialist expertise in a number of scientific and technical fields due to the complexity of batteries. The act of gathering and examining data in order to pinpoint a failure's primary cause is known as failure analysis. The results are frequently used to decide what actions need to be taken to stop the failure of similar items, enhance the design of upcoming products, or deal with liability issues.

A lot of things can go wrong with a battery-powered device, including the battery or cells, the device itself (not the battery), or the battery management control system built into the battery or through separate circuitry built into the device. A battery or cell failure could be due to leakage, safety (such as a cell/battery overheating), or performance (such as the battery's lifetime not meeting specifications) (e.g., the electrolyte starts to leak from the cell container). The difficulty of battery failure analysis is to clearly pinpoint the source of the issue.



Failure analysis calls for the application and usage of a variety of tools, the selection of which necessitates years of experience and technical knowledge. It frequently entails looking at a complicated confluence of circumstances and possibilities. The procedure ultimately identifies a particular underlying cause. In essence, a battery failure analysis entails data gathering, data analysis, and proving that the true root cause has been identified by being able to consciously introduce and remove the issue.

A thorough failure analysis includes the following steps:

- Situation appraisal: A generic word used to describe the requirement to comprehend both the required change and the failure in full. The majority of situation assessments go in a similar natural way, asking the client questions to elicit as much information as possible about the failure, the circumstances surrounding the failure, and any other relevant background data. An evaluation of the current situation is essential to directing efforts in the most effective way and preventing the time and money that would otherwise be wasted on numerous fruitless analyses.
- Examination of batteries and cells may include physical examination, electrical characterization, performance characterization of cells, non-destructive X-ray, examination of the battery management system and control circuitry, dissection of cells and analysis of cell construction, and chemical analysis, depending on the cause of the failure, the type of battery, and the results of the situational appraisal.
- Testing to simulate alleged errors and abuse: For assessments involving performance, it's crucial to understand how the performance shortfall appears. A performance verification may be required for discharge testing, pulsing, cycling (for rechargeables), leakage testing, and accelerated ageing. It will be very challenging to identify the underlying reason of the performance shortfall if you cannot quantify or recreate it in the test lab. There might only be a small number of the "poor" performing cells accessible for the failure analysis, which complicates matters. It's crucial to understand how a cell or battery reacts under certain abuse or misuse for evaluations pertaining to safety. Beyond established tests, forcing the cell or battery to fail will provide crucial details on potential failure modes, such as the severity of the failure.

- It will be very challenging to identify the underlying reason of the performance shortfall if you cannot quantify or recreate it in the test lab. There might only be a small number of the "poor" performing cells accessible for the failure analysis, which complicates matters. It's crucial to understand how a cell or battery reacts under certain abuse or misuse for evaluations pertaining to safety. Beyond established tests, forcing the cell or battery to fail will provide crucial details on potential failure modes, such as the severity of the failure.
- Audits of the manufacturing process are crucial if the root cause is a known or suspected manufacturing problem. Discovering the breadth of a manufacturer's knowledge base is crucial, as is paying particular attention to manufacturing stages that are relevant to the failure or defect. The depth of follow-up questions necessary to go deeply enough to identify a problem can occasionally surprise people.

A company's brand reputation and higher-quality products can both be protected with the help of battery failure analysis.

3.1.10 Trouble Shooting

- In the event of a malfunction, first make sure that:
  - All battery connections between cells and trays. These connections must be tightly tightened and run from positive to negative in series.
  - The connectivity diagram given in the instruction manual should be followed while connecting the battery, SMR panels, AC distribution panel, and DC distribution panel.
  - Voltage of each individual cell. In a typical float: 2.10 to 2.2V per VRLA cell 2.15 to 2.2 V/cell for Conv.LA cells
  - If there is a difference of more than 0.05V between the cells with the lowest and highest readings, turbo charge the battery for 24 hours before rechecking.
  - The system's AC input voltage should range from 150V AC to 275V AC.

Try to remedy the fault in accordance with the guidelines if all of the aforementioned connections are sound and the cell and AC input voltages are within the recommended ranges.

Maintenance of Battery

Battery maintenance is well recognized as an important part of running an efficient and safe warehouse. But the right way to maintain batteries is frequently disregarded. When it comes to conserving time, prolonging the life of your battery, and safeguarding your equipment, performing maintenance in the proper order is just as important as the maintenance tasks themselves.

Follow the recommended battery maintenance schedule:

1. **Charge battery once it is down to 20% capacity**

   Never let the battery's power go below 20% before recharging. The performance and endurance of the battery will be irreparably harmed if the banks are discharged too deeply. Additionally, it might overheat and harm the forklift's electric circuits.

