

Machining

Level-I

Based on March 2022, Curriculum Version 1



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Acronym

VOM:	Volt-Ohm Meter
AMM:	Analogue Multi Meter
DMM:	Digital Multi Meter
DVOM:	Digital Volt-Ohm Meter
AFS:	Airs Factuality Sub system
SIC:	Standard Industrial Classification
PCB:	Printed Circuit Board
PPE:	Personal Protective Equipment
AC:	Alternating Current
DC:	Direct Current
LED:	Light Emitted Diod
MCB:	Main Circuit Breaker
V:	Voltage

Introduction to the Module

In machining basic electrical practice helps to know the Termination/ connection of electrical wiring and electronics connections applies to the connection of wiring and includes termination and connection of all types of cords and cables. If you're planning any electrical project, learning the basics of wiring materials and installation is the best place to start the electrical wiring system used for protection and routing of electrical wiring. to know a network of wire connecting various accessories for distribution of electrical energy from the supply board to the numerical electrical energy consuming devices such as lamps, fans, socket out lets and other domestic appliances through controlling and protective devices is known as residential wiring .

This module is designed to meet the industry requirement under the machining occupational standard, particularly for the unit of competency: Apply basic electrical practice .

This module covers the units:

- Electrical work
- Maintenance
- Quality work

Learning Objective of the Module

- Prepare for work
- Conduct minor handling and maintenance
- Notify the completion of quality work

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

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Unit one: Electrical work

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

- Basic electrical work
- Basic safety practice
- Material and equipment
- Relevant drawings
- Work plans
- Potential hazards
- Control measure
- Work area

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:

- Know basic electrical work
- Apply basic safety practice
- Identify basic materials and equipments
- Interpret relevant drawings
- Setup detail work plans
- Identifies the potential hazards
- Apply control measure
- Prepare work area

1.1. Basic electrical work

1.1.1. Electrical wiring installation, termination and connection

Installing temporary cable for working outside the work shop area and during working on large sized component. In principle, temporary electrical installations should be avoided. However, in the event it should prove necessary to make use of a temporary installation, this must be carried out according to the regulations. Temporary electrical installations must always be installed under the supervision of an authorized person

- **Conductor Splices And Terminal Connections**

Conductor splices and connections are an essential part of any electrical circuit. When conductors join each other or connect to a load, splices or terminals must be used. Therefore, it is important that they be properly made. Any electrical circuit is only as good as its weakest link.

The basic requirement of any splice or connection is that it be both mechanically and electrically as sound as the conductor or device with which it is used. Quality workmanship and materials must be used to ensure lasting electrical contact, physical strength, and insulation. The most common methods of making splices and connections in electrical cables is explained below.

- **Insulation Removal**

The preferred method of removing insulation is with a wire-stripping tool, if available. A sharp knife may also be used.

- **Stripping wire with a hand stripper.**

- I. Insert the wire into the center of the correct cutting slot for the wire size to be stripped.
- II. The wire sizes are listed on the cutting jaws of the hand wire strippers beneath each slot.
- III. After inserting the wire into the proper slot, close the handles together as far as they will go.
- IV. Slowly release the pressure on the handles so as not to allow the cutting blades to make contact with the stripped conductor. On some of the newer style hand

wire strippers, the cutting jaws have a safety lock that helps prevent this from happening. Continue to release pressure until the gripper jaws release the stripped wire, and then remove.

- **Knife Stripping**

A sharp knife may be used to strip the insulation from a conductor. The procedure is much the same as for sharpening a pencil. The knife should be held at approximately a 60° angle to the conductor. Use extreme care when cutting through the insulation to avoid nicking or cutting the conductor.

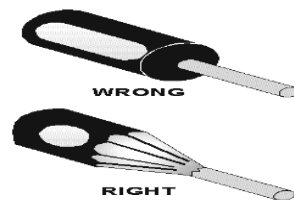


Figure 1. 1. Knife Stripping

1.1.2. Types Of Splices

There are six commonly used types of splices. Each has advantages and disadvantages for use.

A. Western Union Splice:-The Western Union splice joins small, solid conductors.

The steps in making a Western Union splice:

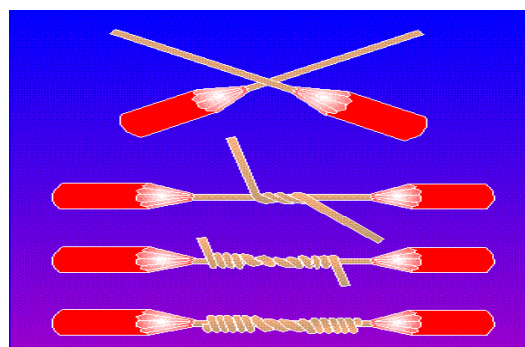


Figure 1. 2 Western Union splice

Procedure:

- Prepare the wires for splicing. Enough insulation is removed to make the splice. The conductor is cleaned.
- Bring the wires to a crossed position and make a long twist or bend in each wire.
- Wrap one end of the wire and then the other end four or five times around the straight portion of each wire.
- Press the ends of the wires down as close as possible to the straight portion of the wire. This prevents the sharp ends from puncturing the tape covering that is wrapped over the splice.

B. Staggering Splices

Joining small multi-conductor cables often presents a problem. Each conductor must be spliced and taped. If the splices are directly opposite each other, the overall size of the joint becomes large and bulky. A smoother and less bulky joint can be made by staggering the splices.

Figure below shows how a two-conductor cable is joined to a similar size cable by using a Western Union splice and by staggering the splices. Care should be taken to ensure that a short wire from one side of the cable is spliced to a long wire, from the other side of the cable. The sharp ends are then clamped firmly down on the conductor. The figure shows a Western Union splice, but other types of splices work just as well.

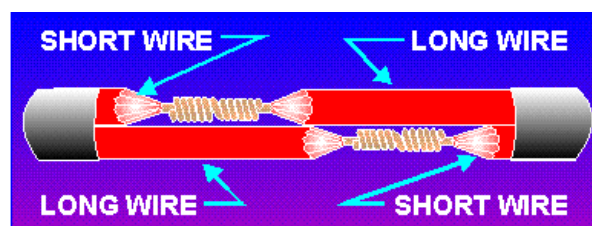


Figure 1. 3. Staggering splices

1.1.3. Rattail/Pig tail Joint

A splice that is used in a junction box and for connecting branch circuits is the rattail joint. Wiring that is installed in buildings is usually placed inside long lengths of steel

or aluminum pipe called a conduit. Whenever branch or multiple circuits are needed, junction boxes are used to join the conduit. To create a rattail joint, first strip the insulation off the ends of the conductors to be joined. You then twist the wires to form the rattail effect. This type of splice will not stand much stress.

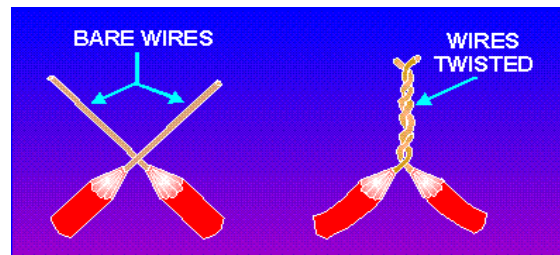


Figure 1.4:- Rattail/pig tail joint

A. Fixture Joint

The fixture joint is used to connect a small-diameter wire, such as in a lighting fixture, to a larger diameter wire used in a branch circuit. Like the rattail joint, the fixture joint will not stand much strain.

The steps in making a fixture joint.

- The first step is to remove the insulation and clean the wires to be joined.
- After the wires are prepared, the fixture wire is wrapped a few times around the branch wire. The end of the branch wire is then bent over the completed turns.
- The remainder of the bare fixture wire is then wrapped over the bent branch wire.
- Soldering and taping completes the job.

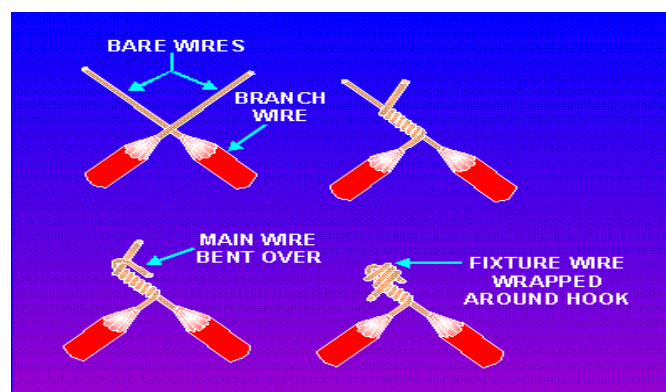


Figure 1. 5:- Fixture joint

B. Knotted Tap Joint

All the splices discussed up to this point are known as butted splices. Each was made by joining the free ends of the conductors together. Sometimes, however, it is necessary to join a branch conductor to a continuous wire called the main wire. Such a junction is called a tap joint.

The main wire, to which the branch wire is to be tapped, has about 1 inch of insulation removed. The branch wire is stripped of about 3 inches of insulation.

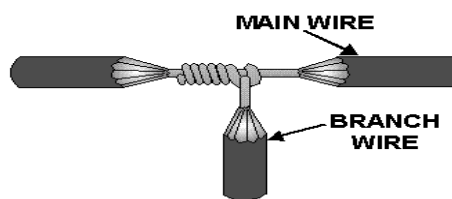


Figure 1. 6:-Knotted tap joint

The branch wire is laid behind the main wire. About three-fourths of the bare portion of the branch wire extends above the main wire. The branch wire is brought under the main wire, around itself, and then over the main wire to form a knot. The branch wire is then wrapped around the main conductor in short, tight turns; and the end is trimmed off. The knotted tap is used where the splice is subject to strain or slippage. When there is no strain, the knot may be eliminated.

