FOUNDRY WORKS

LEVEL – I

Based on March, 2022 Curriculum Version 1

Module Title: Apply Basic Electrical Practices

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Acronyms

DC- Direct current

AC-Alternative current

MSB-Main switch board

ANSI-American National Standards Institute

QC- Quality Control

LAP- Learning activity performance

MW- Mega watt

Introduction to Applying Basic Electrical Practices

In the field of Foundry, Electricity is a useful and powerful tool in our daily life. Everything around us works with electricity such as lamps, TVs, computers, mobile phones and DVD players. Today, electricity has become such an essential part of our life that it is difficult to imagine life without it.

However, electricity is very dangerous. It can cause shock, burn or kill you. Electricity can also damage sensitive devices. This module covers the basic safety rules and practices that apply at home, outdoor, labs and workshops. Electricity is generated from different sources such as power stations, wind turbines, water power, solar power and battery power.

Module units

- Prepare for work
- Minor maintenance
- Work quality

Learning objectives of the Module

At the end of this session, the students will able to:

- Prepare for work
- Conduct minor maintenance
- Notify work quality

Module Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Unit one: Prepare for work

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

1. Basic electrical work requirements
2. Occupational health and safety(electrical)
3. Materials and equipment
4. Work plans and drawing
5. Potential hazards and prevention.
6. Prepare work areas

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:

1. Identify basic electrical work requirements
2. Identify occupational health and safety(electrical)
3. Select materials and equipment
4. Interpret work plans and drawing
5. Identify potential hazards and prevention
6. Prepare work areas

1.1 basic Requirements for Electrical Work

IFS (infrastructure and facilities service) will oversee these general requirements which will apply to managing electrical equipment safely:

- 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 i.e., TEST before touch;
- 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 and 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;

IFS will have a plan for the maintenance of electrical equipment and installations which will be compliant with manufacturer's instructions.

- When someone wants to strengthen existing relationships and build new ones that will promote successful community development in the future.

1.1.1 Installing electrical Wiring systems

A wiring system is defined in BS 7671 as 'an assembly made up of cable or bus bar sand parts which secure, and if necessary, enclose, the cable or bus bars. A description of a wiring system includes the type of cable (or bus bar) and how it is supported and protected.

It is conventional to recognize three types of circuit: mains, sub mains and final, with which experience tends to associate certain types of wiring system. A main circuit feeds a distribution board located at the center of a group of loads or it may feed a single large load.

In extensive installations it may be appropriate to divide the circuit's further using sub mains which connect a main distribution board to smaller boards more convenient to load groups. In very large installations the main switch board may feed one or more section boards which in

turn feed further distribution boards. Final or wiring circuits connect distribution boards to individual points of utilization. For small installations, such as in most domestic and small commercial premises, it is usual for a distribution board to be located at the supply intake, when it takes the form of a consumer unit, with final circuits going directly to points of utilization.

A network of cables connecting various electrical accessories for distribution of electrical energy from the supplier meter board to the various electrical energy consuming devices such as lamps, fans, radio, TV and other domestic appliances through controlling and safety devices is known as wiring system.

The supplier (i.e., EEPCO) service cable feeding an installation terminates at services fuses (sometimes called service cutouts). Service cutouts including service meter (i.e., energy meter) remains the property of the supplier. The point at which the consumer wiring is connected into the cutout is known as point of commencement of supply or consumers terminals. From consumer terminals onwards the supply cables are under the control of consumers and so lay as per his choice. Fig (1.1) illustrates a typical house wiring.

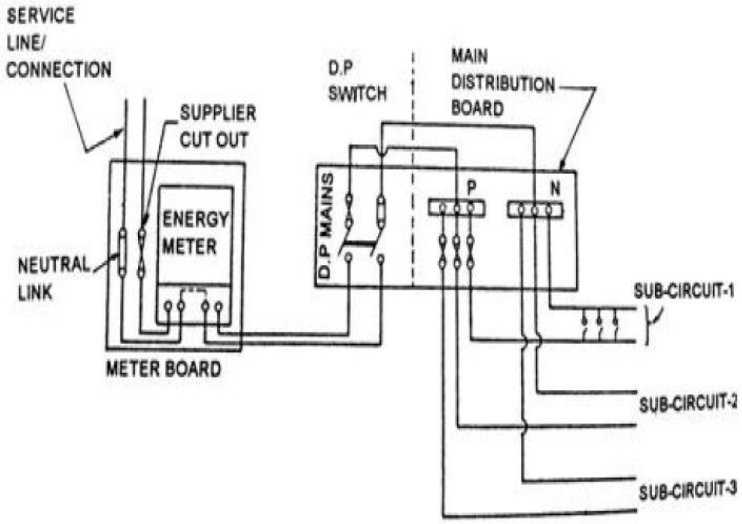

Figure 1.1 Typical House Wiring

Steps for wiring system and installations

Steps	Activities to be carried out
1	Conduit in slab and Junction boxes
2	Conduit in wall, distribution board and out let boxes
3	Pulling gay wire and wiring

