Basic welding work

Level-I

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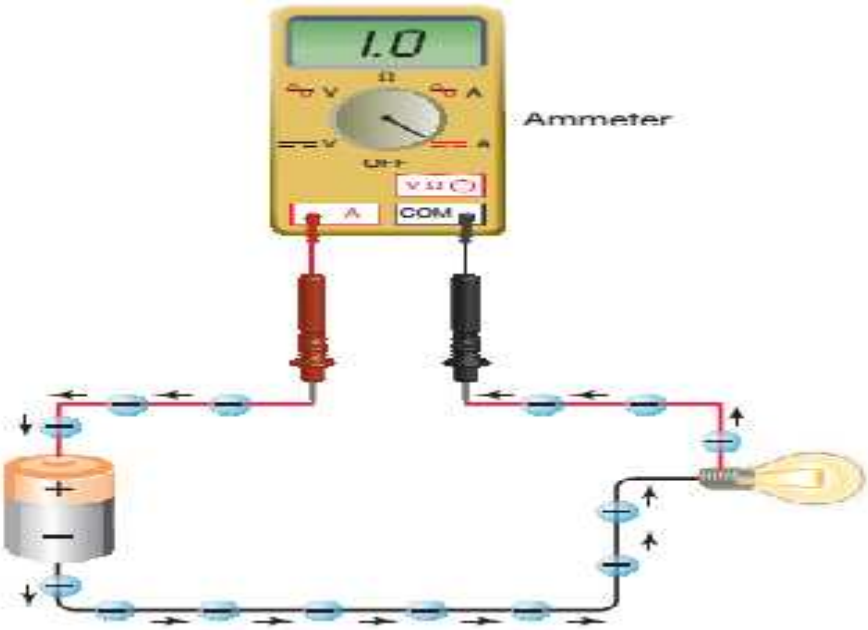

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Acronym

DB-Distribution board

OHS-Occupational health and safety

PPE-Personal protective equipment

AC-Alternating current

DC-Direct current

Introduction to the Module

Basic electrical practices covers skills and knowledge required to apply minor/basic handling and maintenance practices associated with a range of electrical equipment at the metal engineering workplace.

This module covers the units:

- Prepare for work
- Conduct minor handling and maintenance
- Complete report and quality work

Learning Objective of the Module

- Prepare for work
- Perform maintenance and minor handling
- Identify quality

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Prepare for work

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- work requirements
- Occupational Health and Safety
- resources required to perform the tasks
- interpret plans and drawings
- Set-up Work plan
- Potential hazards and prevention measures
- Resolve co-ordination requirements

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify work requirements
- perform Occupational Health and Safety
- Identify resources required to perform the tasks
- interpret plans and drawings
- Set-up Work plan
- Perform Potential hazards and prevention measures
- Resolve co-ordination requirements

1.1. Work requirements

All electrical equipment maintenance and installation will only be undertaken by competent contractors and their workers. Each exposed part of electrical equipment is to be treated as if it is energized until it is isolated and it is proven not to be energized. Electrical switchboards and all isolators for de-energizing electrical circuits and other energy sources will be labeled; All enclosures housing electrical equipment such as substations and switchboards will be fitted with locks and signs to prevent access by unauthorized persons. Only competent a authorized personnel will be permitted to access electrical installations such as substations and switchboards. Wherever possible the space around electrical installations and circuits will have sufficient clearance for safe working conditions. Sufficient light will be installed in the vicinity of electrical installations and circuits to be able to see clearly all labels and markings.

1.2. Occupational Health and Safety

Dealing properly with occupational health and safety policies and procedures for installing and terminating wiring system means follow the correct occupational health safety procedures for safe individual, work area, Tools and equipment from electrical damage. The material that is used to protect individual safety against a risk to health and safety is called PPE (personal protective equipment).

PPE is defined as all equipment designed to be worn, or held, to protect against a risk to health and safety. This includes most types of protective clothing, and equipment such as Goggles- wear of eye, Safety shoes(boot)-wear of foot, Helmet- wears of head, Gloves- wear of hands, Apron- wears of the body, Ear muff- wears of ear, Face mask -wear of face.

Under the Health and Safety at Work Act, employers must provide free of charge any PPE and employees must make full and proper use of it.

PPE are to be used in a particular area. The vulnerable parts of the body which may need protection are the head, eyes, ears, lungs, torso, hands and feet and, additionally, protection from

falls may need to be considered. Objects falling from a height present the major hazard against which head protection is provided. Other hazards include striking the head against projections and hair becoming entangled in machinery. The eyes are very vulnerable to liquid splashes, flying particles and light emissions such as ultraviolet light, electric arcs and lasers. Types of eye protectors include safety spectacles, safety goggles and face shields. Screen-based workstations are being used increasingly in industrial and commercial locations by all types of personnel. Noise is accepted as a problem in most industries and surprisingly there has been very little control legislation. The Health and Safety Executive have published a 'Code of Practice' and 'Guidance Notes' for reducing the exposure of employed persons to noise.

Boots or shoes with in-built toe caps can give protection against impact or falling objects and, when fitted with a mild steel sole plate, can also provide protection from sharp objects penetrating through the sole. Special slip resistant soles can also be provided for employees working in wet areas

Fig.1.1.Safety signs

1.3. Resources required performing the tasks

1.3.1. Wire materials

The most common material for electrical wire is copper and aluminum, these are not the best conductors however they are abundant and low cost gold is also used in applications because it is corrosion resistant.

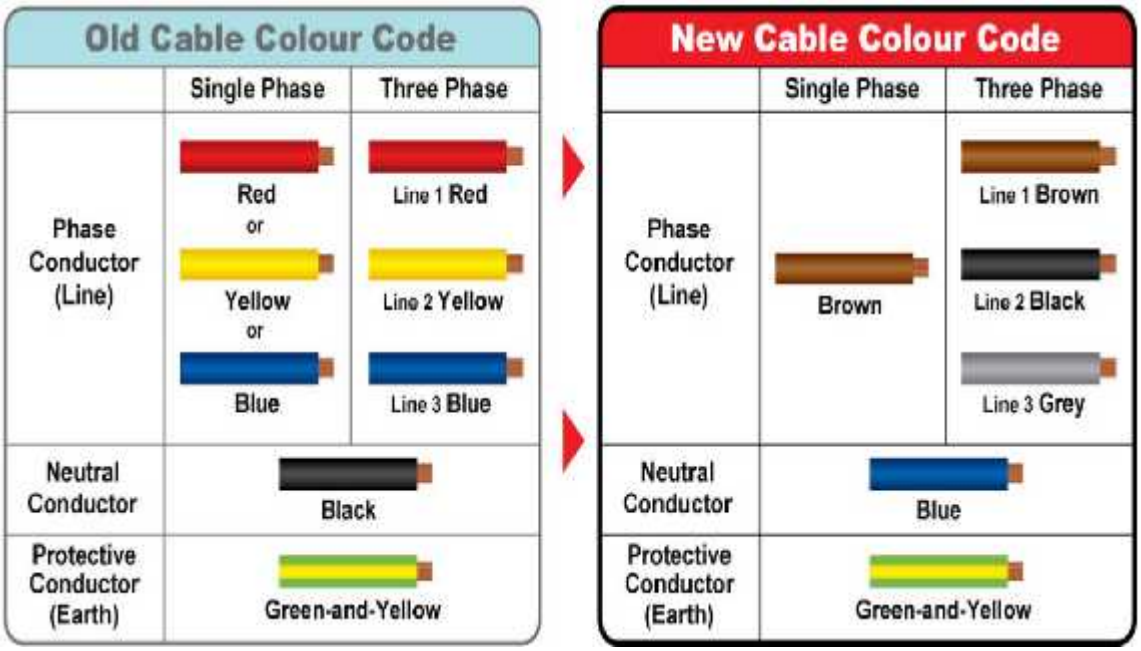

Fig.1.2. Cable color

Electrical wire is made of materials like copper, aluminum and silver. As silver is expensive, mostly copper and aluminum are used in wiring.

Materials are classified into three types according to their properties:

a. Conducting materials
b. Insulating materials
c. Semiconductor materials

a. Conducting Material

(a) **Copper**: It is a good conductor of electricity. It is used in wiring materials in cables. It has low resistance and is used for conduction of electricity at high, medium and low voltage. It is used in wiring and cable making.

Figure 1.22 Copper wires

(b) **Aluminum**: It is light weight and cheaper in comparison to copper. Therefore, this type of conducting material is mostly used in electrical wiring. It is silvery–white in color and it has a soft texture. It is often used in wiring and making cable

Figure 1.23 Aluminum Conductors

Electrical Cables

Electrical cables are used to carry electric currents. Most cables are constructed in three parts:

a. The conductor that carries the current and may have a stranded or solid core.
b. The insulation, that contains the current and is color coded for identification.
c. The outer sheath that may contain some means of providing protection from mechanical damage.

b. Insulating Materials

Insulating materials are used for insulating purpose. These types of materials are bad conductors of current. For example: rubber, paper, mica, wood, glass and cotton.

a) Wiring Accessories

Wiring accessories are used for connecting appliances

Switch: a switch is used to make or break an electrical circuit. It is used to switch 'on' or 'off ' the supply of electricity to an appliance. There are various switches such as

- surface switch
- flush switch
- ceiling switch
- pull switch
- push button switch
- bed switch

Surface switch: It is mounted on wooden boards fixed on the surface of a wall. It is of three types

a. One-way switch
b. Two-way switch
c. Intermediate switch

One-way switch: It is used to control single circuits and lamp/s from one location. It consists of two connection terminals (one terminal phase for life/hot wire and one for Return wire which connected to lamp).