C. Wire Nut and Split Bolt Splices

The wire nut is a device commonly used to replace the rattail joint splice. The wire nut is housed in plastic insulating material. To use the wire nut, place the two stripped conductors into the wire nut and twist the nut. In so doing, this will form a splice like the rattail joint and insulate itself by drawing the wire insulation into the wire nut insulation.

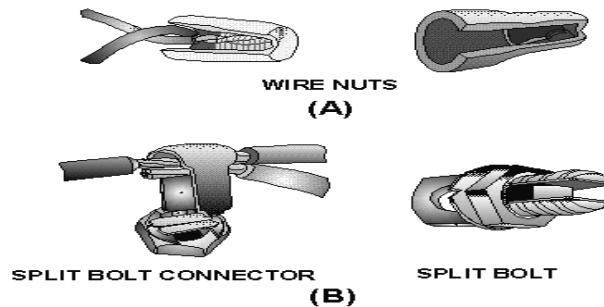


Figure 1. 7:- Wire nut and split bolt splices.

The split bolt splice (view B) is used extensively to join large conductors. In the illustration, it is shown replacing the knotted tap joint. The split bolt splice can also be used to replace the "buted" splices mentioned previously when using large conductors.

D. SPLICE INSULATION

The splices we have discussed so far are usually insulated with tape. The following discussion will cover some characteristics of rubber, friction, and plastic insulation tapes

E. Rubber Tape

Latex (rubber) tape is a splicing compound. It is used where the original insulation was rubber. The tape is applied to the splice with a light tension so that each layer presses tightly against the one beneath it. This pressure causes the rubber tape to blend into a solid mass. Upon completion, insulation similar to the original is restored.

In roll form, there is a layer of paper or treated cloth between each layer of rubber tape. This layer prevents the latex from fusing while still on the roll. The paper or cloth is peeled off and discarded before the tape is applied to the splice.

The rubber splicing tape should be applied smoothly and under tension so no air space exists between the layers. Start the first layer near the middle of the joint instead of the end. The diameter of the completed insulated joint should be somewhat greater than the overall diameter of the original wire, including the insulation.

F. Plastic Electrical Tape

Plastic electrical tape has come into wide use in recent years. It has certain advantages over rubber and friction tape. For example, it can withstand higher voltages for a given thickness. Single thin layers of certain plastic tape will withstand several thousand volts without breaking down. However, to provide an extra margin of safety, several layers are usually wound over the splice. The extra layers of thin tape add very little bulk. The additional layers of plastic tape provide the added protection normally furnished by friction tape.

G. Terminal Lugs

Since most cable wires are stranded, it is necessary to use terminal lugs to hold the strands together to aid in fastening the wires to terminal studs. The terminals used in electrical wiring are either of the soldered or crimped type. Terminals used in repair work must be of the size and type specified on the electrical wiring diagram for the particular equipment

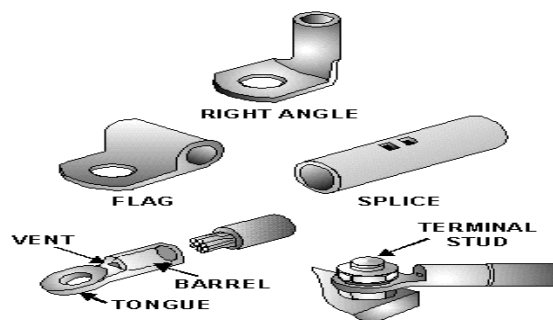


Figure 1. 8. None insulated terminal lugs and splices.

1.2. Basic safety practice

Definition: - Follow OH&S 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).

1.2.1. Personal Protective Equipments

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. Safety signs such as those shown at Fig. below are useful reminders of the type of Safety signs





Figure 1. 9 Safety symbols and Tags

1.2.2. Protective Equipment

Personal Protective Equipment (PPE) that might be needed for protection against electric shock includes but is not limited to:

- Nonconductive hard-hats, gloves, and foot protection or insulating mats^[SEP]
- Eye and face protection whenever there is danger from electric arcs or flashes^[SEP]
- Insulated tools or handling equipment^[SEP]
- Protective shields and barriers to protect against electrical shock and burns

1.2.3. Workplace Electrical Safety Tips

- Plan every job and think about what could go wrong.
- Use the right tools for the job.
- Use procedures, drawings, and other documents to do the job.
- Isolate equipment from energy sources.
- Identify the electric shock and arc flash, as well as other hazards that may be present.
- Minimize hazards by guarding or establishing approach limitations.
- Test every circuit and every conductor every time before you touch it.
- Use personal protective equipment (PPE) as a last line of defense in case something goes wrong.
- Be sure you are properly trained and qualified for the job.
- Work on electrical equipment and conductors only when de-energized, unless procedures and safeguards have been established to ensure zero exposure for the worker and other people in the area.
- Lockout/tag out and ground (where appropriate) before working on equipment.
- Treat de-energized electrical equipment and conductors as energized until lockout/tag out, test, and ground procedures (where appropriate) are implemented.
- Wear protective clothing and equipment and use insulated tools in areas where there are possible electrical hazards.

Before any work is undertaken on low-voltage (50–1000 V AC) installations, supplies should be isolated and proved dead; the procedure is as follows:

- Identify the circuit or item to be worked on.
- Switch off/isolate and lock off or place warning notices if locking is not available.
- Select a suitable approved voltage indicator and check that it works, on a known supply.
- Test that the circuit or equipment is dead using the tester.
- Recheck the tester on the known supply again.

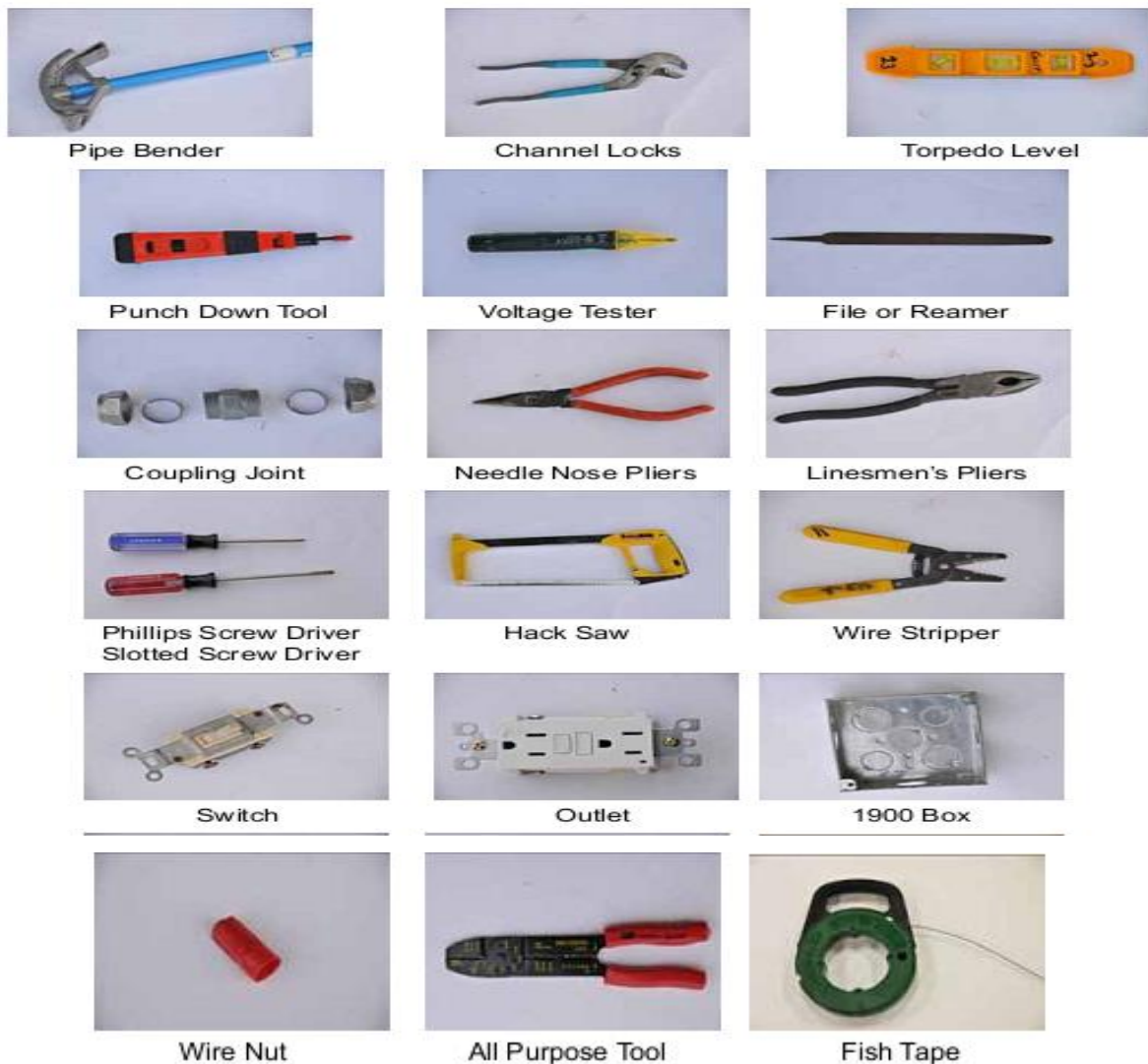
Never assume or take someone else's word that supplies are dead and safe to work on. Always check for yourself.