4	Splicing, connections and insulating
5	Fixing fixtures (lamps, switches, circuit breakers, socket out lets, junction box covers)
5	Testing & Commissioning
6	Final completion submission of completion drawings Electrical Inspector approval.

1.1.2 Electrical Energy Distribution Systems

As per the recommendations of ISI the maximum number of points of lights, fans and socket outlets cannot be exceed beyond 10 and the maximum load that can be connected in such a circuit is 800 watts. Hence in case of more load or more points to be connected to the supply system, then it is to be done by having more than one circuit through (a) distribution board system and (b) the tree system (c) Joint box system and (d) loop in system.

A. **Distribution Board System:** It is the most commonly adopted system for distribution of electrical energy in buildings. The fuses of all circuits are grouped on a distribution board and are also known as fuse board [now days the DP (double-pole) main switch and fuses are grouped on a single board only]. The distribution board has 3 sub-circuits or ways, each circuit is provided with a fuse. The lamps or fans connected to each circuit need not be in the same room or even on the same floor. For determination of electrical load of an installation, the following ratings of the appliance may be assumed unless specified:
   - ✓ Incandescent lamp …….60W
   - ✓ Fluorescent lamp …… 40W
   - ✓ Fans 80W
   - ✓ Socket outlets ….. …….100W
   - ✓ Power socket Outlets ….1, 000 W

B. **Tree System**: In tree system the sub circuits are taken from the main circuit or main line as shown in fig (1.2). The wiring system resembles like a tree; hence it is known as tree system. Now a days this system is obsolete due to scattered fuses, a greater number of joints involved, and difficulty to find the fault since the joints will be beneath the roof or floor and the lamps in the last sub-circuit will have less voltage because of more voltage drop in leads etc.

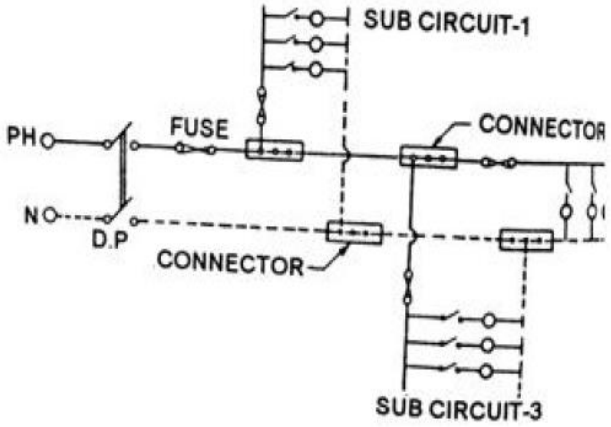

Figure. 1.2 Tree System

C. **Joint Box or Tee System**: In this system the connections to the lamps are made through joints made in joint boxes by means of connectors. The disadvantage of this system is that a greater number of T-connections in the wiring. Now days the use of this system is limited to temporary installation only as its cost is low and less cable is required.

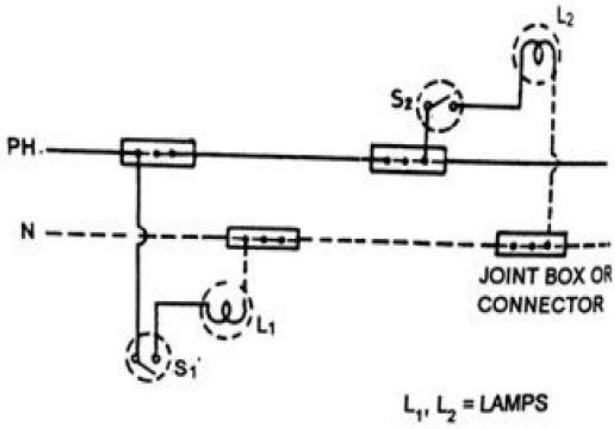

Figure 1.3 Joint Boxes or Tee System

D. **Loop in System**: This system is universally adopted for connections of various lamps, fans and other appliances to the supply source. In this system the feed conductor looped in by bringing it direct to the terminal and then carrying it forward again to the next point to be feed as shown in fig 1.4.