Two-way switch: It is used to divert the flow of current to either of two directions. The two-way switch can also be used to control one lamp from two different places/locations

Intermediate switch: It is used to control a lamp from more than two locations with interconnection of 2 two way switches at right and left side and intermediate switch in between.

1.3.2. Reconnect/terminate wires

Obtain Tools, equipment and testing devices needed to carry out the installation work means identify the hand tools and power tools, equipment and testing instrument that necessary to complete installing the electrical apparatus with good appearance.

Some additional tools required by an electrician engaged in industrial installations.

- ✓ Where special tools are required for example, those required to terminate cables or the bending and cutting tools for conduit and cable trays.
- ✓ They will often be provided by an employer but most hand tools are provided by the electrician himself.
- ✓ In general, good-quality tools last longer and stay sharper than those of inferior quality, but tools are very expensive to buy.
- ✓ A good set of tools can be assembled over the training period if the basic tools are bought first and the extended tool-kit acquired one tool at a time.
    i. Tools should be cared for and maintained in good condition if they are to be used efficiently and remain serviceable.
    ii. Screwdrivers: should have flat squared off end and wood chisels should be very sharp.
    iii. Wire stripper: that is used to remove insulation from conductor. Steel rule is used to scribe strait line.
    iv. Long nose pliers, flat screw driver, Phillips screw driver, test light Access to a grind-stone will help an electrician to maintain his tools in first-class condition.
    v. Additionally, wood chisels will require sharpening on an oilstone to give them a very sharp edge.

1.3.3. Tools and Equipment

Pliers (Long Nose, Combination, Diagonal Cutter)

Pliers are available in different types, shape, and sizes. They are also available in both insulated and un-insulated handles. An insulated handle should be used when working on or near hot wires. It is also used for cutting big and small wires.

Fig.1.4.plier

Screw Drivers (Flat (Universal) and Philips)

A screwdriver comes in various sizes and with several tip shapes. Screwdrivers used by electricians should have insulated handles. Using a screwdriver for a particular job, the width of the screwdriver tip should match the width of the screw slot.

Fig.1.5.screw drivers

Drilling Equipment

Drilling equipment is needed to make holes in building structure passages of conduits and wires.

Fig.1.6.driiling equipment

Sawing and Cutting Tools

Saws commonly used by electricians include the crosscut, keyhole, and hacksaw.

Fig.1.7.saw

Soldering Equipment

In doing electric wiring, splices and taps (connections made to wire) should be soldered, unless you use solder less connectors. Typical equipments available for soldering are shown below.

Fig.1.8.soldering equipment

Hammers

Hammers are used with chisels and for nailing and fitting. Below are examples of carpenter's claw hammer, lineman's hammer, and machinist's ball-peen hammer

Fig.1.9.hamers

Fig.1.3.Tools and Equipment

1.3.4. Measuring Tools

To measure wire length and other items, the electrician finds considerable use for measuring tools such as the extension or zigzag rule, push-pull rule and a steel tape as shown below.

Fig.1.10. measuring tools

Knife (Electrician Knife)

You will need to have a good knife, and I prefer a standard utility knife for stripping the PVC jacket from Romex, stripping large gauge wire, and for many other jobs as well.

Fig.1.11.knife

Wire Strippers

Have a good quality wire stripper. I prefer a T-Stripper with a wire cutter, light-duty pliers nose, and holes for bending termination loops on wires for most home electrical work. A combination crimper, cutter, stripper, bolt cutter and more, like those found in automotive electrical repair kits can be very handy as well, but the multi-purpose aspect means that the wire stripping function is compromised.

Fig.1.12.wire strippers

Fish Tape, and/or Fishing Tools

A fish tape is very handy, and essential if working with conduit.

A fish tape or fishing tools are required if you are installing electrical in existing walls or ceilings and are trying to minimize the damage you may cause by cutting as few access holes as possible.

Fig.1.13.fishing tools

Electrical Tape (Insulation Tape)

Every electrical tool kit should have at least a roll of black electrical tape, and having a few colors like red and blue helps as well for identifying wires, etc.

Fig.1.14.electrical tape

Digital Multi-meter (DMM)

Multi-meters are commonly used to measure current, resistance, or voltage. Originally termed analog Volt-Ohm-Millimeter (VOM), some models are referred to as Volt-Ohm Meters (VM). Digital Volt Meters (DVMs) measure voltage (certain oscilloscope models have this capability, as well).

Fig.1.15.digital multi-meter

A voltmeter (Analog)

Voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter.

A voltmeter in a circuit diagram is represented by the letter V in a circle.

In electrical and electronic engineering, a current clamp or current probe is an electrical device with jaws which open to allow clamping around an electrical conductor. This allows measurement of the current in a conductor without the need to make physical contact with it, or to disconnect it for insertion through the probe. Current clamps are typically used to read the magnitude of alternating current (AC) and, with additional instrumentation, the phase and waveform can also be measured. Some clamps meters can measure currents of 1000 A and more. Hall Effect and vane type clamps can also measure direct current (DC).

Fig.1.16. **A voltmeter (Analog)**

1.3.5. Electrical Testing devices

The electrical contractor is charged with a responsibility to carry out a number of tests on an electrical installation and electrical equipment. The individual tests are dealt with in Part 6 of the IEE Regulations and described later in this chapter. The reasons for testing the installation are:

- to ensure that the installation complies with the Regulations,
- to ensure that the installation meets the specification
- To ensure that the installation is safe to use.

Those who are to carry out the electrical tests must first consider the following safety factors:

- An assessment of safe working practice must be made before testing begins.
- All safety precautions must be put in place before testing begins.
- Everyone must be notified that the test process is about to take place, for example the client and other workers who may be affected by the tests.
- 'Permits-to-Work' must be obtained where relevant.
- All sources of information relevant to the tests have been obtained.
- The relevant circuits and equipment have been identified.

a. Digital millimeters or instruments

Digital meters provide the same functions as analogue meters but they display the indicated value using a seven-segment LED to give a numerical value of the measurement.

Fig.1.17. Digital millimeters

b. Clamp-on ammeter or Tong tester

The tong tester or clamp-on ammeter works on the same principle as the transformer. The laminated core of the transformer can be opened and passed over the bus bar or single-core cable. In this way a measurement of the current being carried can be made without disconnection of the supply. The construction is shown in Fig. below

1.4. interpret plans and drawings

1.4.1 Interpreting electrical Diagrams and drawings

These are scale drawings based upon the architect's site plan of the building and show the position of the electrical equipment which is to be installed. The electrical equipment is identified by a graphical symbol. The standard symbols used by the electrical contracting industry are those recommended by the British Standard EN 60617, Graphical Symbols for Electrical Power, Telecommunications and Electronic The Layout drawing or site plan of a small domestic extension is shown. It can be seen that the mains intake position, probably a Consumer Unit, is situated in the store-room which also contains one light controlled by a switch at the door. The bathroom contains one lighting point controlled by a one-way pull switch at the door. The kitchen has two doors and a switch is installed at each door to control the fluorescent luminaries.

There are also three double sockets situated around the kitchen. The sitting room has a two-way switch at each door controlling the center lighting point.

Two wall lights with built-in switches are to be wired, one at each side of the window. Two double sockets and one switched socket are also to be installed in the sitting room. The bedroom has two lighting points controlled independently by two one-way switches at the door.

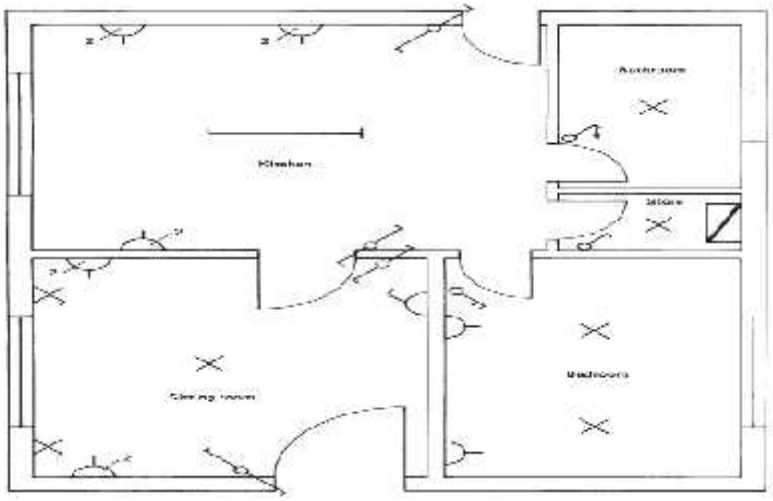

Figure 1.18 Layout drawing or site plan of a small electrical installation

Detail Drawings and Assembly Drawings: These are additional drawings produced by the architect to clarify some point of detail. For example, a drawing might be produced to give a fuller description of a suspended ceiling arrangement or the assembly arrangements of the metalwork for the suspended ceiling.

Location Drawings: Location drawings identify the place where something is located. It might be the position of the manhole covers giving access to the drains. It might be the position of all water stop taps or the position of the emergency lighting fittings. This type of information may be placed on a blank copy of the architect's site plan or on a supplementary drawing.

Block Diagrams: A block diagram is a very simple diagram in which the various items or pieces of equipment are represented by a square or rectangular box. The purpose of the block diagram is to show how the components of the circuit relate to each other and, therefore, the individual circuit connections are not shown. Figure below shows the block diagram of Light circuit control.