   Allow battery to charge completely and continuously. The quantity of charges a battery receives is frequently inversely correlated with its longevity. Reduced performance rate and a shorter battery life can result from undercharging, charging frequently for brief intervals of time (including quick charging during a lunch break), or charging before the battery has lost more than 50% of its power.

2. **Deliver equalizer charge when necessary**

   Many batteries require this intentional overcharge in order to operate correctly and effectively. Batteries that require this type of charging will have a button on their chargers that must be manually pressed to activate the equaliser charge. Consult your battery/charger manual for more information if you're unsure whether an equaliser charge is required, how frequently to deliver one, or how to deliver one.

   Batteries will charge for a longer amount of time when receiving an equalisation charge. Batteries should be kept under close observation during this operation because the prolonged charging time could cause overheating.

3. **Turn power off and allow battery to cool before removing**

   Power should not be turned off until the battery is fully charged. If the battery is fully charged, it will function more effectively throughout the day. The battery's lifespan will be extended by reducing the number of times it needs to be charged as a result of this approach.

   Power should not be turned off until the battery is fully charged. If the battery is fully charged, it will function more effectively throughout the day. The battery's lifespan will be extended by reducing the number of times it needs to be charged as a result of this approach.

   Battery must cool before being put back into use; otherwise, it could overheat and harm electrical circuits as well as the battery.

4. **When water/electrolytes are needed, be sure to water battery after charging and disconnecting**

   At any other moment, it is unsafe to water batteries. Charge before watering since the heat from charging can modify the amount of the water (both as evaporation and overflow). You can add a tiny amount of water if the water levels are very low before charging to avoid the battery overheating.

5. **If battery is overfilled, clean battery immediately following overflow**

   If there is a spill during this operation, battery acid will leak across the battery's surface and cause corrosion if it is not cleaned up right away. Battery life can be shortened by corrosion and leftover acid, which can also make the battery overheat when being charged and used.

6. Clean battery with a neutralizing detergent solution on a regular basis.

Surface cleaning will stop the accumulation of dirt, corrosion, and related issues. After watering, clean the batteries. In the event of an overflow, water drops, etc., this will prevent you from having to repeat a step. Always wash batteries with the proper tools and specific neutralising detergent in the designated place. A specific cleaning product or a simple sprinkle of baking soda might be used as the neutralising agent. Whatever method is employed, it is imperative to complete this step in order to neutralise any battery acid that has accumulated on the battery's surface and stop corrosion of the battery and nearby electrical circuits.

After watering, clean the batteries. In the event of an overflow, water drops, etc., this will prevent you from having to repeat a step. Always wash batteries with the proper tools and specific neutralising detergent in the designated place. A specific cleaning product or a simple sprinkle of baking soda might be used as the neutralising agent. Whatever method is employed, it is imperative to complete this step in order to neutralise any battery acid that has accumulated on the battery's surface and stop corrosion of the battery and nearby electrical circuits.

Establishing the proper battery maintenance procedure is essential to ensuring a safe and effective work environment. Batteries should undergo the proper maintenance, which may be ensured via charts and timetables.

Our top priorities are your happiness and safety. To keep your fleet operating effectively and increase battery life, speak with your IBCI representative about options for planned maintenance programmes.

Exercise

1. Explain in brief the Electrochemical impedance spectroscopy (EIS) & Vibration test.
2. Explain thermal performance test in battery.
3. Write the process for Use of A Battery Hydrometer

Notes

Scan the QR Code to watch the related videos

https://www.youtube.com/watch?v=XCSKqVcv20Y

Testing the Battery system after assembly

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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

ELE/N9905

Key Learning Outcomes

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

1. Work effectively at the workplace
2. Demonstrate practices related to gender and PwD sensitization

UNIT 4.1: Effective Communication and Coordination at Work

Unit Objectives

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.