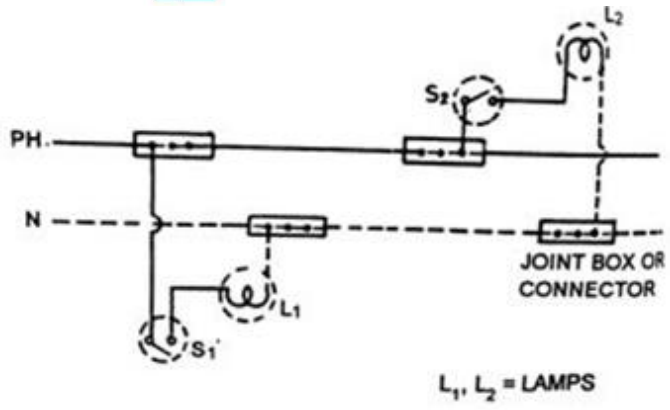

Figure 1.4 Loop in System

Advantages of loop – In – system:

- Joint boxes or connectors are avoided.
- No joint is made in the run cable.
- Joints are not concealed beneath the floor or roof.
- All the joints are at switches and lamps or fans which are accessible for inspection in case of faults simply by removing the fitments concerned.

Disadvantages of loop – in – system:

- Length of the cable required is more:
- Voltage drops and copper losses are more.
- Looping – in switches and lamps is usually difficult.

Another method of loop in is with the help of 2 plate ceiling roses as shown in fig (1.5)

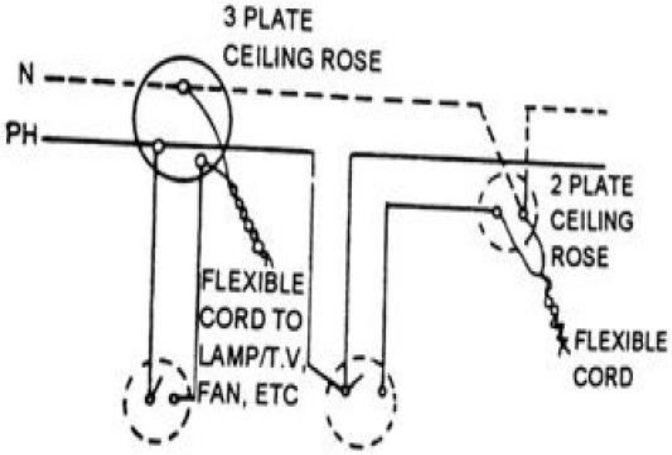

Figure 1.5 Looping in From Ceiling Rose

1.1.3 System of Wiring

The following are the different types of house wiring system:

1. Cleat wiring
2. Wooden casing capping
3. CTS or TRS wiring
4. Lead (or metal) Sheathed Wiring
5. Conduit Wiring
    - ✓ Surface or open type
    - ✓ Recessed or concealed type.

The following points to be considered before deciding any type of wiring:

Durability: The wires selected must be durable and it must be able to withstand wear and tear due to weather.

Safety: It is one of the foremost points to be considered. The system selected should be such that poor workman ship may not produce dangerous results.

Cost: The system adopted must be economical to suit the purse of the individual concerned.

Appearance: The appearance of wiring has an important bearing on the architectural beauty and, from aesthetic point of view; concealed conduit wiring is the proper choice.

Accessibility: The repair and/or extension of the wiring should be feasible.

1.1.4 Specifying IEE wiring regulations, EBCS-10 standards

A. General Rules for Wiring

The following general rules should be kept in mind while executing the electrical wiring work:

- ❖ The current rating of the cable / conductor should be slightly greater (at least 1.5 times) than the load current.
- ❖ Every live wire / line should be protected by a fuse of suitable rating as per load requirements.
- ❖ Every sub-circuit should be connected with the fuse distribution board.
- ❖ All metal coverings used for the protection of earth must be connected to earth.
- ❖ No switch or fuse is used in earth or neutral conductor.
- ❖ Every apparatus should be provided with a separate switch.
- ❖ No additional load should be connected to the existing installation until it has been satisfied that the installation can safely carry the additional load.
- ❖ All the switches and starters should be accessible to the operator.
- ❖ A caution notice (danger plate) should be fixed on very equipment.

- In any building light wiring and power wiring should be kept separately.
- In 3-phase, 4 – wire installation the load should be distributed almost equally on all the phases.
- In case of 3-phse, 4-wire system, at the main board, indication should be done in Red, Yellow and Blue. Neutral should be indicated in black.