1.3. Material and equipment

Definition: - 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.

- 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 a 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.



-Figure 1. 10 electrical 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.



Figure 1.11. Pliers

- **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.



Figure 1. 12 Screw Drivers

- **Drilling Equipment**

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



Figure 1. 13 Power Drill

- **Sawing and Cutting Tools**

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



Figure 1. 14 Hack 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.



Figure 1. 15 Soldering Gun

- **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



Figure 1. 16 Boll pin Hammer

- **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.



Figure 1. 17 Measuring Taps

- **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.



Figure 1.18 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.



Figure 1.19 Wire Strippers

- **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.



Figure 1. 20 Insulation 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).



Figure 1.21 Digital Multi-meter

- **Mega-ohmmeters/Insulation Tester**

An insulation tester is an ohmmeter that measures the electrical resistance of insulating components. The tester outputs a high DC voltage to generate a current through and over the tested insulation. Readings indicate the amount of current escaping from the insulating material. Since meter resistance values can be displayed in mega ohms, devices are also called mega ohmmeters



Figure 1. 22 Insulation Tester

- **Ammeter (Analog)**

An ammeter (from Ampere Meter) is a measuring instrument used to measure the current in a circuit. Electric currents are measured in amperes (A), hence the name. Instruments used to measure smaller currents, in the milliampere or microampere range, are designated as milliammeters or micro ammeters. Early ammeters were laboratory instruments which relied on the Earth's magnetic field for operation. By the late 19th century, improved instruments were designed which could be mounted in any position and allowed accurate measurements in electric power systems.



Figure 1. 23 Ammeter (Analog)

- **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).



Figure 1. 24 A voltmeter (Analog)

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- **Drill**

A **drill** is a [tool](#) with a rotating [drill bit](#) used for [drilling](#) holes in various materials.

Drills are commonly used in [woodworking](#), [metalworking](#) and construction.



Figure 1.25 Portable power drill

A large drill used in construction for drilling out holes needed for the electrical wiring

- Wire stripper/ Electrician Pocket knife
- Soldering Iron
- Solder Sucker
- Terminating lug

- **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 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.

- **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.



Figure 1.26 Digital millimeters

- **Voltmeter**

Historical voltmeter from the physics class

A **voltmeter** is an instrument used for measuring the 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.

Voltmeters are made in a wide range of styles



Figure 1. 27 Voltmeter

- **Wattmeter**

The **wattmeter** is an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit.



Figure 1.28 Wattmeter

- **Electrical Cables**

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

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

Figure 1.28 shows PVC insulated and sheathed cable. The type used for domestic installations.

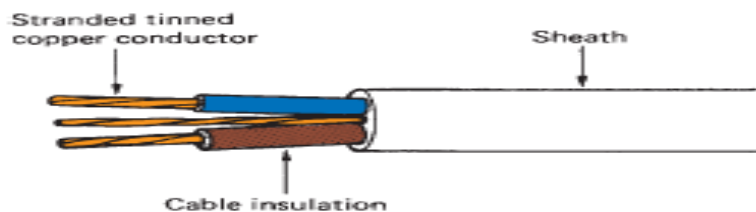


Figure 1.29 PVC insulated and sheathed cable

- **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.

- Wiring Accessories**

Wiring accessories are used for connecting appliances (Fig. 1.10).



Figure 1. 30 wiring accessories

- **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).

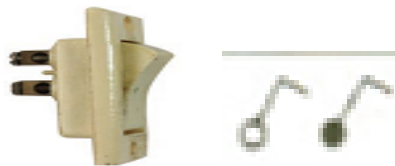


Figure 1. 31 one way switch pictorial diagram and symbol

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.

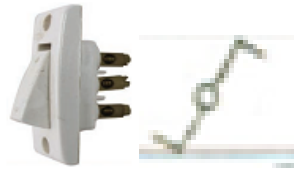


Figure 1. 32 two way switch pictorial diagram and symbol

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.



Figure 1. 33 Intermediate switch pictorial diagram and symbol

(b) Holders: Is used to hold the lamps. A holder is of two types.



Batten holder

Pendant holder

Figure 1.34 types of lamp holders

(c) Ceiling rose: It is used to provide a tapping to the pendant lamp-holder through the flexible wire or a connection to a fluorescent tube.



Figure 1. 35 Ceiling rose

(d) Socket outlet/plug:-The socket outlet has an insulated base with the molded or socket base having three terminal sleeves



Figure 1. 36 Socket out let

(e) **Main switch:** To control the electrical circuit a main switch is used. Through the main switch, the power in a building is controlled completely



Figure 1.37 Main Switch/Main MCB

Cartridge Fuses (BS 1361)

The cartridge fuse breaks a faulty circuit in the same way as a semi-enclosed fuse, but its construction eliminates some of the disadvantages experienced with an open-fuse element. The fuse element is encased in a glass or ceramic tube and secured to end-caps which are firmly attached to the body of the fuse so that they do not blow off when the fuse operates. Cartridge fuse construction is illustrated in Fig. 1.18 with larger size cartridge fuses, lugs or tags are sometimes brazed on the end-caps to fix the fuse cartridge mechanically to the carrier. They may also be filled with quartz sand to absorb and extinguish the energy of the arc when the cartridge is brought into operation.

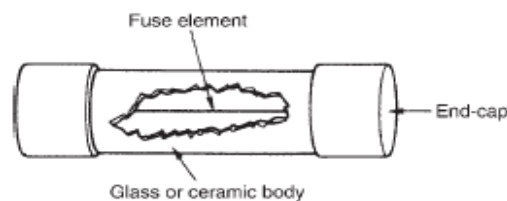


Figure 1.38 Cartridge fuse

Main Circuit Breakers (BS 3871)

The disadvantage of all fuses is that when they have operated they must be replaced. An MCB overcomes this problem since it is an automatic switch which opens in the event of an excessive current flowing in the circuit and can be closed when the circuit returns to normal. An MCB of the type shown in Fig. 1.19 incorporates a thermal and magnetic tripping device. The load current flows through the thermal and the electromagnetic devices in normal operation but under over current conditions they activate and trip the MCB. The circuit can be restored when the fault is removed by pressing the ON toggle. This latches the various mechanisms within the MCB and ‘makes’ the switch contact. The toggle switch can also be used to disconnect the circuit for maintenance or isolation or to test the MCB for satisfactory operation.



Figure 1.39 MCBs Breaker fits Wylex Standard consumer unit, Courtesy of Wylex.

1.4. Relevant Drawing

Many different types of electrical drawing and diagram can be identified: layout, schematic, block, wiring and circuit diagrams. The type of diagram to be used in any particular application is the one which most clearly communicates the desired information.

electrical Diagrams and drawings

Voltmeter Schematic Symbol

The voltmeter symbol (V) is shown in the diagram.

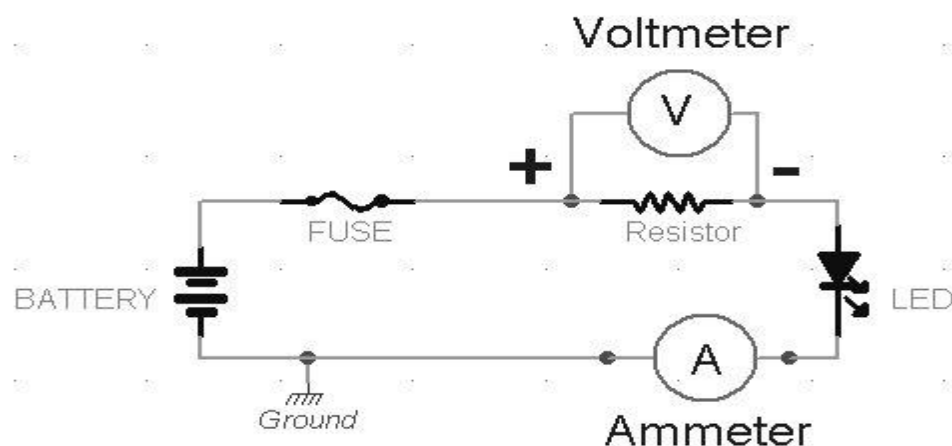


Figure 1.40 Voltmeter Schematic Symbol

Ammeter

- An **ammeter** is a measuring instrument used to measure the electric current in a circuit.
- Electric currents are measured in amperes, hence the name.
- The word "ammeter" is commonly misspelled or mispronounced as "ammeter" or "ammeter" by some. Ammeter Schematic Symbol
- The ammeter symbol (A) is shown in the diagram.

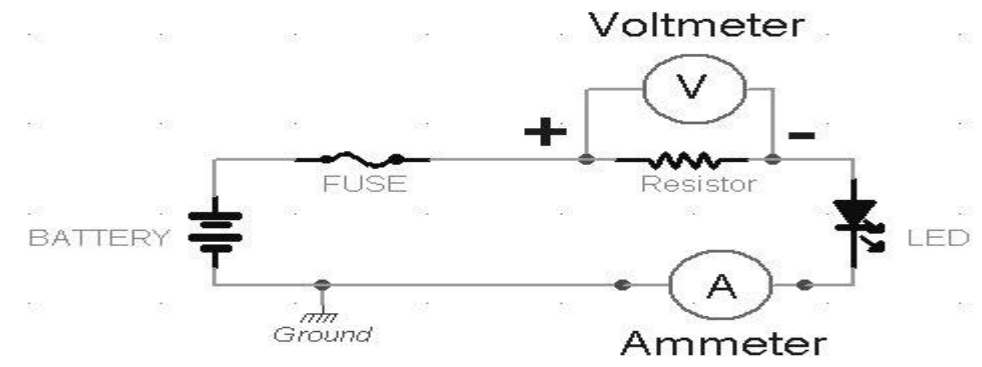


Figure 1.41 Ammeter schematic symbol

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 1.43 shows the block diagram of Light circuit control.