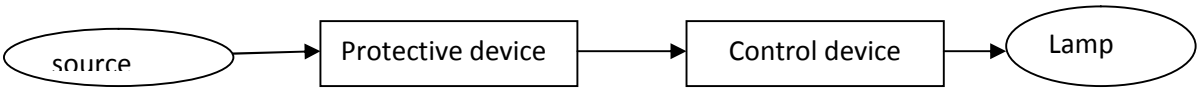

Figure 1.25 Block diagram

Wiring Diagrams: A wiring diagram or connection diagram shows the detailed connections between components or items of equipment. They do not indicate how a piece of equipment or circuit works. The purpose of a wiring diagram is to help someone with the actual wiring of the circuit. Figure 1.26 shows the wiring diagram for a space heating control system

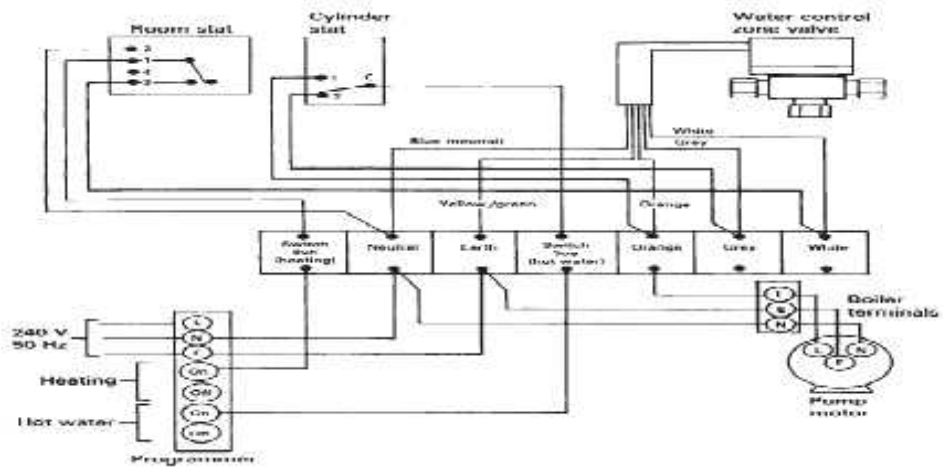

Figure 1.19.Wiring diagram of space heating control system (Honeywell Y. Plan)

Circuit Diagrams: A circuit diagram shows most clearly how a circuit works. All the essential parts and connections are represented by their graphical symbols. The purpose of a circuit diagram is to help our understanding of the circuit.

It will be laid out as clearly as possible, without regard to the physical layout of the actual components and, therefore, it may not indicate the most convenient way to wire the circuit. Figure 1.58 shows the circuit diagram of our same space heating control system.

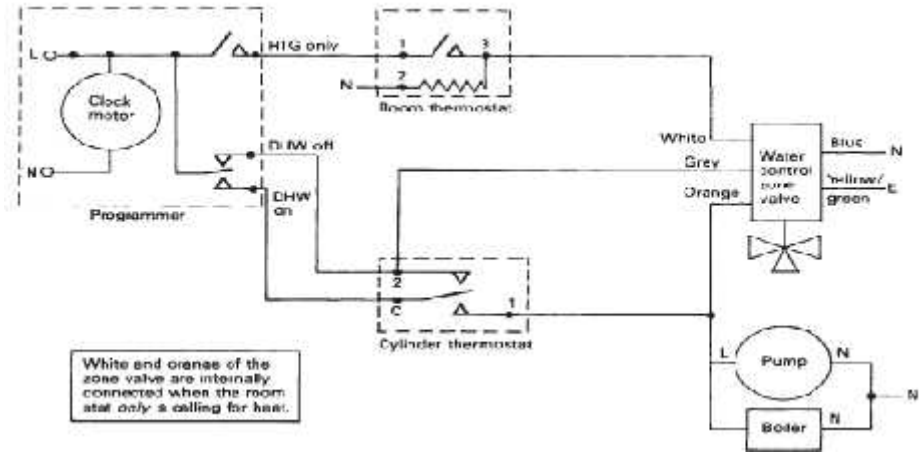

Figure 1.20 Circuit diagram of space heating control system (Honeywell Y. Plan)

Schematic Diagrams

A schematic diagram is a diagram in outline of, for example, a motor starter circuit. It uses graphical symbols to indicate the inter-relationship of the electrical elements in a circuit. These help us to understand the working operation of the circuit but are not helpful in showing us how to wire the components. An electrical schematic diagram looks very like a circuit diagram

Freehand Working Diagrams

Freehand working drawings or sketches are another important way in which we communicate our ideas. . A freehand sketch may be done as an initial draft of an idea before a full working drawing is made. It is often much easier to produce a sketch of your ideas or intentions than to describe them or produce a list of instructions.

To convey the message or information clearly it is better to make your sketch large rather than too small. It should also contain all the dimensions necessary to indicate clearly the size of the finished object depicted by the sketch.

1.5. Set-up Work plan

Process planning consists of selection of means of production (machine-tools, cutting tools, presses, jigs, fixtures, measuring tools etc.), establishing the efficient sequence of operation, determination of changes in form, dimension or finish of the machine tools in addition to the specification of the actions of the operator. It includes the calculation of the machining time, as well as the required skill of the operator. It also establishes an efficient sequence of manufacturing steps for minimizing material handling which ensures that the work will be done at the minimum cost and at maximum productivity. The basic concepts of process planning are generally concerned with the machining only. Although these concepts may also be extended to other processes such as casting, forging, sheet metal forming, assembling and heat treatment as well

1.6. Potential hazards and prevention measures

1.6.1. Safety Requirements for Electrical Wiring Works

In Residential Buildings *PPE* is defined as all equipment designed to be worn, or held, to protect against a risk to health and safety. This includes most types of *protective clothing*, and equipment such as eye, foot, Hand and head protection, *safety harnesses*, life jackets and high visibility clothing.

Under the Health and Safety at Work Act, employers must provide free of charge any PPE and employees must make full and proper use of it. Safety signs such as those shown at Fig. 1.15 are useful reminders of the type of PPE to be used in a particular area. The vulnerable parts of the body which may need protection are the head, eyes, ears, lungs, torso, hands and feet and, additionally, protection from falls may need to be considered. Objects falling from a height present the major hazard against which head protection is provided. Other hazards include striking the head against projections and hair becoming entangled in machinery. Typical methods of protection include helmets, light duty scalp protectors called ‘bump caps ’and hairnets.

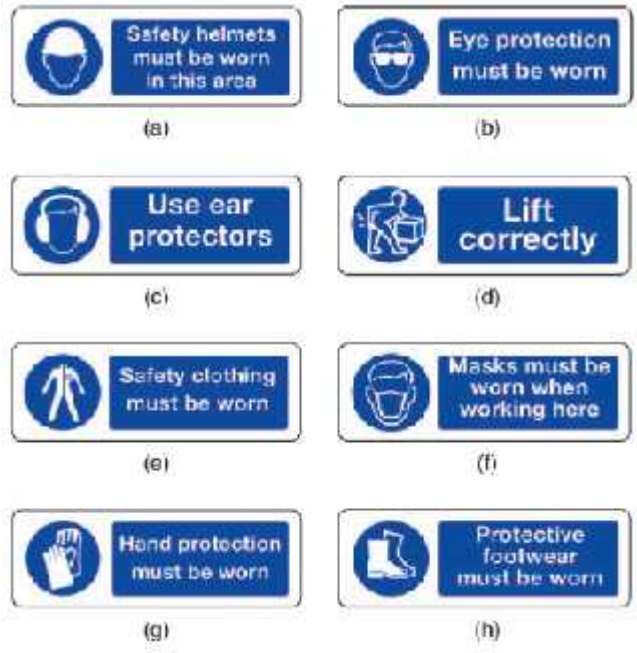

Figure 1.21 PPE

Eye protection: The eyes are very vulnerable to liquid splashes, flying particles and light emissions such as ultraviolet light, electric arcs and lasers. Types of eye protectors include safety spectacles, safety goggles and face shields.

Ear Protection: Noise is accepted as a problem in most industries and surprisingly there has been very little control legislation. The usual basis for measuring noise or sound level is the decibel scale. Whether noise of a particular level is harmful or not also depends on the length of exposure to it. This is the basis of the widely accepted limit of 85 dB of continuous exposure to noise for 8 hours per day.

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Where individuals must be subjected to some noise at work, it may be reduced by ear protectors. These may be disposable ear plugs, reusable ear plugs or ear muffs. The chosen ear protector must be suited to the user and suitable for the type of noise and individual personnel should be trained in its correct use.

Safety Mask (mouth protection): Breathing reasonably clean air is the right of every individual, particularly at work. Some industrial processes produce dust which may present a potentially serious hazard. The lung disease asbestosis is caused by the inhalation of asbestos dust or particles and the coal dust disease pneumoconiosis, suffered by many coal miners, has made people aware of the dangers of breathing in contaminated air.

Some people may prove to be allergic to quite innocent products such as fl our dust in the food industry or wood dust in the construction industry.

The main effect of inhaling dust is a measurable impairment of lung function. This can be avoided by wearing an appropriate mask, respirator or breathing apparatus as recommended by the company's health and safety policy and indicated by local safety signs.

Safety Clothes (body protection): A worker's body may need protection against heat or cold, bad weather, chemical or metal splash, impact or penetration and contaminated dust.