B. Selection of Wiring Cable Type

The selection of the cable size has to take into consideration the following: -

- All wiring cables must be PVC or PVC/PVC insulated with copper conductors. Conductors with cross sectional areas of 16mm2 or less must be of copper. Aluminum conductors are not permitted.
- Select the current carrying capacities of copper conductor;
- Cables for swimming pools must be water resistant PE (polyethylene) insulated;
- The selected cable must be capable of delivering the electrical energy efficiently;
- The cable size allows it to carry the current without heating the cable;
- The voltage drop must not exceed ±2.5% of the supply voltage.
- The cable insulation must be suitable for the surrounding conditions of the installation, such as the ability to withstand the surrounding temperatures and the ability to provide mechanical protection;
- Each conductor in the installation must be protected from over current by means of over current protection devices needed to prevent damage to the cable insulation.

The following are the minimum cross-sectional areas of conductors based on their applications:

Table 1.1 Minimum cross-sectional areas of conductors

Conductor Cross Sectional Area in mm^2	Material	Application
1.5 mm^2	Copper	Lighting/fan circuit
2.5 mm^2	Copper	13A socket outlet circuit
4.0 mm^2 – 6.0 mm^2	Copper	General Power Circuit (example: water heater, cooker unit, motor/pump)
16.0 mm^2 / 25.0 mm^2	Copper	Main Circuit

The following table shows the functions and color identification of non-flexible cables:

Table 1.2 Functions and Color Identification of Non-Flexible Cables

Function	Cable Colour
Phase of Single Phase Circuit	Red, Yellow or Blue
Red Phase of Three Phase Circuit	Red
Yellow Phase of Three Phase Circuit	Yellow
Blue Phase of Three Phase Circuit	Blue
Neutral of Circuit	Black
Protection/Earthing Conductor	Green or Green-Yellow

C, Flexible Cables

- Flexible cables of cross-sectional area less than 4.0 mm2 are used in installations for electrical accessories such as ceiling roses, lamp
- Fixtures or attachments, socket plugs for mobile appliances, etc.
- Flexible cables shall not be used for permanent wiring.
- Flexible cables for the permanent use of electrical appliances should not exceed 3 meters in length.

Table 1.2 Functions and Color Identification of Flexible Cables

No. of Cores	Function	Cable Colour
1, 2 or 3	Phase Conductor	Brown
	Neutral Conductor	Blue
	Protection Conductor	Green or Green-Yellow
4 or 5	Phase Conductor	Brown or Black
	Neutral Conductor	Blue
	Protection Conductor	Green or Green-Yellow

Various material and insulation layers are used for conductor protection. Cable selection in accordance to insulation layers must be done correctly for the type of the wiring installation as shown in the table below:

Table 1.3 Conductor Insulation and Types of Wiring

Conductor Insulation Layer	Wiring Type
Single Insulated Conductor	Conduit, Duct or Concealed
Double Insulated Conductor	Surface
Armored PVC Insulated Conductor	Underground Cable

D, Legal Requirements for Installation

- The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the construction manager / Consultants.
- Pendent fixtures specified with overall stem lengths are subject to change and shall be checked with conditions on the job and installed as directed.
- All suspended fixtures shall be mounted rigid and fixed in position in accordance with drawings, instructions and to the approval of the construction manager / consultants.
- Fixtures shall be suspended true to alignment, plumb level and capable of resisting all lateral and vertical forces and shall be fixed as required.
- All suspended light fixtures, fans etc, shall be provided with concealed suspension arrangement in the concrete slab / roof members. It is the duty of the contractor to make these provisions at the appropriate stage of construction.
- Exhaust fans shall be fixed at location shown on drawings. They shall be wired to a plug socket outlet at a convenient location near the fan.
- All switch and outlet boxes, for fans and light fittings shall be bonded to earth. The recessed type fixtures shall not be supported into the false ceiling frame work. This shall have independent support from the socket of ceiling using conduit down rods / steel chain with provision for adjusting the level of fitting.
- Wires shall be connected to all fixtures through connector blocks. Wires brought

out from junction boxes shall be encased in flexible pipes for connecting to fixtures concealed in suspended ceiling.

- The flexible bush, double checkout at the fixture and flexible pipes, wherever used shall be of make and quality approved by the Construction manager / Consultants.