Figure 1.42 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 1.22 shows the wiring diagram for a space heating control system

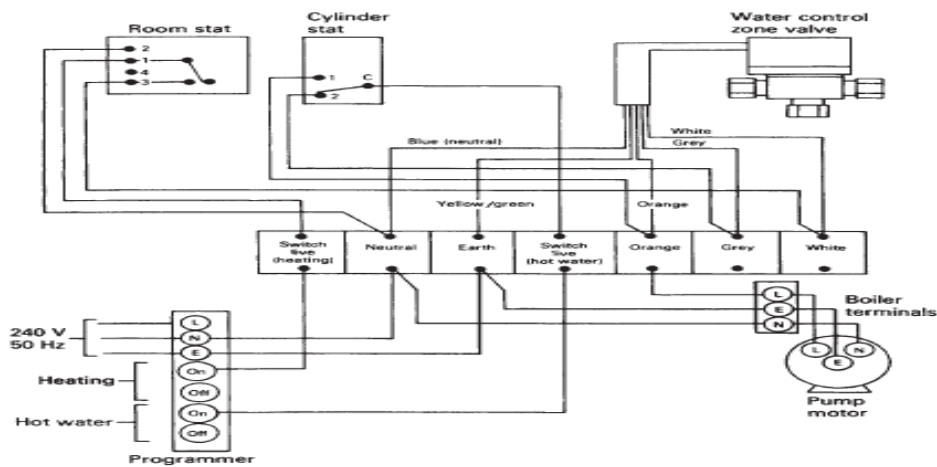


Figure 1.43 Wiring diagram of space heating control system (Honeywell Y. Plan)

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 1.23 shows the circuit diagram of our same space heating control system.

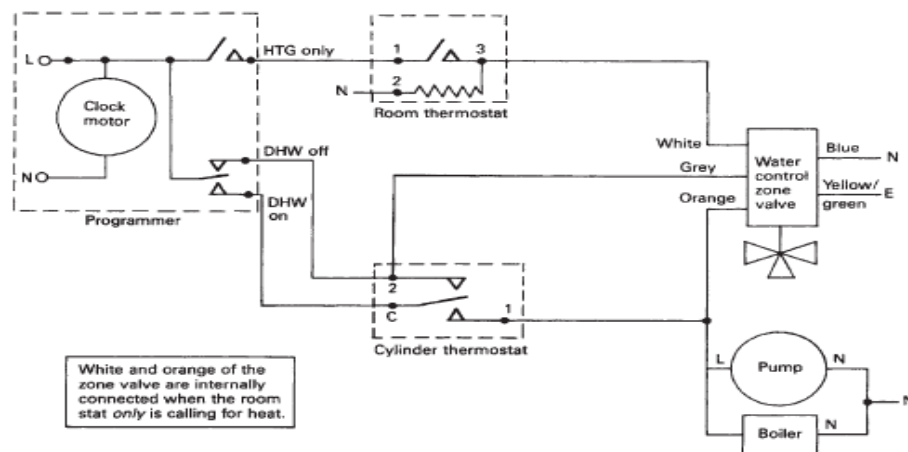


Figure 1.44 Circuit diagram of space heating control system (Honeywell Y. Plan)

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.

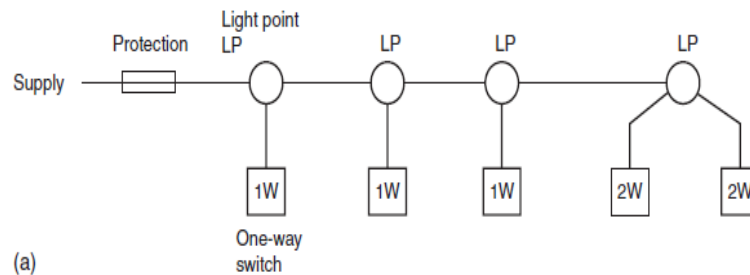


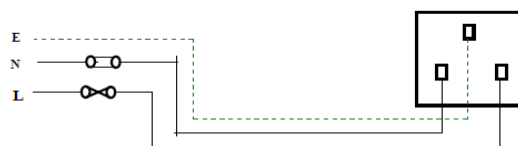
Figure 1. 45 Schematic and wiring diagrams

1.5. Setup work plan

Socket outlet circuits

Radial circuits

Radial circuits are arranged in the same way as lighting layouts, in that each socket outlet is supplied via the previous one (Fig.1.25).



A. Single Socket outlet

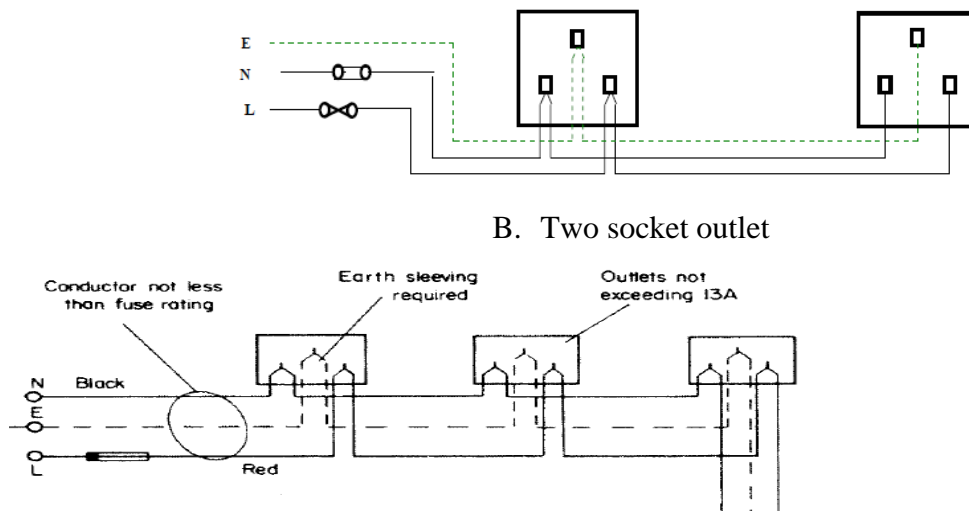


Figure 1. 46 Radial circuits (PVC insulated)

1.6. Potential Hazards

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

a) Terms and Definition used in Types of Health Hazards

Burns:-Most common shock-related injury results in electrical, arc flash, or thermal contact injuries.

Electrocution:- Means to kill with electricity and occurs when a person is exposed to a lethal amount of electrical energy.

Shock:- A reflex response to the passage of electric current through the human body and results when electric current enters the body at one point and leaves through another.

Arc Flash or Arc Blast:- Sudden release of electrical energy through the air that gives off thermal radiation (heat) and bright, intense light that can cause burns. Temperatures have been recorded as high as 35,000 °F.

Fire:- Fixed wiring, such as faulty electrical outlets and old wiring, is the most common cause. Problems with extension and appliance cords, plugs, receptacles, and switches are also responsible.

Explosions:- Can occur when electricity ignites an explosive mixture of materials in the air.

1.6.2. 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.

ii. Why Electric Shocks Occur

a) Unsafe Work Method or Action

- **Undertaking Electrical Work Without Disconnecting the Supply**

Maintenance or circuit testing work done without disconnecting the supply will have a high possibility of electrical shocks occurring.

- **Not Following Safe Work Procedures**

To eliminate the occurrence of electrical shocks, each worker has to always follow safe work procedures which are set by regulations and standards.

b) Defects in the Electrical System

- **Leakage Current**

Leakage currents or earth leakage currents can result in the metallic frames becoming live and energized. This can give rise to the danger of electrical shock to the worker, consumer or the public if they hold or come into contact with the metallic frame.

- **Exposed Conductor or Disconnected Cable**

Exposed conductors or cables which are broken and are alive (energized) can result in electrical shock when touched. The supply source must be immediately isolated or switched off and a report must be made to the responsible entity. The effects of electric shock on the human body depend on several factors. The major factors are:

- a) Current and Voltage
- b) Resistance
- c) Path through body
- d) Duration of shock

Electrocution Dangers

The most common electrocution dangers in the construction industry are:

- Contacting overhead power lines.
- Contacting energized sources, such as live parts, damaged or bare wires, defective equipment, or tools.
- Using extension or flexible cords improperly.

a) Overhead Power Lines

- Overhead and buried power lines are especially dangerous to workers because they carry extremely high voltage ranging from 120 to 750,000 volts. The most reliable way to know a power line's voltage is to ask the utility company that owns the line.

a) Energized Sources

- Electrical shock and burns are the major dangers from contact with energized sources. Electrical shock happens when an individual comes in contact with

- both wires of an electrical circuit
- one wire of an energized circuit and the ground, or
- a metallic part that is energized by contact with an electrical conductor.

b) Improper Use of Cords

Flexible extension cords are more susceptible to damage than fixed wiring because they are exposed and unsecured. Workers create hazards when cords, cord connectors, receptacles, and cord- and plug-connected equipment are not used and maintained properly

1.7. Control Measure

1.7.1. 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.

Safety Steps

Safety requirements have to be followed whenever electrical works are undertaken in a residential building.