Alternatively, there may be a risk of the worker's own clothes causing contamination of the product, as in the food industry. Appropriate clothing will be recommended in the company's health and safety policy. Ordinary working clothes and clothing provided for food hygiene purposes are not included in the Personal Protective Equipment at Work Regulations.

Safety Glove (Hand protection): Hands and feet may need protection from abrasion, temperature extremes, cuts and punctures, impact or skin infection. Gloves or gauntlets provide protection from most industrial processes, but should not be worn when operating machinery because they may become entangled in it. Care in selecting the appropriate protective device is required; for example, barrier creams provide only a limited protection against infection.

Safety shoes (Foot Protection): Boots or shoes with in-built toe caps can give protection against impact or falling objects and, when fitted with a mild steel sole plate, can also provide protection from sharp objects penetrating through the sole. Special slip resistant soles can also be provided for employees working in wet areas. Whatever the hazard to health and safety at work, the employer must be able to demonstrate that he or she has carried out a risk analysis, made recommendations which will reduce that risk and communicated these recommendations to the workforce. Where there is a need for PPE to protect against personal injury and to create a safe working environment, the employer must provide that equipment and any necessary training which might be required and the employee must make full and proper use of such equipment and training.

1.6.2. Electrical Hazards

Basically, electrical hazards can be categorized into three types.

- The first and most commonly recognized hazard is electrical shock.
- The second type of hazard is electrical burns

- The third is the **effects of blasts** which include pressure impact, flying particles from vaporized conductors and first breath considerations

a) Safety Requirements

Safety requirements for electrical wiring works have to be followed to eliminate any accidents which can result in physical damage or loss of life or property. Failure to meet the safety regulations may result in workers, consumers or the public being inflicted with electrical shocks.

In addition to this, safety steps will also encourage workers or electricity consumers who are disciplined and who always give importance to safety.

1.6.3. Dangers of Electrical Shocks

i. **Electrical Shock**

Electric shock occurs when the human body becomes part of a path through which electrons can flow (of an electrical circuit). There are many ways that a person's body can become part of an electrical circuit and get shocked. Shocks can happen in three ways.

- A person may come in contact with both conductors in a circuit.
- A person may provide a path between an ungrounded conductor (live wire) and the ground.
- A person may provide a path between the ground and a conducting material that is in contact with an ungrounded conductor.

The level or intensity of the shock will depend upon many factors such as ***age, fitness*** and the ***circumstances*** in which the *shock is received.*

Electrical shocks can occur due to direct or indirect contact.

a. Direct Contact: Direct contact occurs when the worker or consumer receives an electrical shock on touching directly a live conductor or cable.

b. Indirect Contact: Here the electric shock occurs due to contact with a part which is connected to the electrical installation and not to a direct contact with a live cable or conductor, possibly due to damages in the appliance or insulation, resulting in leakages of current.

Safety Signs

Safety signs are displayed in the working environment to inform workers of the rules and regulations especially relevant to inform and give warning of possible danger and **must be obeyed**. There are **four types** of safety signs:

a. Warning signs
b. Advisory signs
c. Mandatory signs
d. Prohibition signs particular section of the workplace

1.7. Resolving co-ordination requirements

1.7.1. Establish effective communication

Each general contractor establishes and implements a procedure to ensure the exchange of information about hazards present on site and the hazard control measures in place. Thus, all workers on the site are aware of worksite hazards, and the methods and procedures needed to control exposures to them.

1.7.2 Establish effective coordination

General contractors, contractors, subcontractors, and staffing agencies coordinate on work planning, scheduling, and resolving program differences to identify and work out any concerns or conflicts that could impact safety or health.

- Include in contracts and bid documents any safety-related specifications and pre-qualifications and ensure that contractors, subcontractors, and staffing agencies selected for the work meet those requirements.
- Identify issues that may arise during on-site work and include procedures to be used by the general contractor, contractors, subcontractors, and staffing agencies for resolving any conflicts before work starts. This may be accomplished through pre-construction meetings.
- Ensure that joint-employed workers are adequately trained and equipped before arriving on the worksite.
- Harmonize their safety and health policies and procedures to resolve important differences, so that all workers at the site have the same protection and receive consistent safety information (i.e., conduct site-specific training).

- Work together to deal with unexpected staffing needs by ensuring that enough trained and equipped workers are available or that adequate lead time is provided to train and equip workers.
- Make sure that managers with decision making authority are available and prepared to deal with day-to-day coordination issues.

Self check-1

I. True/ false

Write true if the statement is correct and false if it is wrong

1. Safety signs are displayed in the working environment to inform workers of the rules and regulations

2. Electric shock occurs when the human body becomes part of a path through which electrons can flow (of an electrical circuit).

3. A circuit diagram shows most clearly how a circuit works

4. A wiring diagram or connection diagram shows the detailed connections between components or items of equipment

5. Electrical cables are used to carry electric currents

II**. Multiple choices**

Select one of the appropriate answers and give on the space provided

1. _____ the most common material for electrical wire is:

A. steel B. copper C. silver D. carbon

2._____ electrical instrument commonly used to measure current, resistance, or voltage.

A. multi-meter B. cable C. pliers D. none

3. _____one of the following is can be categorized in to electrical hazards

A. electrical shock B. bare foot C. maximum current
D. safety sign

4._____ it is not the types of safety signs:

A. Warning signs B. advisory signs
C. mandatory signs D. none

III. **Matching**

Match column A within column B

A	**B**
1. Eye protection	A. glove
2. Hand protection	B. volt-meter
3. Face protection	C. goggle
4. to measure electric current	D. helmet
5. To measure potential d/ce	E. ammeter

Operation sheet 1.1: voltmeter reading

Operation title: reading voltmeter

Purpose: To read voltage

Instruction: properly follow the given procedures

Quality Criteria: the circuit free from fault system

Precautions: follow all safety rules

Tools:

1. Voltmeter
2. Screw driver
3. Connecting devices
4. Personal protective equipment

Steps in doing the task

1. Visually check the circuit
2. Adjust any faults
3. Prepare the instrument to the appropriate reading
4. Carryout the reading
5. Complete the work
6. Record the reading

Lap Test-1

Task-1: identify the line to be checked

Task-2: perform visual inspection

Task-3: prepare the appropriate instrument

Task-4: perform measuring process repeatedly

Unit Two: Conduct minor handling and maintenance

This unit to provide you the necessary information regarding the following content coverage and topics:

- Confirm required isolations
- Conduct minor maintenance
- Undertake minor adjustments
- Report faults

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform isolations activity
- Perform minor maintenance
- Undertake minor adjustments
- Report faults

2.1. Confirm required isolations

2.1.1 Energy Isolation

Energy sources will be isolated whenever workers are required to work in and around energized equipment regardless of the source of energy. The following requirements apply and will be overseen by the nominated representative:

- Isolation will always be undertaken at the energy source and will not rely on control circuitry such as stop switches , interlocks, emergency stops or lanyards ;
- Positive isolation will be used i.e. the energy source has been isolated, tested and the isolation is proved to have worked;
- Wherever practicable, isolation will be secured by the use of a personal locking device which requires a key for removal;
- The equipment will also be tagged at the control panel to indicate it is isolated;
- Prior to work com mincing the equipment will be tested to verify it has been isolated;

If a personal locking device cannot be used, a personal danger tag will be used instead by each worker involved with the job.

The danger tag indicates that the person identified on the tag is involved in the work related to the item of equipment and is at risk of personal harm if the equipment is re -energized while the danger tag is in place;

- A personal danger tag will only be removed from the isolation point by the person identified on the tag who placed it on the isolator;
- De-isolation and re -energizing of equipment will only occur when all personal locks or danger tags have been removed;
- If for any reason the person identified on a personal danger tag is not available to remove it when the work is completed, it will only be removed by an authorized person at the site after following these actions:
  - ✓ Inspecting the area;
  - ✓ Making personal contact with the tag owner, in person or by phone; or
  - ✓ Seeking reliable information from a third party that the person has left the area. Out of Service Tags

An out of service tag is used to indicate an item of equipment is defective and that the equipment will not be used until cleared for safe operation by an authorized and competent person. The following requirements apply to out of service tags:

- An out of service tag will be placed on all defective equipment as soon as the defect has been recognized;
- The item of equipment will not be used while the out of service tag is in place. The tag will remain in place at all times while the equipment is isolated, defective or being worked on;
- The tag will indicate the date and time that it has been applied and the name of the person who placed the tag;
- An out of service tag will only be removed by a competent person once the defect has been corrected.

Function intended to cut off for reasons of safety the supply from all, or a discrete section, of the installation by separating the installation or section from ~very source of electrical energy.

Isolator*:* a mechanical switching device which provides the function of isolation.

Every year, people working on construction sites suffer electric shock and burn injuries some of which, tragically, are fatal. Members should be aware that some of these accidents are a direct consequence of electrical contractors not implementing safe isolation procedures. An example of one such fatal incident that occurred recently in the work site is provided in the box below.

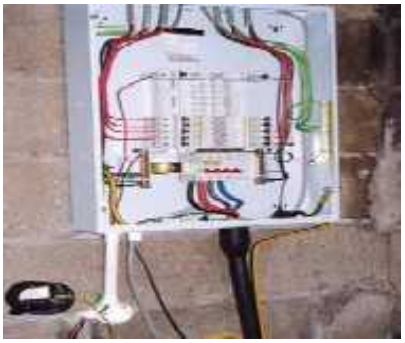


Figure 2.1.Wrong installation of socket out let from distribution board

An electrician working on a new-build construction project installed the 3-phase and neutral distribution board shown in the photograph.