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

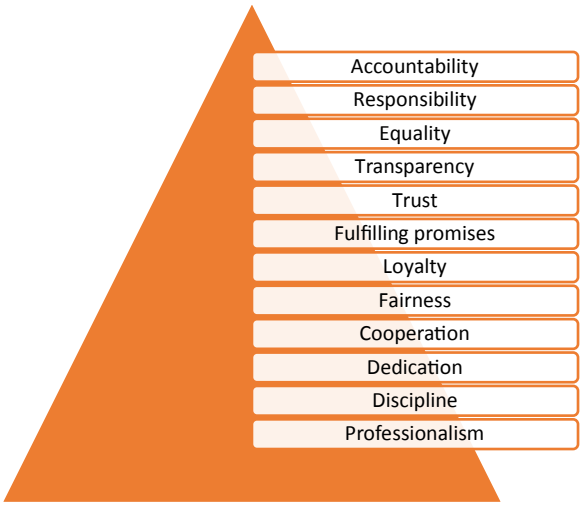

Fig. 4.1.1 Examples of Common Workplace Ethics

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

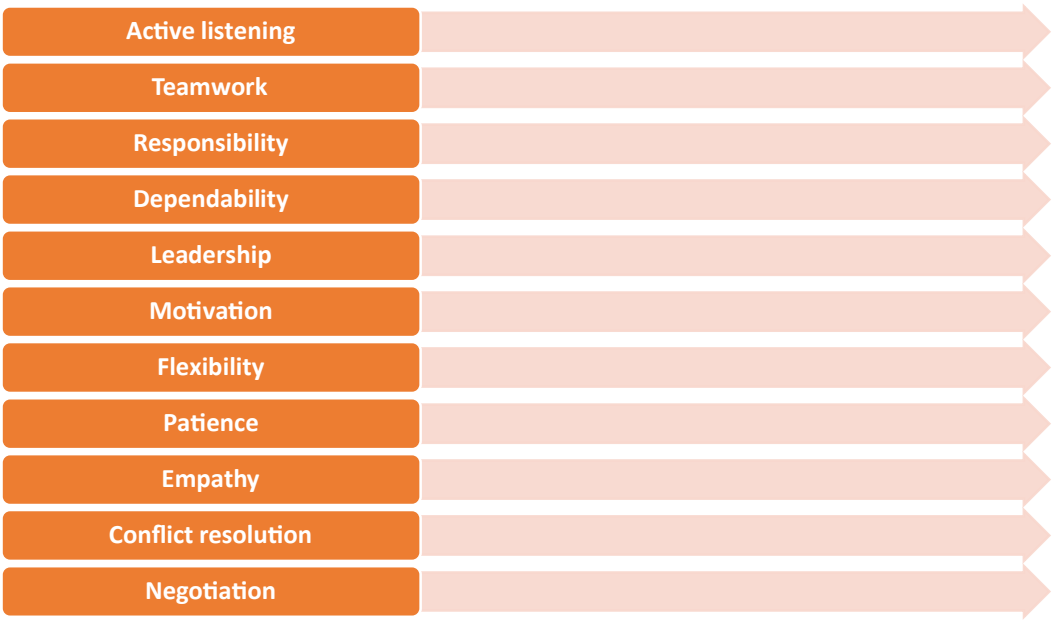

Fig 4.1.3 Examples of Interpersonal Skills

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 communication skills that vital for success at work:

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.

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.

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.

Notes

UNIT 4.2: Working Effectively and Maintaining Discipline at Work

Unit Objectives

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

1. Discuss the importance of following organizational guidelines for dress code, time schedules, language usage and other behavioural aspects.
2. Explain the importance of working as per the workflow of the organization to receive instructions and report problems.
3. Explain the importance of conveying information/instructions as per defined protocols to the authorised persons/team members.
4. Explain the common workplace guidelines and legal requirements on non-disclosure and confidentiality of business-sensitive information.
5. Describe the process of reporting grievances and unethical conduct such as data breaches, sexual harassment at the workplace, etc.
6. 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 action to take while initiating disciplinary action

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

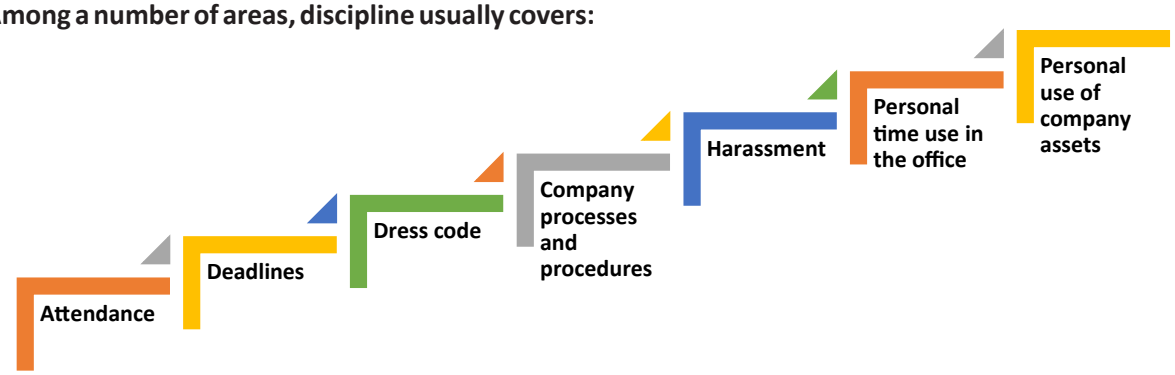

Fig 4.2.2 Examples of Workplace Discipline

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:

1. **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.