I. Personal Safety

- a) Use suitable personal protection equipment as needed such as safety shoes, gloves, safety helmet, etc. when at the work place.
- b) Use safety clothing suitable for the work to be undertaken.
- c) Do not wear jewelry or decorative items such as rings, watches, chains, etc. while carrying out electrical works.

II. Safety at the Work Place

- a. Acquire knowledge about the dangers of electrical works that is to be undertaken and how to deal with those dangers.
- b. Always adhere to the safety regulations which have been set for the work place.

- c. Ensure that the electricity supply is switched off before carrying out the works.
 - d. Acquire the needed knowledge and practice a cautious and calm attitude while working, ensure cleanliness in and around the workplace, do not smoke and always coordinate work with fellow workers.
 - e. While working at elevated places, the worker should always use suitable equipment such as wooden or aluminum ladders, iron scaffoldings or platforms, safety belts or other equipment needed to ensure that the work can be undertaken safely.
 - f. Use electrical equipment which is operational and safe to be used and ensure that the supply for it is being supplied through a residual current device (RCD) with a sensitivity of 30mA.
 - g. Ensure that exposed temporary supply electrical cables have mechanical protection.
 - h. If inflammable or corrosive material is present, necessary safety steps have to be undertaken as required by the relevant safety regulations.
- Risks of electrocution shock or burn due to electrical malfunctions, torn cables and lack of proper insulation or proper earthing .
 - Cracked or broken grinding wheels or cracked blades can cause injuries. E.g. cracked abrasive wheels could fly apart in operation, which could lead to serious injury or death.

1.7.2. 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

A. Warning Signs (these give safety information)

These are triangular yellow signs with a black border and symbol as shown in Fig. 1.26

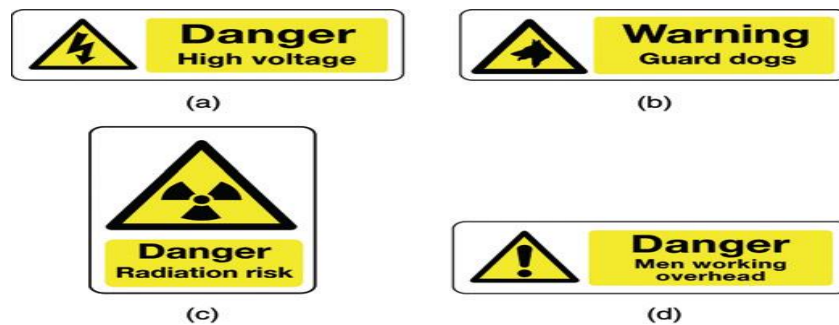


Figure 1. 47 Warning Signs

B. Advisory Signs (these also give safety information)

Advisory or safe condition signs are square or rectangular green signs with a white symbol as shown in Fig.1.27. They give information about safety provision

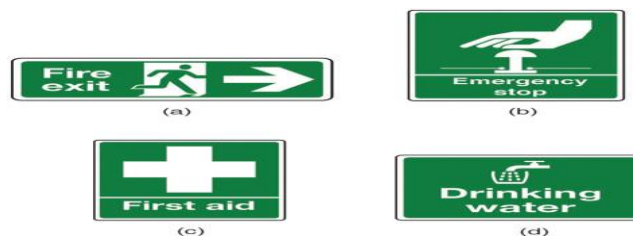


Figure 1. 48 Advisory or Safe Condition Signs

1.8. Working area

1.8.1. Cleaning Work area

Definition of Cleaning work area

Housekeeping is not limited to keeping the place clean; it is also concerned with keeping equipment and materials in good repair and in their proper place. Good housekeeping is essential to preventing losses or injuries. Every injury caused by housekeeping can be prevented if everyone helps to keep the work area clean.

Cleanliness gives rise to a good character by keeping body, mind, and soul clean and peaceful. Maintaining cleanliness is the essential part of healthy living because it is the cleanliness only which helps to improve our personality by keeping clean externally and internally

Classification of cleaning methods

- Mechanical-by machine or human action or both
- Chemical
- Combination of both mechanical and chemical
- Heat and Steam (sterilization).

1.8.2. Purpose/use Cleaning work area

Experts recommend that you work on educating your workers on the importance of maintaining a clean and hygienic office space. An unclean work environment is an excellent breeding ground for various germs and allergens, which only emphasizes the need to keep it clean at all times

1.8.3. Necessary tools and equipment for Cleaning work area

Selection of cleaning equipment Cleaning equipment covers a wide range of products and items. The following information is to help you decide which machine you may need to use.

- **Vacuum cleaners:** the vacuum cleaner is the most used piece of electrical cleaning equipment. If it is properly cared for it will become your best friend!



Figure 1.49:- Vacuum cleaners

- **Barrel style:** the barrel vacuum cleaner is named because of its appearance. They are usually on wheels with a flexible hose and have extension tubes with a nozzle attached. The nozzles can be interchanged for different surfaces e.g. a brush nozzle would be used on hard floor, where a flat nozzle would be used on carpet.



Figure 1. 50:- Barrel style

- **Floor scrubbing machines:** a floor scrubbing machine is used for wet scrubbing on hard floors. They vary in sizes and the machine can be either manually operated or automatic.



Figure 1. 51:- Floor scrubbing machines

Self Check-1.1: matching test

Directions: Answer all the questions listed below. You have given 1 Minute for each question. Each question carries 2 Point:

A

1. Western union
2. Stripping
3. Rat/Pig tail
- 4 Tap splice
- 5 splicing

B

- A. T-splice
- B. used for extension purpose
- C. used for making branch circuit
- D. Removing insulation
- A. connecting wires together

Self Check -1.2: multiple choices

Directions: Chose the correct answer for the ff question. You are provided 1 minute for each question and each point has 1 Points.

1. When you arrive to troubleshoot a defective machine you should?
 - A. Switch on the start push button switch
 - B.. Open the enclosure and make a visual inspection
 - C. Reset the overload relay
 - D. Talk and inquire the operator
2. A noisy operator of an electric motor is caused by?
 - A..Winding
 - B. Open centrifugal switch
 - C. Rotor and stator touched each other
 - D. Open capacitor
3. A device which is used to removes rough edges of the conduit is called ?
 - A. Bender
 - B. Reamer
 - C. Grinder
 - D. Cutter
4. A piece of personal protective equipment or PPE.
 - A. Prevents heavy equipment
 - B. Prevents injuries

- C. Prevents accident
 - D. Prevents short circuit
5. A ground conductor in a three-way system shall not be protected by a fuse since?
- A. Fuse is expensive
 - B. A blown fuse in the ground conductor will make the circuit unbalance
 - C. Fuse is not necessary
 - D. Fuse will not protect
6. The capacitor can correct power factor because?
- A. It can carry current
 - B. It can charge electricity
 - C. It can handle power factor
 - D. It can create short circuit
7. The standard unit of power is
- A. Volt
 - B. Ampere
 - C. Watt
 - D. Ohm

Operation Sheet -1.1 Installing Wiring system

Operation sheet title: western union splice

Purpose: to wind one form of western union splice

Instructions:- using figure 1.2 on the above . try to make a western union splicing technique.

You have 5 min for the task. And show the task after finishing

Tools and Equipments:- fixable wire 1.5 mm in cross section

Wire cutter

Long nose pliers

Knife

Meter

Soldering gun

solder

Steps for western union splice:

Step 1- Wear safety clothes

Step 2- plan and prepare work place

Step 3- Prepare the wires for splicing

Step 4- Remove enough insulation to make the splice

Step 5- Clean the conductor for splicing.

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Step 6- Bring the wires to a crossed position and make a long twist or bend in each wire.

Step 7- Wrap one end of the wire and then the other end four or five times around the straight portion of each wire.

Step 8- Press the ends of the wires down as close as possible to the straight portion of the wire.

Step 9- Solder the spliced part.

Step 10- wrap part with insulation tape.

Quality Criteria:- the measurement is 30mm and 75 mm splice is measure with 0 tolerance

Preclusions:- protect your fingers from blade injuries

LAP Test 1.1

Task: western union splice

Unit Two: Maintenance

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

- isolations
- minor maintenance
- Handling and maintenance of electrical machinery and tools
- Undertaking minor adjustment
- Reporting 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:

- Install isolation point
- Conducting minor maintenance
- Handle and maintain electrical machineries and tools
- Undertake minor adjustment
- Reporting fault .

2.1. Isolations

Isolations shall be secure throughout the duration of the activity and be adequately tested to prove their effectiveness.

Isolation: a 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 every source of electrical energy.

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

Plant and equipment shall be clearly identified. Isolation documentation shall be developed according to the Permit to Work requirements.

Personnel shall be proven competent in their knowledge and understanding of hazards, the plant and equipment and the skills necessary to effect, prove and remove isolations.

When carrying out isolations the following general rules apply:

- The valves closest to the equipment should be used.
- Some process plant and equipment is potentially dangerous if valves that are part of the isolation scheme are not operated in the correct sequence.
- Do not block in Pressure Safety Valves until the equipment or vessel is depressurized and adequate vents are open to prevent over pressurizing equipment.
- Ensure that no gas or liquid is trapped in sections that do not have pressure protection or thermal release. In certain circumstances pressure build up due to increase in ambient temperature can lead to catastrophic failure of equipment.

2.2. Conducting Minor maintenance

2.2.1. Maintenance and inspection program

The key to safe maintenance is putting in place a maintenance program, integrating safety and health aspects of maintenance and including inspection, reporting and record keeping procedures. Records must be kept to provide information for planning maintenance and replacement activities so that they occur at the proper time. Proper maintenance management of equipment requires a detailed inventory of all major items, including among other things information on

manufacturer, model, year and number, and a list of the parts required for normal service and major repairs respectively.