S/He energized the supply to the distribution board before the circuits connected to it were complete, to provide a supply to a socket outlet.

S/He was connecting the supply cables to a wall-mounted timer unit, with the phase conductor connected to the circuit breaker at the top left hand side of the bus bar assembly. The circuit breaker had not been securely isolated and was ON as s/he stripped the insulation from the end of the cable. S/He touched the live copper conductor of the cable and was electrocuted.

The distribution board was manufactured to a high standard of safety. However, if s/he needed to energies the board before it was complete, s/he should first have replaced the cover and switched off and locked the circuit breakers supplying unfinished or incomplete circuits.

S/He should also have ensured that circuits were not connected into circuit breakers until after they were complete and had been tested

This brochure has been produced in conjunction with the Health and Safety Executive (HSE), and its purpose is to provide practical guidance on low voltage safe isolation procedures during construction projects and is aimed at preventing these types of incidents, and protecting employees and other workers against serious or fatal electrical injuries. The guidance is particularly relevant to circumstances where work is being carried out in the presence of other trades, and to sites where more than one electrician is employed, although the principles will apply generally.

A. Isolation using a main switch or distribution board (DB) switch-disconnected

Isolation of equipment or circuits using the main switch or DB switch-disconnected is the preferred method. The point of isolation should be locked off using a unique key or combination retained by the person carrying out the work. In the case of multiple isolations on a DB, a multi-lock hasp can be used to prevent access to a main isolator until such time that all persons working on a system have completed their work and removed their padlocks from the hasp.

If locking-off facilities are not provided on the relevant switch then a locked DB door or locked switch-room door is acceptable provided the key or combination is unique, and is retained by the person doing the work. Again, multi-lock hasps can be used to control multiple isolations, although a key box or similar system may be needed to retain and control access to the main door key

Figure2.2 Main Switch/MCB Isolation, Lock and Tag

Where it is intended that more than one person will be working on circuits supplied from a DB, (i.e. multiple isolations) and a multi-lock hasp cannot be used to secure the main point of isolation, individual isolation of each circuit by one or more of the methods shown below is recommended, to prevent inadvertent reinstatement of the supply. The principle is that each person carrying out such work should have control of their own point(s) of isolation and not rely on others to prevent inadvertent energize.

Figure2. 3. Multi-Lock Hasp

B. Isolation of individual circuits

Where it is not practical to isolate a distribution board, individual circuits supplied from it can be isolated by one of the methods described below, depending on the type of protective device used. However, bear in mind the overriding advice to avoid energize any outgoing electrical distribution services, preferably until the distribution switchgear and all connected circuits are complete and have been inspected and the relevant tests carried out.

If any items required to carry out the procedures recommended below are not manufactured for the DB in question or cannot be obtained through retail/trade outlets, it is acceptable to disconnect the circuit from the DB as long as the disconnected tails are made safe by being coiled or insulated. Suitable labeling of the disconnected conductors is important to prevent the supply being re-instated, particularly if other electricians are present.

It should be remembered that work carried out inside a live DB is regarded as live working when there is access to exposed live conductors. In this case the appropriate precautions should be taken as described in HSG85 with respect to Regulation 14 of the Electricity at Work Regulations.

i. Isolation of individual circuits protected by circuit breakers

Where circuit breakers are used the relevant device should be locked-off using an appropriate locking off clip with a padlock which can only be opened by a unique key or combination. The key or combination should be retained by the person carrying out the work.

Figure2. 4. Circuit Breaker locking off clip with a padlock

Note

Some DBs are manufactured with 'Slider Switches' to disconnect the circuit from the live side of the circuit breaker. These devices should not be relied upon as the only means of isolation for circuits as the wrong switch could easily be operated on completion of the work.

ii. Isolation of individual circuits protected by fuses

Where fuses are used, the simple removal of the fuse is an acceptable means of disconnection. Where removal of the fuse exposes live terminals that can be touched, the incoming supply to the fuse will need to be isolated. To prevent the fuse being replaced by others, the fuse should be retained by the person carrying out the work, and a lockable fuse insert with a padlock should be fitted as above. A caution notice should also be used to deter inadvertent replacement of a spare fuse. In addition, it is recommended that the enclosure is locked to prevent access as stated above under 'Isolation using a main switch or distribution board (DB) switch-disconnection

2.2. Conduct maintenance

Maintenance

In the design, construction and installation of an electrical installation, consideration must be given to its subsequent maintenance. It should be noted that electrical equipment must not only be so constructed and protected as to be suitable for the conditions under which they are required

to operate, but must also be installed to be capable of being maintained, inspected and tested with due regard to safety.

(b) For the purpose of maintenance, it is important to ensure the safety of persons approaching electrical equipment to work on it or attend to it. Guidelines on the provision of adequate and safe means of access and working space are described in Codes 4E and 4F.

2.1.1. Basic Maintenance of Electrical Tools and Equipment

To ensure that your electric tools work when you need them, you must take proper care of them. A good routine of maintenance for your tools is one thing that you can do to make sure that the tool you need is working when you need it.

1. Clean out the Dust. To make sure that your electric tools are ready to go when you are, keep them clean and free of dust. Spend some time to clean out the dust every once in a while on your tools while they are inactive in storage.

Fig2. 5 checking cord

2. Check the Cords. Look for tear/cut insulator on the power cords on your electric tools.

This will ensure that your electric tool can get the power that it needs to function without an accident.

3. Use the right tool correctly. Use tools correctly and for their intended purposes. Follow the safety directions and operating procedures recommended by the manufacturer.

When working on a circuit, use approved tools with insulated handles.

1. Protect your Tools. Keep tools and cords away from heat, oil, and sharp objects. These hazards can damage insulation. If a tool or cord heats up, stop using it. Report the condition to a supervisor or instructor immediately.

2. Use double-insulated tools - Portable electrical tools are classified by the number of insulation barriers between the electrical conductors in the tool and the worker.

3. Storing Your Tools- Keep your electric tools stored in their original cases and containers. This will keep them free of dust and dirt while they are not being used.

2.2.2. Change globes, starters and switchboard indicator lenses

A. Globes

LED globe light bulbs have been designed to look like the incandescent light bulbs they supersede. They have the classic globe shape and as the technology develops, they are beginning to look more like traditional light bulbs.
Incandescent globes, on average, last between 700 to 1,000 hours. Halogen globes can last up to two or three times that amount, depending on the quality of the globe. Compact fluorescent lamps (CFLs) last considerably longer, with an average lifespan of between 6,000 and 15,000 hours.

Generally, there are three types of globes. There are also globes that illustrate the physical features of celestial bodies, such as the moon or Mars. Celestial globes, like the one pictured here, are spherical maps of the sky—models of the visible heavens.

B. starter

Starters are devices that control the use of electrical power to equipment**.** As the name implies, starters “start” motors. They can also stop, reverse, accelerate and protect them. Starters are made from two building blocks: contactors and overloads.

C. Switchboard indicator lenses

Lenses: - the flat or concave lenses made of polymethyl methacrylate are available in various colors, as well as translucent or transparent. Perfect illumination of the different colors of lenses is assured by mid-get-grooved lamps for supply voltages above 60v, it is necessary to use a voltage reduction element (external series resistor, capacitor or transformer)

2.2. 3. Check transformer oil levels, Change of oil and air filters

1. Transformer oil level

The oil level indicator displays if air bubbles have remained in the transformer, if gas has been generated because of an internal failure or if there is a leakage at the transformer tank.oil level indictor provides continuous indication of the liquid level inside of a transformer’s main tank, conservator tank or load tap changer compartment. Integrated switches allow limit and alarm functions. It is for monitoring oil level within an oil filled transformer’s main tank, load tap changers or conservator.

Fig2.6.oil level indicator

2. Air filters

When air passes through your heating and cooling system, electronic air cleaner traps large particles (such as dust and dander) in a pre-filter. Electrically charged filters attract and trap smaller particles (such as bacteria and mold) to prevent them from re-circulating through your home.

A good rule of thumb is to replace pleated filters every 90 days. If you have electrostatic or washable filters, they should be washed, dried, and re-installed once a month. The washable filters are more eco-friendly and, if cleaned and reused appropriately, can last **5 to 10 years**.
They only remove particulate matter: Electrostatic air filters reduce levels of particles in the air such as dus**t**, pet dander and other allergens, yet they do not address harmful gases at all

If you set your filter up backwards, the normally collective end of the device will not face the air supply. In effect, your filter will help keep debris in the air. This results in a clogged filter and improperly cleaned air when it reaches your lungs.

In all cases, the furnace filter should be dirty on the side that the air comes into the furnace from. If your air filters are dirty in some other fashion, it is likely your furnace is not working properly, or the filter was installed incorrectly.

The filters don't need to fit with an "air tight" seal, but you should be able to easily install and uninstall your filter without a struggle, plus the filter shouldn't be so small that it moves freely within your unit.

2.2.4. Battery inspection and record of cell voltages

1. Battery inspection

1.1. **Performance testing and charging**

Before performance testing can take place on the battery, a visual check must be done to determine if the battery's physical condition is adequate for proper operation.

The following general information has been assembled as a guide for battery inspection and testing. Refer to the appropriate Original Equipment Manufacturer's service manual for specific information pertaining to battery inspection and testing procedures and safety precautions for your vehicle. Before performing any electrical system diagnosis or repair, make sure the battery has been:

1. Visually inspected.
2. Fully charged.
3. Performance test

Check that battery model and cell/unit manufacturing data code are visible and cell numbering is adequate and correct.