2. **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.

3. **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.

4. **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. Harbouring negative emotions affects one emotionally, affecting their job performance also. Engaging in enjoyable activities after work is a good stress reliever.

Notes

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.

Notes

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Transforming the skill landscape

ESSCI
Skilling India in Electronics

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

ELE/N1002

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 the 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:

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. 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

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'.

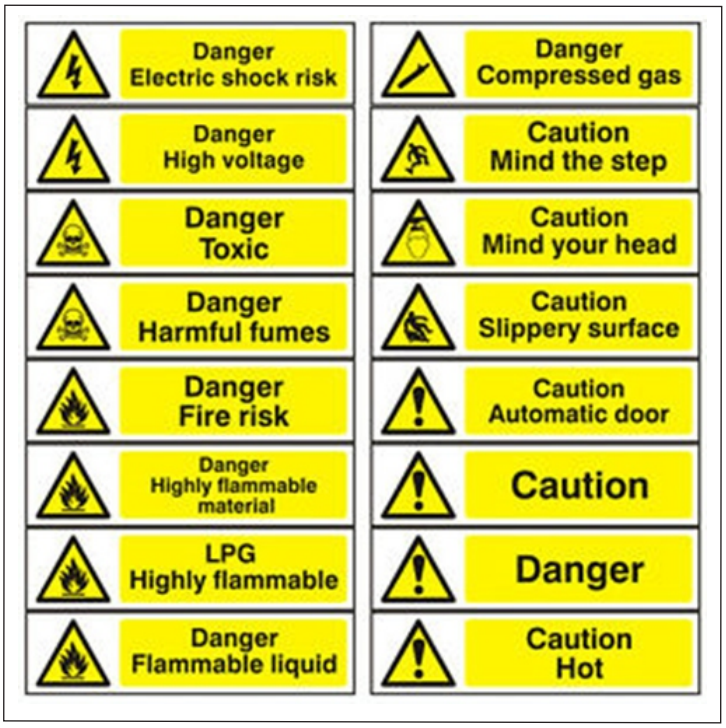


Fig. 5.1.3. Warning Signs

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.

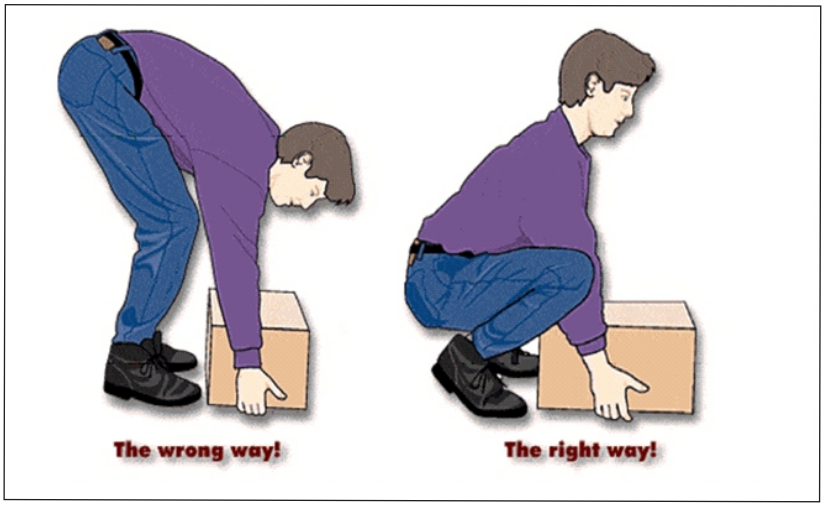


Fig. 5.1.5. Lifting loads technique

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.

Technique	Demonstration
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.	
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.	

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	

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[1]

[1]*Source:https://www.braceability.com/blogs/articles/7-proper-heavy-lifting-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:

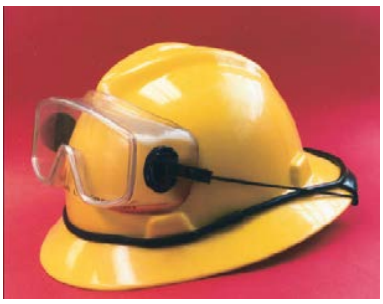
- Never carry tools up or down a ladder in a way that makes it difficult to grip them. Instead of being carried by the worker, tools should be lifted up and down using a bucket or strong bag.
- Tools should never be tossed but should be properly passed from one employee to the next. Pointed tools should 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 and face 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.	