An important part of the maintenance program is the inspection program setting out the frequency of formal inspections to be carried out by competent and trained maintenance technicians.

A. Portable tools must be checked:

- Before the tool is put into use for the first time
- After servicing and changing parts
- At regular intervals appropriate for each tool.

The period between inspections can vary, depending on the type of tool, the conditions of use and the environment. In Germany there are technical rules and accident prevention regulations that give advices on how to identify and set maintenance intervals for powered portable tools.

2.3. Handling and maintenance of electrical machineries and equipments

2.3.1. 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.

- 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.



Figure 2. 1 Cleaning dust

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- ii. 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.



Figure 2.2 Checking the cord

- iii. . 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.

- i. 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.
- ii. 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.
- iii. 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.



Figure 2.3 Tool Kit

Handling of electrical hand tools without damage means the way work of keeping something in proper condition. This would imply that maintenance should be actions taken to prevent a device or component from failing or to repair normal equipment degradation experienced with the operation of the device to keep it in proper working order. Properly maintained tools help improve efficiency of operation while minimizing opportunities for injuries and extending tool life. Time spent in tool maintenance (sharpening, cleaning, lubrication etc.) is time well spent. Prior to use, always inspect the tools for defects or damage. Check for loose, bent, or cracked tool handles, mushroomed tool heads, sprung tool joints or worn teeth. If a hand tool fails the initial inspection, inform the crew leader, tag the tool clearly as “defective”, and remove it from service. Allow adequate time at the end of each work day to clean the tools and properly pack and secure for transportation or storage.

2.3.2. Maintaining electrical hand tools .

A. Handling of electrical hand tools /Maintenance/ should be:

- Keep metal blades of all tools sharp and well-oiled.
- Check for loose and worn out parts on tools regularly, and replace if necessary.
- Identify damaged tools and store them in a designated location to allow either the supervisor or maintenance person to arrange for their repair.
- Workers should know that the job is not complete until the tools are cleaned and stored in a designated location.

B. There are four principal causes of electrical failure:

- Dust and dirt accumulation; moisture.
- Loose connections; and friction of moving parts.
- An effective maintenance program should aim to minimize these effects by keeping equipment clean and dry, keeping connections tight and minimizing friction.

C. Visual Checks Are Carried Out As Follows:

For Tools/appliance

- On/off switch is working correctly
- No signs of damage to casing
- No loose parts or missing screws

- Live parts are properly guarded so as not to be inadvertently accessible
- Ensure equipment is disconnected when not in use

For Cables

- Securely anchored to the plug with no signs of cuts, frays, brittleness, leads kinked or coiled, taped joints, overloading (overheating indicated by color change or smell), cable cores not externally visible.
- **Plug:** Securely anchored no sign of cracked casing, overheating, loose or bent pins.

2.4. Under taking minor adjustment

Circuit Faults and Testing

Circuit faults are conditions that can cause a circuit to not function properly or not function at all. Vibration issues are common causes of problems in manufacturing wiring. Diagnosing problems related to these and other causes requires more than just knowledge of how the circuit operates. Effective diagnosing requires a logical approach to solving and correcting problems.

Circuit Faults: A circuit fault is something that causes a circuit to not operate as it was designed. The results of circuit faults range from very basic, such as a burned-out light bulb, to complex. Regardless of the type of fault or the circuit affected, diagnosis requires a logical and systematic

approach. Begin by determining what type of fault you are dealing with. faults you may encounter: open circuits, short circuits, and unwanted resistance. Each has its own symptoms and diagnostic procedures.

Replacing a Connector. Sometimes a connector is damaged and requires replacement. Replacement connectors are available for many applications, making replacing a damaged connector easy and economical.

Replacing a Terminal. Over time, the terminal connection can weaken due to fretting and from being

repeatedly disconnected and reconnected. Fretting is the term that applies to the movement of the connectors against each other due to thermal cycling.

2.5. Reporting faults

2.5.1. Concepts of reports

A **report** is a part of a documentation which is sharp and short and specially written for a particular purpose and audience. A report consists of specific and important information which is analyzed and applied to a particular problem or issue, often making recommendations for future action.

A. Characteristics of reports

Requirements and content of a report may vary business to business and departments to a department. Thus, to understand the information that written, a report has possessed the following;

- Clear and well-structured format
- Provides a brief of instruction and guideline
- Outline of the purpose of report, audience, and issue or problems.
- Easy to locate and follow.

2.5.2. Reporting emergency situations

An emergency is a situation that poses an immediate risk to health, life, property, or environment. Reporting emergency situations are rare but do occur, so having a plan for handling them is helpful. If the practitioner(s) believe his/her client is in imminent danger of killing or injuring themselves or another person,

- Phone the local police or emergency services immediately
- Stay with the person until help arrives
- Ask what is the root cause of emergency situation
- If the root cause is being known:
 - Instruct the client to give the object to someone for safekeeping
 - Discuss who can be notified of the risk and weapon and follow up
 - Listen, but do not judge, argue, threaten, or yell

2.5.3. Inspection Report

Inspector will prepare a formal report to document the inspection findings. This report will consist of the completed checklist.

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All inspection reports will contain the information and be presented in the format described as follows. (See Attachment C for an example report format):

- **Heading** - This indicates the type of inspection performed, e.g., joint air compliance overview inspection report
- **Facility Identification** - This includes the name, location, telephone number, Airs Facility Subsystem (AFS) Plant I.D., the date of the inspection and the regional office conducting the inspection.
- **Participants** - This section includes the name, title and affiliation of each participant.
- **Inspection Procedures** - This section briefly describes the activities conducted during the inspection.
- **Process/Facility Description** - This section should contain a description of the process including the Standard Industrial Classification (SIC) number and a description of the facility, its process and air pollution control equipment. The detail included will depend on the facility inspected and the extent to which information is current and available in the files from previous inspections. Applicable previous inspection information should be referenced.

Self Check 2.1: written test

Directions: choose the best answer all the questions listed below.

1. Which of the following is not **correct** for Storing tools safely in appropriate locations?
 - A. Keep Each Tool In Its Proper Storage Place.
 - B. Keep Your Tools In Good Condition
 - C. Do not Keep Your Tool Set complete
 - D. Never Use Damaged Tools
2. Which one of the following **is not true** for clearing work station ready.
 - A. Clean the tools immediately after use.
 - B. Don't Wash the tools using water.
 - C. Avoid the risk of spreading pathogens while the tools are being cleaned.
 - D. Coat the blades with light oil like WD-40 on areas prone to rust.
3. Which one of the following **is true** when working on electrical circuits
 - A. Before you begin a task, ask yourself:
 - B. What could go wrong?
 - C. Do I have the knowledge, tools, and experience to do this work safely?
 - D. All
4. A safe work environment is not enough to control all electric hazards.
 - A. True
 - B. False
5. Tool boxes are **NOT** used for storing tools
 - A. False
 - B. True

Self check 2.2:- written test

Directions: Answer all the questions listed below.

I. Say "TRUE" if the statement is correct and say "FALSE" if the statement is Incorrect

1. You must keep a record of any reportable injury, disease or dangerous occurrence for three years
2. A report is **not** a part of documentation.
3. Specified dangerous occurrences, which may not result in a reportable injury.

4. The ‘responsible person’ has the duty to notify and report.
5. Inspector will **not** prepare a formal report to document the inspection findings.

Operation Sheet -2.1: using electrical measuring instruments to identify circuit problems

Operation Sheet Title :- measuring voltage, resistance and currents flow in a circuit

Purpose:- to measure voltage drop, resistance and current fluctuation

Instruction:- use digital multi-meter Applying for measuring instruments/Test Equipment’s in electronics hand tools

Tools and equipment:- digital multi meter, Pen and paper

Steps in doing the task

Steps 1 - Measuring tools and instruments which are selected as per object to be measured.

Step 2 - Adjust the range of the Instrument to measure current, voltage and resistance and else

Step 3 - Measurements is obtained according to job requirements performed.

Step 4 - calculation of resistance, current, and voltage using Ohms Law are obtained.

Quality Criteria:- display the setup and quantity measured

Precaution:- don’t adjust the pointer for volt to resistor and current

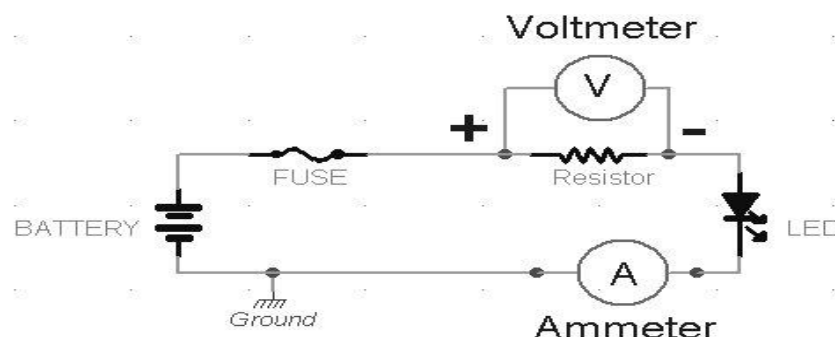
LAP Test 2.1

Instruction: Do the following task from the schematic diagram given below

Task:1 Measure the voltage

Task:2. Measure the current

Task:3. Measure the resistance



Unit Three: Notifying final work quality

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

- Report to responsible person
- Final checks
- Clear and restore secure work area

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:

- Reporting to responsible person
- Conducting final checks
- Clearing and restoring secure work area

3.1 . Reporting to responsible person

3.1.1. Quality of Work and Completion.

All work to be done in the course of the electrical installation will be done in a good manner, free from material defect or fault. The maintenance technician will promptly and punctually achieve Completion of the Project within the time frames represented to supervisor as set forth in the maintenance Schedule, but in all events prior to the Completion Date there.