1. Look for dust, corrosion, water or electrolyte.
2. Check posts and seals.
3. Inspect inter-cell connections.
4. Check covers for cracking
5. Look for post discoloration
6. Check containers
7. Inspect electrolyte levels.

Before a performance test can be conducted, it is necessary to inspect the battery for visual defects and adjustments.

1. Make sure the battery is the proper size and type for the vehicle application. Compare each of the following characteristics to the vehicle manufacturer's specifications:

- Cold Cranking Amps (CCA) rating Note: The cranking amps (CA) rating is different than the CCA rating.
- Physical size and mounting style.
- Post orientation

Make sure the battery does not have loose posts, and the case is not cracked, bulging, or showing signs of leaking fluid.

Make sure the battery surface is free of dirt and moisture.

Make sure the battery connections are clean and corrosion free. This includes the frame and body ground connections and connections at the starter motor, starter solenoid and alternator.

- Make sure the battery cables are properly sized.
- Make sure the battery cables have no frayed wires and the insulation is intact.

- Make sure the battery cables are flexible and bend freely. Popping or crackling sounds while bending the cables indicate corrosion. Replace the cables.

Check the electrolyte solution if the battery has access. Add enough distilled water to maintain the electrolyte level just below the filler tube.

Check that the battery is properly secured and the mounting hardware is not too tight.

1. Charge the battery to obtain at least 12.6 volts (full charge). After charging the battery apply a 150 amp load for 10 to 15 seconds to remove any surface charge. Check the open circuit voltage. If 12.6 volts or above is not measured, replace the battery and continue to evaluate the charging system.
2. If the open circuit voltage is 12.6 volts or above, load-test the battery. A good battery will be capable of producing one-half of its CCA rating for 15 seconds and maintain a voltage reading of 9.6 volts (adjusted at 70º F) or above (Table 1). Perform the load test twice, waiting approximately 30 seconds between tests.
3. Check for parasitic loads at the battery. An excessive parasitic load can drain the battery in a short period of time. Draws in excess of 0.35 amps should be investigated. Refer to the Original Equipment Manufacturer's service manual for the parasitic load specification for your vehicle.

Cell voltage

Cell voltage is also known as cell potential (E) and electromotive force (emf). The electrical voltage or potential is measured in volts (V). The volt is related to energy values, joules (J), and electric charge, coulomb (C).

2.3. Undertake minor adjustments

2.3.1. Adjustment of Electrical installation

Socket outlets, installed in locations other than and intended to be used for the connection of electrical equipment that may represent an increased risk of electric shock to the user, shall be protected.

The installation of all electrical products and equipment shall be installed to the manufacturer's guidelines to the correct and relevant regulations and Standards, by a licensed and registered electrician or a trainee under the supervision of a registered and licensed electrician, and, where required by regulations, inspected by a licensed and registered electrical inspector.

2.3.2. Adjustments of Switches, socket outlets and fixed outlets

Switches, sockets and fixed outlets shall be:

a) Flush type

b) Standard manufactured type, commonly available with clip-on metal or plastic colored over plates

c) Standard manufactured type, commonly available plastic or polycarbonate color faceplates.

3.2.2 Surface Type

Surface type shall have:

a) Enclosures of the impact resistant, corrosion resistant, surface mounted type, as per

2.4. Report faults

A fault is any abnormal condition in a power system. The steady state operating mode of a power system is balanced 3-phase a.c .However, due to sudden external or internal changes in the system, this condition is disrupted.

When the insulation of the system fails at one or more points or a conducting object comes into contact with a live point, a short circuit or a fault occurs.

2.4.1. **Causes of power system faults**

The causes of faults are numerous, e.g.

- Lightning
- Heavy winds
- Trees falling across lines
- Vehicles colliding with towers or poles
- Birds shorting lines
- Aircraft colliding with lines
- Vandalism
- Small animals entering switchgear
- Line breaks due to excessive loading

2.4.2. Common Power System Faults

Power system faults may be categorized as one of four types; in order of frequency of Occurrence, they are:

- Single line to ground fault
- Line to line fault
- Double line to ground fault
- Balanced three phase fault

Self check-2

I. True/ false

Write true for correct statement and false for wrong one

1. A fault is any normal condition in a power system
2. Line breaks due to excessive loading can cause power system fault
3. Electric tools must be kept from heat and oil to avoid hazards
4. It is not necessary that electrical tools and equipment to make free from dust

II. Multiple choices

Select one of the appropriate alternatives and provide the answer on the space provided

1. _____a function intended to cut-off the supply from all for reasons of safety is:

   A. isolation B. inspection C. detection

   D. formation

2. A mechanical switching device which provides the function of isolation is:

   A. wire B. isolator C. circuit

   D. distribution board

3. Which one of the following device can stop, reverse and accelerate motors

   A. lenses B. starter C. isolator D. globe

4. One of the following is the causes of faults in circuit system

   A. lighting B. heavy wind

   C. birds shorting lines D. all

III. Give appropriate answers for the following given questions blow.

1. Write some of voltage reduction elements

2. What are the advantages of visual check of battery?

3. Write some of the materials the electric wires made of

4. What is electric circuit?

5. Write some of measuring instruments of electric current

Operation sheet 2.1: tool and equipment maintenance

Operation title: maintaining tool and equipment

Purpose: To maintain tools

Instruction: properly follow the given procedures

Quality Criteria: functionality of tools

Precautions: follow all safety rules

Tools:

1. Voltmeter
2. Ammeter
3. Screw driver
4. Pliers
5. Personal protective equipment

Steps in doing the task

1. identify functional and non-function tools
2. .perform inventory on non-functional tools
3. Identify particularly damaged parts of tools
4. Perform minor maintenance
5. Complete the work
6. Check the performance

Unit three: Complete report and quality work

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Complete work
- Make final checks
- Clean, restore and secure work area
- Maintain and store plant, tools and equipment

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Complete work
- Make final checks
- Clean, restore and secure work area
- Maintain and store plant, tools and equipment

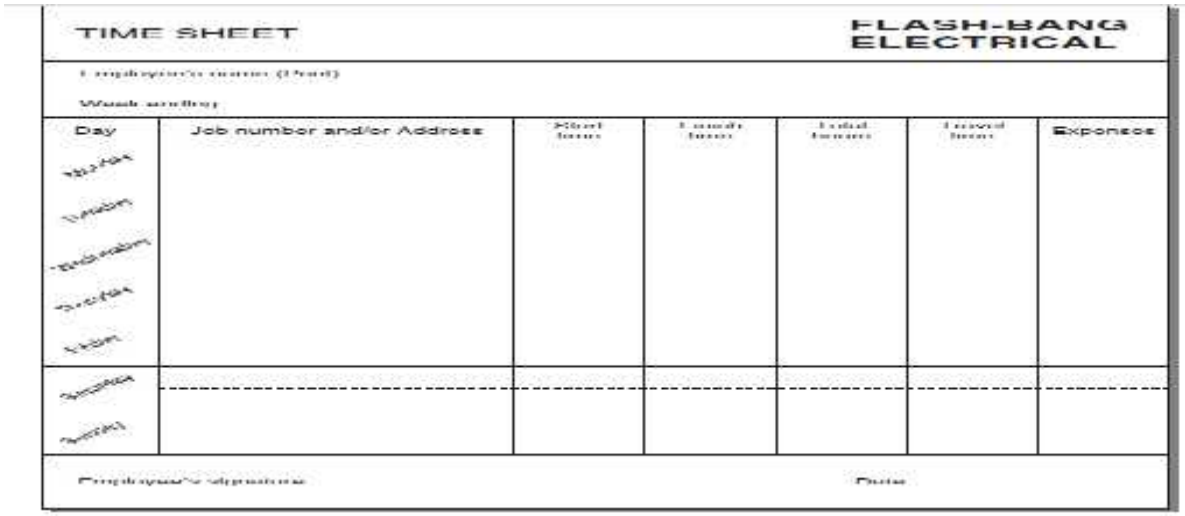
3.1. Complete work

Most electrical companies have standard forms which help them to keep track of time put in and materials used. When completing standard forms, follow the instructions given and make sure that your writing is legible – print if it makes your writing clearer. Finally, read through the form to make sure that you have completed all the relevant sections. Now, let us look at the following standard forms used by most electro-technical companies.

Time Sheets

A time sheet is a standard form completed by each employee to inform the employer of the actual time spent working on a particular contract or site. This helps the employer to bill the hours of work to an individual job. It is usually a weekly document and includes the number of hours worked, the name of the job and any travelling expenses claimed. Office personnel require time sheets such as that shown in Table 1.1 so that wages can be made up.