Protection against Hearing Loss	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.	
Hand Injury Protection	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.	
Whole Body Protection	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.	

Table 5.1.2 Personal protective equipment

Notes

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 extinguishers.

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 soon. 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 (Co2).
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 (Co2):** 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.

Notes

UNIT 5.3: First Aid

Unit Objectives

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

1. Explain how the 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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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.

5.3.3 Treating Minor Cuts and Scrapes

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.

Notes

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.

- **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.
- **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 Blacks:
   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 _____.

Notes

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7. Annexure

Annexure I - QR Codes - Video Links

Annexure of QR Codes for Battery System Assembly Operator

Chapter Name	Unit Name	Topic Name	Page No.	URL	QR Code	Video Duration
Chapter 1: Introduction and Orientation to the Role of a Battery System Assembly Operator	Unit 1.1 – Introduction of Electronic Sector	1.1 Electronic Industry overview	6	https://www.youtube.com/watch?v=JgLu40JBa-c	Electronic Industry overview	00:06:05
	Unit 1.2 – Introduction to Battery System Assembly	1.2.1 Future of Transportation: Electric Mobility	14	https://www.youtube.com/watch?v=ArSyi1cfMq8	Future of Transportation: Electric Mobility	00:04:18
		1.2.4. Types of Electric Vehicle		https://www.youtube.com/watch?v=jM1wTNQERAU	Types of Electric Vehicle	00:03:57
		1.2.5.Components of an Electric Vehicles		https:://www.youtube.com/watch?v=SLGI7W5THhI	Components of an Electric Vehicles	00:06:50
	Unit 1.3 – Job Role and Responsibilities of a Battery System Assembly Operator	1.3.1 Job Role and Responsibilities of a Battery System Assembly Operator	19	https://www.youtube.com/watch?v=WcrAFNuGnNY	Job Role and Responsibilities of a Battery System Assembly Operator	00:49:58
Chapter 2: Assemble the Battery System	Unit 2.1 – Principles of Battery Asembling	2.1.1 Basic principles of Electricity and Electronics	43	https://www.youtube.com/watch?v=mc979OhitAg	Basic principles of Electricity and Electronics	00:10:10

Chapter Name	Unit Name	Topic Name	Page No.	URL	QR Code	Video Duration
		2.1.2 Fundamentals of electricity	43	https://www.youtube.com/watch?v=_1xjkl5MCIA	Fundamentals of Electricity	00:06:48
		2.1.3 Electric Circuit		https://www.youtube.com/watch?v=ouOJW_ozx6Q	Electric Circuit	00:17:55
		2.1.4 Electronic Components		https://www.youtube.com/watch?v=VBZ-3Ma7Ohc	Electronic Components	00:07:55
		2.1.5 Electrical Safety		https://www.youtube.com/watch?v=GFFkeQ5dIgU	Electrical Safety	00:17:35
	Unit 2.2 – Technology associated with Battery	2.2.1 Terminologies, graphical representations, signs and symbols	61	https://www.youtube.com/watch?v=DOBBwx3Cbbk	Technology Associated with Battery	00:20:21
		2.2.2 Various Important Terminology				
	Unit 2.3 – Maintaining Quality & Safety in Assembling process	2.3.1 Importance of Quality assurance in battery assembly	71	https://www.youtube.com/watch?v=3Fnwabe9Ps8	Maintaining Quality & Safety Assembling in Process	01:01:07
		2.3.2 Electrical Short Circuit				
		2.3.3 Explain the factors that may cause short circuits in the battery pack assembly.				
		2.3.4 Electrostatic Discharge				

Chapter Name	Unit Name	Topic Name	Page No.	URL	QR Code	Video Duration
		2.3.6 Personal Protective Equipment (PPE) to avoid shock, heat, deformation, short circuit etc. during the assembly process	71			
Chapter 3: Testing the Battery system after assembly	Unit 3.1 – Testing the Battery system after assembly	3.1.1 Globally accepted standards for testing BE systems 3.1.2 Battery Testing Comparison 3.1.3 Automotive Industry Standards (AIS)-India 3.1.5 Battery pack tests 3.1.6 Getting to the Root of the Problem 3.1.7 Trouble Shooting	94	https://www.youtube.com/watch?v=XCSKqVcv20Y	Testing the Battery system after assembly	01:05:15

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