Completing works are noticing to the responsible person after recognizing maintenance record, job cards and check sheets and finally report and documenting the record.

3.1.2. Maintenance Records

Maintenance record, as name suggests, is a document that includes information regarding each repair and maintenance work that is done on asset or equipment. In simple words, it keeps tracks of assets failures and repairs. It is one of best way to maintain health and safety management.

Record all information during maintaining/repairing electronically-controlled domestic appliance. This recorded Service information may include but not limited to:

- job report sheets
- job order
- bill of materials
- customer index
- service flowchart
- stock and inventory record

The Organizational Unit is to keep testing and inspection records which are to be stored on a shared system drive.

- Complete, accurate, and current documentation is essential to an effective maintenance program. Whether performing preventive, predictive, or reliability centered maintenance, keeping track of equipment condition and maintenance—performed and planned—is critical.

- The maintenance recordkeeping system must be kept current so that a complete maintenance history of each piece of equipment is available at all times. This is important for planning and conducting an ongoing maintenance program .
- Regular maintenance and emergency maintenance must be well documented as should special work done during overhauls and replacement. The availability of up-to-date drawings to management and maintenance staff is extremely important. Accurate drawings are very important to ongoing maintenance, testing, and new construction; but they are essential during emergencies for troubleshooting. In addition, accurate drawings are important to the continued safety of the staff working on the equipment.

Service manual is the full written information provided by the manufacturer regarding the equipment. This service manual usually accompanies the equipment at time of purchase.

A service manual consists of some or all of the f/f

1. Safety & precautionary measures during disassembling
2. Dismantling or blow-up diagram
3. Block diagram of the equipment
4. Circuit diagram
5. PCB lay out
6. Parts-list
7. Service manual/schematic diagram/parts list

A. 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 in table 3.1

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Table 3.1 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			Office use	
.....		
.....		
.....		
Site supervisor or F.B. Electrical Representative responsible for carrying out work						
Signature of person approving work and status e.g.						
Client <input type="checkbox"/>	Architect <input type="checkbox"/>	Q.S. <input type="checkbox"/>		Main contractor <input type="checkbox"/>	Clerk of works <input type="checkbox"/>	
Signature						

B. 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.

3.1.1. Job Cards

A job sheet or job card such as that shown in Fig. 3.1 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.

JOB SHEET	FLASH-BANG ELECTRICAL
Job Number	
Customer name	
Address of job	
.....	
.....	
Contact telephone No.	
Work to be carried out	
.....	
.....	
.....	
Any special instructions/conditions/materials used	

Figure3.1 Typical Job Card

3.1.2. Report and Documentation

A. **Report** is a part of a documentation which is sharp and short and specially written for a particular purpose and audience. A report consists of specific and important information which is analyzed and applied to a particular problem or issue, often making recommendations for future action.

B. Characteristics of reports

Requirements and content of a report may vary business to business and departments to a department. Thus, to understand the information that written, a report has possessed the following;

- Clear and well-structured format
- Provides a brief of instruction and guideline
- Outline of the purpose of report, audience, and issue or problems.

- Easy to locate and follow.

C. Reporting emergency situations

An emergency is a situation that poses an immediate risk to health, life, property, or environment. Reporting emergency situations are rare but do occur, so having a plan for handling them is helpful. If the practitioner(s) believe his/her client is in imminent danger of killing or injuring themselves or another person,

- Phone the local police or emergency services immediately
- Stay with the person until help arrives
- Ask what is the root cause of emergency situation
- If the root cause is being known:
 - Instruct the client to give the object to someone for safekeeping
 - Discuss who can be notified of the risk and weapon and follow up
 - Listen, but do not judge, argue, threaten, or yell

D. Inspection Report

Inspector will prepare a formal report to document the inspection findings. This report will consist of the completed checklist.

All inspection reports will contain the information and be presented in the format described as follows.

- **Heading** - This indicates the type of inspection performed, e.g., JOINT AIR COMPLIANCE OVERVIEW INSPECTION REPORT
- **Facility Identification** - This includes the name, location, telephone number, AIRS Facility Subsystem (AFS) Plant I.D., the date of the inspection and the regional office conducting the inspection.
- **Participants** - This section includes the name, title and affiliation of each participant.
- **Inspection Procedures** - This section briefly describes the activities conducted during the inspection.
- **Process/Facility Description** - This section should contain a description of the process including the Standard Industrial Classification (SIC) number and a description of the facility, its process and air pollution control equipment. The detail included will depend on the facility inspected and the extent to which information is current and available in the files from previous inspections. Applicable previous inspection information should be referenced.

- **Discussion of Inspection Procedures** - This section contains discussion of the specific inspection procedures used by the state/local inspector. This section should include specific procedures used by the state/local inspector and comments on those procedures. Any problems, discrepancies and deficiencies, as well as positive aspects should be discussed. The discussion should be based on observations of the inspector's activities and the information contained on the Joint Overview Air Compliance Inspection and Report Checklists.
- **Summary/Recommendations** - This is based upon the previous sections and should include conclusions which can be made about the state/local agency inspector's activities and state/local agency inspection policies. Both positive and negative comments should be included. Also discuss any influence your actions might have had on the state/local inspector's inspection. This section should be oriented toward improving the state/local agency's air compliance inspections.
- **Signatures** - The inspector will sign the report. The date signed will be included, e.g.: (Inspector's Name) Environmental Engineer and Date:
- **Attachments** - These are identified by a number (e.g., Attachment 1) and placed in numerical sequence in the report. They may include: (1) Joint Air Compliance Overview

3.2. Final Checks

Introduction to Testing

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.

a) Protection Conductor Continuity Test

- To ascertain that all protection conductors are connected in the correct and effective manner.
- Test equipment – Multi-meter (Ohm range) or Ohm meter.
- Test Method:
 - Ensure that the main switch, RCD and MCB are open circuited (switched off) and all loads are disconnected;
 - Connected the test leads as in the **Figure 3.2**
 - The meter reading shall be less than 1 ohm.

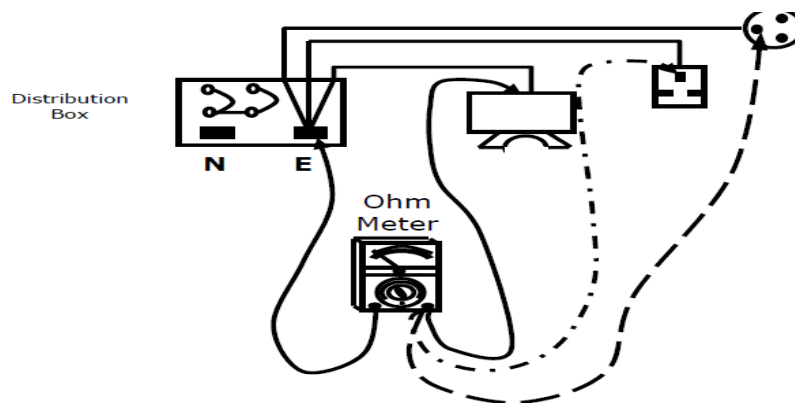


Figure3.2 Protection Conductor Continuity Test

b) Final Ring Circuit Conductor Continuity Test

- To ensure that all conductors around the ring circuit have continuity;
- Test Equipment :- Multi-meter (Ohm range) or Ohm Meter
- Test Method:
 - Disconnect both the supply source live conductors from the MCB, the neutral conductor from the neutral terminals and the earth conductor from the earth terminal in the distribution fuse box;
 - Connect the test leads as in the Figure 3.3.(EE);
 - Repeat the procedure for (L-L) and (N-N);
 - The meter reading value shall be less than 1 ohm.

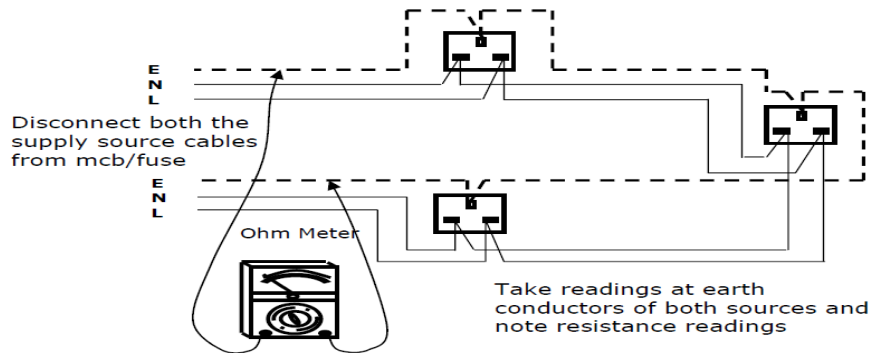


Figure3.3 Final Ring Circuit Conductor Continuity Test

c) Live and Neutral Conductor Continuity Test

- To ensure that each conductor in the circuit has continuity;
- Test Equipment – Multi-meter (Ohm range) or Ohm Meter
- Test Method:
 - Switch off the Main switch, RCD and MCB;
 - Disconnect all loads;
 - Switch on all switches in the circuit;
 - Disconnect the fuses/final circuit breakers and close the circuit;
 - Carry out the test as shown in Figure 4.3
 - The meter reading value shall be less than 1 ohm.