Table 3.1 Time Sheets



TIME SHEET — FLASH-BANG ELECTRICAL

Day | Job number and/or Address | Expenses

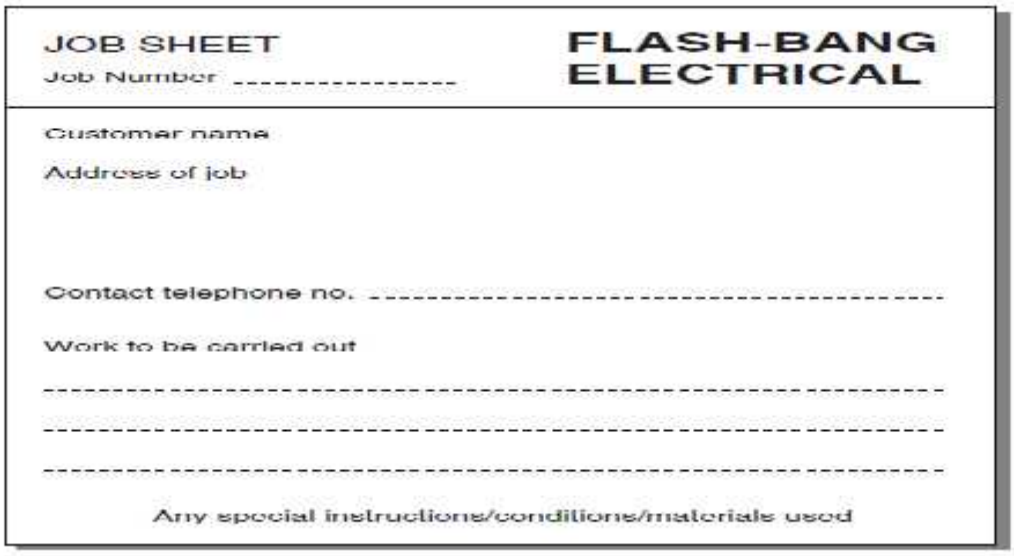
Job Sheets

A job sheet or job card such as that shown in table3.1 carries information about a job which needs to be done, usually a small job. It gives the name and address of the customer, contact telephone numbers, often a job reference number and a brief description of the work to be carried out. A typical job sheet work description might be:

- Job 1 – Upstairs lights not working
- Job 2 – Funny fishy smell from kettle socket in kitchen

The time spent on each job and the materials used are sometimes recorded on the job sheets, but alternatively, a day work sheet can be used. This will depend upon what is normal practice for the particular electrical company. This information can then be used to 'bill' the customer for work carried out.

Table 3.2 Job Sheets

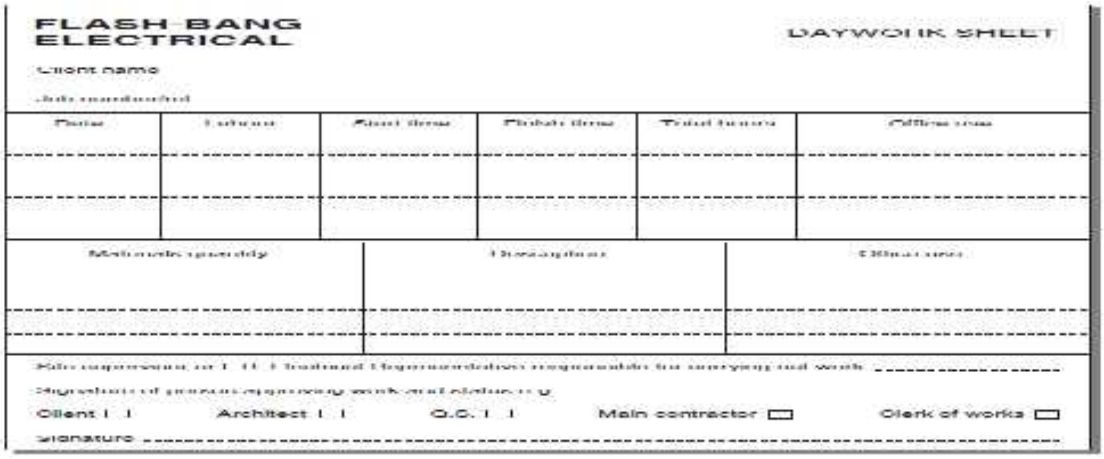

JOB SHEET
Job Number ----------
FLASH-BANG ELECTRICAL
Customer name
Address of job
Contact telephone no. ----------
Work to be carried out

Any special instructions/conditions/materials used

Day work Sheets

Day work is one way of recording variations to a contract, that is, work done which is outside the scope of the original contract. If day work is to be carried out, the site supervisor must first obtain a signature from the client's representative, for example, the Architect, to authorize the extra work. A careful record must then be kept on the day work sheets of all extra time and materials used so that the client can be billed for the extra work and materials. A typical day work sheet is shown

Table 3.3 Day work Sheets



FLASH BANG ELECTRICAL

DAYWORK SHEET

Client name

Job number/ref

Date	Labour	Start time	Finish time	Total hours	Office use

Materials quantity	Description	Other uses

Site supervisor or Tel. No. / Indirect Organisation responsible for carrying out work

Signature of person signing work and status e.g.

Client [ ] Architect [ ] Q.S. [ ] Main contractor [ ] Clerk of works [ ]

Signature

Delivery Notes

When materials are delivered to site, the person receiving the goods is required to sign the driver's 'Delivery Note'. This record is used to confirm that goods have been delivered by the supplier, who will then sent out an invoice requesting payment, usually at the end of the month.

The person receiving the goods must carefully check that all items stated on the Delivery Note have been delivered in good condition. Any missing or damaged items must be clearly indicated on the Delivery Note before signing because, by signing the Delivery Note the person signing is saying 'yes, these items were delivered to me as my company's representative on that date and in good condition and I am now responsible for those goods'. Suppliers will replace materials damaged in transit, provided that they are notified within a set period, usually three days. The person receiving the good should try to quickly determine their condition has the packaging been damaged – does the container 'sound' like it might contain broken items? It is best to check at the time of delivery if possible or as soon as possible after delivery and within the notify able period. Electrical goods delivered to site should be handled carefully and stored securely until they are installed. Copies of Delivery Notes should be sent to Head Office so that payment can be made for the goods received.

3.2. Make final checks

On completion of a wiring installation, a number of tests on the installation have to be conducted to ascertain that the wiring circuits and connected appliances are safe for use. Prior to carrying out the tests, an inspection has to be done.

There are different types of testing methods in wiring installation. Two of these are:

I. Continuity Test
II. Polarity Test

Continuity Test

There are 3 main types of continuity tests for the final circuits:-

a) Protection Conductor Continuity Test.
b) Final Ring Circuit Conductor Continuity Test.
c) Live and Neutral Conductor Continuity Test.

Polarity Test

- Ensure that each fuse or single pole control and protection device is connected only in the phase conductor.
- Intermediate contact of Edison screw lamp holder is connected to the phase conductor.
- Ensure that phase, neutral and earth conductors at socket outlets are connected at the correct terminals.
- Test Equipment: - Multi-meter (Ohm range) or Ohm meter.
- Test Method:
  - ✓ Switch off Main switch;
  - ✓ Disconnect all loads
  - ✓ Switch on all circuit control switches;
  - ✓ Carry out test as in Figure 1.74;
  - ✓ Test switches and single phase control devices at the phase conductors.
  - ✓ Test socket outlet connection sources.
  - ✓ Test Edison screw lamp holder connections.
  - ✓ Meter reading value shall be less than 1 ohm.

Figure3 1 Testing

Inspection

Check the following items to ensure:

A. All mechanical connections are tight, as factory connections may loosen during shipment and storage.
B. All accessible electrical connections are tightened to the torque specifications on the panel labeling.
C. All screws connecting and tight switches, breakers, socket outlets, lamps, etc are properly installed and tightened.
D. Connections between branch circuits and breakers are properly secured.
E. All ground connections are properly made (Note: ground wire must be installed after the panel box is mounted on the wall).
F. All foreign materials have been removed from the panel and enclosure before installing the dead front and trim.
G. Before energizing – Dead front is properly aligned and securely installed.
H. Before energizing – Trim is properly mounted and securely installed.

Before the electrical wiring is energized, it must be thoroughly inspected and tested. Any deviation must be corrected prior to energizing.

Introduction Periodic inspection and testing of internal wiring installations is necessary. Internal wiring should be checked and corrected every work for safe operations.

3.3. Clean, restore and secure work area

Clean work area and dispose of ,reuse or recycle materials according to legislation/regulation/code means clean work area before starting any work and after completion of work and dispose of ,reuse or recycle materials is classify types of materials with their function and identify by dispose, reuse or recycle after use the original materials.

Clean, check, maintain and store Plant, tools and equipment means clean, check, maintain tools and equipment before Install and terminate wiring system and clean work area and store after completion of Install and terminate wiring system

3.4. Maintain and store plant, tools and equipment

3.4.1 Maintaining and Storing Tools & Equipment

An important aspect of any business is the maintenance and storage of tools and equipment. The investment in tools and equipment is a significant part of the overhead expenses in any operation. Proper selection and maintenance of equipment are important factors in managing business. Selecting the proper tool for the job and using the tool properly will increase efficiency and reduce maintenance problems. Purchase tools, which are well-made and suited to the intended use. Commercial usage may entail more heavy duty demands on equipment.

Hand tools:

1. Clean dirt and debris from tools after each use.
2. Oil metal parts to prevent rust.
3. Lightly sand rough wooden handles and apply linseed oil.
4. Repair loose handles.
5. Sharpen blades of cutting tools.
6. Store tools in a clean dry storage area.
7. Protect surfaces of cutting tools in storage.

Power tools:

1. Read and follow the maintenance schedule in the owner’s manual for each piece of power equipment.

2. Change the oil.
3. Clean the air filter.
4. Lubricate moving parts.
5. Sharpen dull blades or replace worn blades according to the owner's manual.
6. Replace spark plugs.
7. Drain oil and gasoline before long-term storage.
8. Check electric cords and connections on electric-powered tools.
9. Store tools in a clean dry storage area.