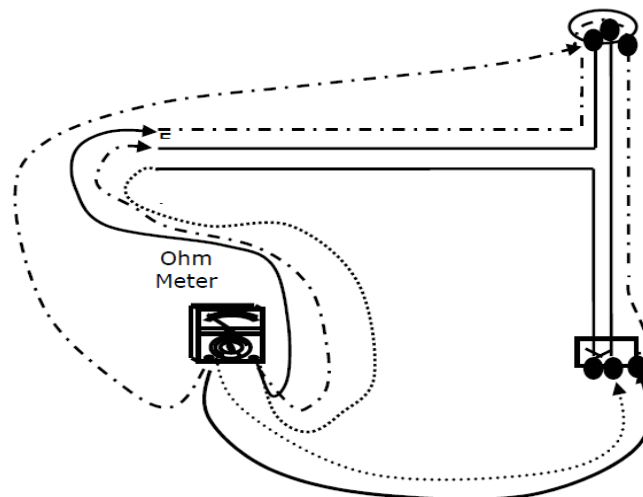


Figure3.4 Live and Neutral Conductor Continuity Test

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.

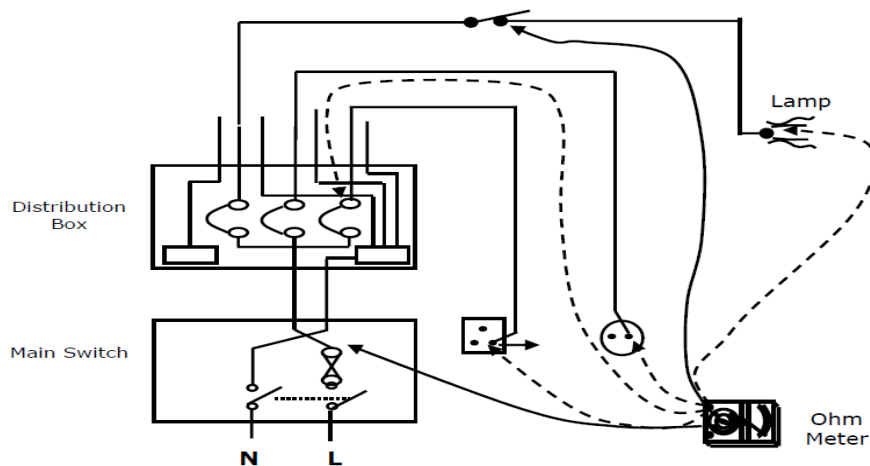


Figure3.5 Polarity Test



Figure3.6 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. While carrying out inspection and testing of internal wiring installations, following point's correction action must be carried out.

Correction action for Electrical wiring and enclosures tested and inspected

- Tester or inspector Name: ----- Date: -----
- Types of tested and inspected circuit: _____
Location/Client: _____
- Installation type (New/addition/alteration of exist installation): _____

N o	Inspecting and Testing activities	Correction Action for Inspected and Tested activities
A	Inspecting	After Inspection
1	All mechanical connections are tight, as factory connections may loosen during shipment and storage.	Check and retighten all mechanical connections
2	All accessible electrical connections are tightened to the torque specifications on the panel labeling.	Check and retighten all All accessible electrical connections
3	All screws connecting and tight switches, breakers, socket outlets, lamps, etc are properly installed and tightened	Check, reinstall and retighten All screws connecting and tight switches, breakers, socket outlets, lamps, etc
4	Connections between branch circuits and breakers are properly secured.	Check and reconnect the connections between branch circuits and breakers
5	All ground connections are properly made (Note: ground wire must be installed after the panel box is mounted on the wall).	Check and reconnect the all ground connections
6	All foreign materials have been removed from the panel and enclosure before installing the dead front and trim.	Check and remove foreign materials from the panel and enclosure

7	Dead front is properly aligned and securely installed.	Check, re-align and re-secure dead fonts
8	Trim is properly mounted and securely installed.	Check, re-mount and re-secure installation
B	Continuity Test	After Continuity Test
1	Conductors are connected in the correct and effective manner.	Check and reconnect the conductors
2	all conductors around the ring circuit have continuity	check and reconnect the ring circuits
3	Live and Neutral Conductor Continuity Test	check and reconnect the Live and Neutral Conductor
C	Polarity test	After Polarity test
1	Each fuse or single pole control and protection device is connected only in the phase conductor.	check and reconnect fuse or single pole control and protection device in the phase wire
2	Intermediate contact of Edison screw lamp holder is connected to the phase conductor	check and reconnect Edison screw lamp holder Intermediate contact to phase conductor
3	phase, neutral and earth conductors at socket outlets are connected at the correct terminals	check and reconnect phase, neutral and earth conductors at socket outlets correct terminals
D	Over all functionality test	After Over all functionality test
1	Light circuits are functional	Check and rewire the light circuit
2	Control and protective devices are functional	Check, reconnect, rewire or replace Control and protective devices
3	General purpose socket outlets are functional	Check, reconnect, rewire or replace General purpose socket outlets
4	Metallic body of electrical devices are grounded	Check, reconnect, rewire and ground the metallic body of electrical devices

Table 3. 2 Electric... Check list (e.g. Refrigerator, washing machine, flat iron)

Part of equipment	condition	
	good	defective
Power cord		
Power switch		
•		
•		

customer's Signature _____ Date Repaired: _____

technician's Signature _____ Date Checked: _____

3.1. Clearing, restoring and securing work area

Leaving unfinished work

If work is left unfinished, you must ensure that the workplace is left in a safe state, so far as reasonably practicable. For example:

- terminate any exposed conductors
- physically secure any exposed conductors or surrounding metal work
- tag and tape off the electrical equipment and the workplace area
- inform affected persons at the workplace the work is not complete and advise of potential hazards
- ensure that the status of switchboards and electrical equipment are clearly and correctly labeled

Self Check: 3.1. Choose the best alternative

1. What is the need of maintenance?
 - A. To keep a machine in a good condition
 - B. To increase working life of a machine
 - C. To avoid sudden break down
 - D. To control accident
 - E. All of the above
2. Preventive maintenance of an equipment?
 - A. Prolongs life
 - B. Keeps the equipment in good condition
 - C. Makes beautiful
 - D. Makes someone safety
3. Maintenance can be defined as
 - A. Is to keeping a machine in existing state
 - B. Reduce down time
 - C. Insure maximum safety during operation
 - D. Reduce cost of maintenance
4. Before inspecting machines, what do you do
 - A. Machine managers need to plan the inspection program.
 - B. Machine managers should determine in advance the scope of the program
 - C. Deciding how to store and manage the volume of data collected during the inspections
 - D. All of above
5. Frequency of inspection may be
 - A. Daily
 - B. Weekly
 - C. Two weeks period
 - D. Monthly
 - E. All of above
6. A Job Sheet or Job Card shows:
 - A. a record of goods delivered by a supplier
 - B. a record of work done which is outside the original contract
 - C. information about work to be done, usually a small job

- D. the actual time spent working on a particular job or site
7. A Day Work Sheet shows:
- A. a record of goods delivered by a supplier
 - B. a record of work done which is outside the original contract
 - C. information about work to be done, usually a small job
 - D. the actual time spent working on a particular job or site
8. A Delivery Note shows:
- A. a record of goods delivered by a supplier
 - B. a record of work done which is outside the original contract
 - C. information about work to be done, usually a small job
 - D. the actual time spent working on a particular job or site
9. A ‘competent’ worker is one who:
- A. cannot do the job or task
 - B. can do the job or task more quickly than anyone else
 - C. is quarrelsome and likely to cause an argument at work
 - D. has been trained to do a job or task successfully

Operation Sheet-3`1:- Techniques of Reporting events to the supervisor

Operation Sheet Title:- reporting the failure of the lathe to the supervisor

Purpose:- to report the cause of the lathe machine failure to the relevant personnel

Instructions:- let one lathe machine in your work shop is stop working completely, but you don't know when it happens. Then Make sure the reliability and validity of Information sources a like who, when and Where and identify the problem involved and report for your shop supervisor.

Tools and Equipment :- Multi meter

Steps:-

Step 1- Provide nature of the incident/action/measures:

Step 2- record the place of the event.

Step 3- Description of suspect involved

Step 4- Injuries that have occur

Step 5- report of any harm involved

Step 6- report of material goods involved

Quality Criteria:- the measurement is done using digital multi meter

Precaution:- adjust the meter for specific voltage

LAP Test 3.1

Task.1. Reporting the failure of the lathe to the supervisor

N o	Name	Qualificati on (Level)	Field of Study	Organization/ Institution	Mobile number	E-mail
1	Meseret W/Mariam	A(MSC)	Manufacturing	Wolkite polytechnic college	0912117416	Bmesi2007@gmail.com
2	Solomon Negtu	A(MSC)	Manufacturing	Harer polytechnic college	0912762152	solonnigatu@gmail.com
3	Kibru getahun	B(BSC)	Manufacturing	M.G.M.B. polytechnic college	0912370975	bmkibru@gmail.com
4	Efrem Kebede	B(BSC)	MAT	BPTC	0910410054	efremkebede27@gmail.com
5						
6						
7						

List of Reference Materials

1. Electrical installation designs _2nd_edition, Bill Atkinson
2. Introduction to Electrical installation work, Trevor Linsley
3. Electrical installation Handbooks, 3rd edition, Gunter G. seip
4. Handbook of Electrical installation Practice, 4th edition, Geoffrey Stoke
5. Electrical installation Work, 4th edition , Brain Scaddan