Equipment:

1. Store equipment in a clean dry storage area.
2. Rinse and clean spray equipment after each use.
3. Clean spreaders and check wheel-driven gears.
4. Clean carts and wheelbarrows after use

Fig. 3.2.samleproperarrangement and storage of tools and equipment

3.4.2. Classifications of tools and equipment according to their uses:

1. Measuring tools
2. Holding tools
3. Cutting tools
4. Driving tools
5. Boring tools
6. Electrical equipment
7. Miscellaneous tools/instrument/equipment

3. 4.3 Classification of non-functional and functional tools

Tools are very useful to us in our homes especially to our job. But tools that are no longer Functional may cause harm.

A. Make an inventory of functional and non-functional tools in your shop.

B. Classify your tools according to is function.

3. 4.4 Method of identifying non-functional tools and equipment

1. Visual inspection. It refers to the visual observation of an expert on the appearance of the tools and equipment.
2. Functionality. Vibration or extra noise from the operation means problems on parts and accessories started to develop.
3. Performance. When there is something wrong with the performance of either hand tools or equipment they need an immediate repair or maintenance.
4. Power supply (for electrically operated only). Failure to meet the required power supply, malfunction will occurs in the part of hand tools or equipment.
5. Person's involved. It refers to the technical person who has the knowledge and skills about the technology.

Non-functional tools and equipment are those that are not able to perform its regular function because of impaired and damage part. Examples of these are the following:

Fig.3.3. tools

Electrical Measuring Instruments

i. Ammeter

An instrument called an ammeter is used to measure current flow in a circuit (Figure 1.9).

The ammeter is inserted into the path of the current flow, or in series, to measure current. This means the circuit must be opened and the meter leads placed between the two open points.

Although the ammeter measures electron flow in coulombs per second, it is calibrated or marked in amps or amperes. For most practical applications, the term amps is used instead of coulombs per second when referring to the amount of current flow.

Current	Base Unit	Units for Very Small Amounts		Units for Very Large Amounts	
Symbol	A	μA	mA	kA	MA
Pronounced As	Ampere (Amp)	Microampere	Milliampere	Kilcampere	Megampere
Multiplier	1	0.000001	0.001	1,000	1,000,000

Figure3.4. Ammeter connected to measure current.

ii. **Voltmeter**

- A voltmeter is used to measure the voltage, or potential energy difference of a load or source, as illustrated in Figure 1.10.
- Voltage exists between two points and does not flow through a circuit as current does. It is possible to have voltage without current, but current cannot flow without voltage.
- A voltmeter is connected across, or in parallel, with the two points.

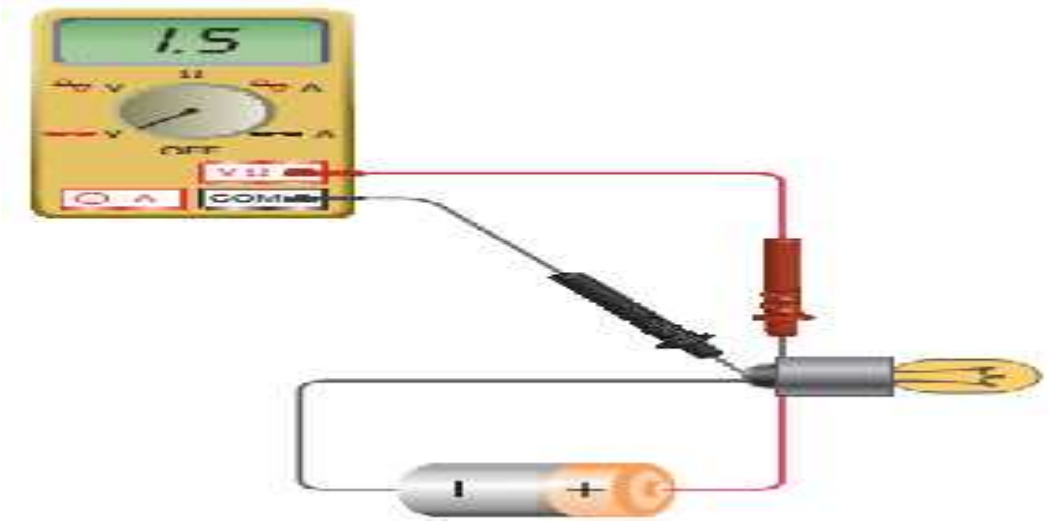


Figure 3.5.Voltmeter connected to measure voltage.

Voltage	Base Unit	Units for Very Small Amounts		Units for Very Large Amounts	
Symbol	V	μV	mV	kV	MV
Pronounced As	Volt	Microvolt	Millivolt	Kilovolt	Megavolt
Multiplier	1	0.000001	0.001	1,000	1,000,000

iii. **Ohmmeter**

An ohmmeter is used to measure resistance, as illustrated in Figure 1.11. Unlike the voltmeter and ammeter, which use energy in the current to make their measurements, the ohmmeter uses its own power source. For example, a multi-meter contains an ohmmeter that operates by a battery located inside the instrument. The ohmmeter applies a known voltage into a circuit, measures the resulting current, and then calculates the resistance. For this reason ohmmeters should never be connected to live circuits!

Figure 3.6.Ohmmeter connected to measure resistance.

Resistance	Base Unit	Units for Very Small Amounts		Units for Very Large Amounts	
Symbol	Ω	μΩ	mΩ	kΩ	MΩ
Pronounced As	Ohm	Microhm	Milliohm	Kilohm	Megohm
Multiplier	1	0.000001	0.001	1,000	1,000,000

iv. Digital Multi-meter

- DMM is a measuring instrument
- An ammeter measures current
- A voltmeter measures the potential difference (voltage) between two points
- An ohmmeter measures resistance
- A multi-meter combines these functions, and possibly some additional ones as well, into a single instrument

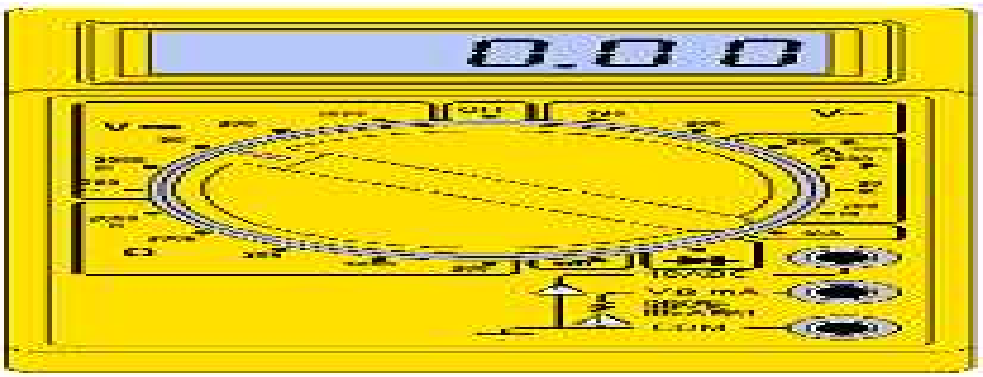


Figure3.7. Digital Multi-meters (DMM)

- Voltmeter:-connected in Parallel connection
- Ammeter: - Series connection
- Ohmmeter:- connected in parallel Without any power supplied
- Adjust range (start from highest limit if you don't know)

v. Wattmeter

Power can be measured using a wattmeter. The wattmeter is basically a voltmeter rand ammeter combined into one instrument (Figure 1.13). The ammeter terminals are connected in series, and the voltmeter terminals are connected in parallel with the circuit in which the power is being measured. The wattage rating of a lamp indicates the rate at which the device can convert electric energy into light. The faster a lamp converts electric energy to light, the brighter the lamp will be

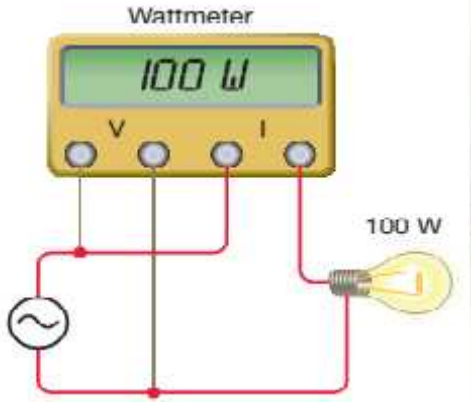


Figure3.8. Wattmeter connected to measure power Figure3.9. Kilowatt-hour meter

vi. Kilowatt-hour meter (Energy meter)

A kilowatt-hour meter connected to a residential electrical system is used to monitor your daily power

Self-check-3

I. **True/false**

Write true for correct statement and false for wrong one

1. Selecting the appropriate tools for the job will increase the efficiency
2. Non-functional tools are those that are not able to perform their regular function
3. Maintenance and storage may improve the functionality of tools
4. Ohmmeter is used to measure the amount of voltage
5. Incoming materials do not have any defects

II. **Multiple choices**

Choose one of the best answers from the given alternatives

1. The testing method in wiring installation is:
   A. delivery test B. polarity test
   C. material test D. all
2. One of the following can be taken as the maintenance of parts
   A. change the oil B. clean the air filter
   C. lubricate moving parts D. all
3. Which one of the following is classified under tools and equipment?
   A. measuring tools B. holding tools
   C. cutting tool D. all
4. The mechanism that help to identify functional and non-functional tools is:
   A. manufacturing system B. inventory system
   C. storage system D. none
5. One of the following shows the removal of materials after the original use
   A. disposes B.re-use
   C. recycles D. rework

III. **Matching**

Match column A within column B

A	B
1. Hand tool	A. drill
2. Power tool	B. pliers
3. Holding tool	C. ammeter
4. Electrical measuring instrument	D. vice
5. Moving part	E. motor

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