1.1.5 Selection of Wiring Accessories

- All wiring accessories to be used have to be of those approved by the Energy Commission and labeled with labels issued
  - ✓ For all wiring using UPVC conduits: - Switches, socket outlets, 3 pin plugs, ceiling roses, connectors, sockets – construction material shall be of polycarbonate type.
  - ✓ For all wiring using metal conduits: - Switches, socket outlets and connectors – construction material shall be of metal clad type, and All accessories shall be effectively earthed.
- **Switch fuse** used in single phase installations shall have the fuse permanently connected and not move with the fuse.
- **Fuse switch** used in 3 phase domestic installations also has fuse and switch. The fuse connector is installed together to allow the fuse to move simultaneously with the switch.
- **Lamp:**
  - ✓ Fluorescent lamps using magnetic ballasts (watt loss not exceeding 6 watts) shall be equipped with dry paper type capacitor;
  - ✓ Fluorescent lamps using electronic ballasts or high frequency electronic ballasts do not need capacitors;
  - ✓ Outdoor domestic lamp installations shall use weather proof and water proof lamps;
  - ✓ Submerged light installations (example in swimming pools, fountains, etc.) shall have water proof lamps with a voltage not exceeding 12 Volt AC.
- **Electric water heaters** are divided into 2 types, namely instantaneous water heaters and stored water heaters (storage tank type)
  - ✓ Instantaneous water heaters shall be equipped with a 2-pole control switch and its own residual current device. Storage water heaters (storage tank type) shall be installed with an isolator and its own residual current device; and Water heaters exceeding 3kW shall be permanently connected to a

20A/30A rated circuit breaker/fuse with an isolator switch and residual current device.

- ✓ **Electric cookers** exceeding 3kW shall have its own circuit connected permanently to a 30A rated circuit breaker or fuse with an isolator switch and cooker control unit incorporated with a 13A socket outlet. Two or more cooker appliances may be installed in the same room within a distance of 2 meters.
- ✓ **Electric bells** – the circuit shall have a push button switch and a AC/DC transformer.
- ✓ **Ceiling fans** shall conform to clause 21.101 of the MS 1219:2002 standard with regards to test on the suspension system of ceiling fans.

1.1.6 Electric Circuit

In electrical system, we are often interested in communicating or transferring energy from one point to another. To do this requires an interconnection of electrical devices. Such interconnection is referred to as an electric circuit, and each component of the circuit is known as an element.

In short, an **electric circuit** is an interconnection of electrical elements. It is used in numerous electrical systems to accomplish different tasks**.** The essential parts of an electric circuit consist of a power source, protection device, conductors, control device, and load. A closed circuit is a closed loop or path from one side of a voltage source to the other.

A complete or closed circuit is needed for current to flow. If the circuit is broken at any point, there is no longer a closed loop and no current can flow. This is often referred to as an open circuit.

1.2 Occupational health and safety(electrical)

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).

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 1.6 Safety signs

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. Working with VDUs (visual display units) can cause eye strain and fatigue and, therefore, this hazard is the subject of a separate section ‘VDU operation hazards.

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.

Figure 1.7 Safety Tag

- ❖ Turn the power off at the circuit breaker to the wires you'll strip or splice.
- ❖ Ensure the power is off by testing the wires.
- ❖ Be careful not to cut into the wire while stripping it.
- ❖ Make sure all splices are secure. Loosely joined wires can cause shorts.

1.2.1 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
- ❖ Eye and face protection whenever there is danger from electric arcs or flashes
- ❖ Insulated tools or handling equipment
- ❖ Protective shields and barriers to protect against electrical shock and burns

1.2.2 Legislative requirements of Workplace procedures and regulations

Occupational health and safety legislation. In brief, the Occupational Safety and Health Act specify the following fundamental, generic requirements:

- ❖ An employer or trainee shall provide and maintain a working environment in which the employees are not exposed to hazards and in particular,
- ❖ an employer or trainee shall provide such information, instruction, and training to, and supervision of, where it is not practicable to avoid the presence of hazards at the workplace, provide the employees with adequate personal protective clothing and equipment to protect them against those hazards
- ❖ An employee shall take reasonable care to ensure his or her own health and safety at work;
  - ✓ A manner in which he or she has been properly instructed to use it; or misuses or damages any equipment provided in the interests of safety or health; or fails to report forthwith to the shop assistance or the trainer;
  - ✓ Any injury or harm to health of which he or she is aware that arises in the course of, or in connection with, his or her work

- ❖ The Occupational Safety and Health Regulations principally specify detailed requirements for risky or potentially hazardous work activities or hazardous situations, to ensure an adequate level of safety for workers and other persons in the vicinity of the work being performed.

For example, the regulations specify certain safe work practices requirements for work in confined spaces, or for demolition work, or work involving asbestos products.

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.

1.3 Materials and equipment

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.

- **Cable color**

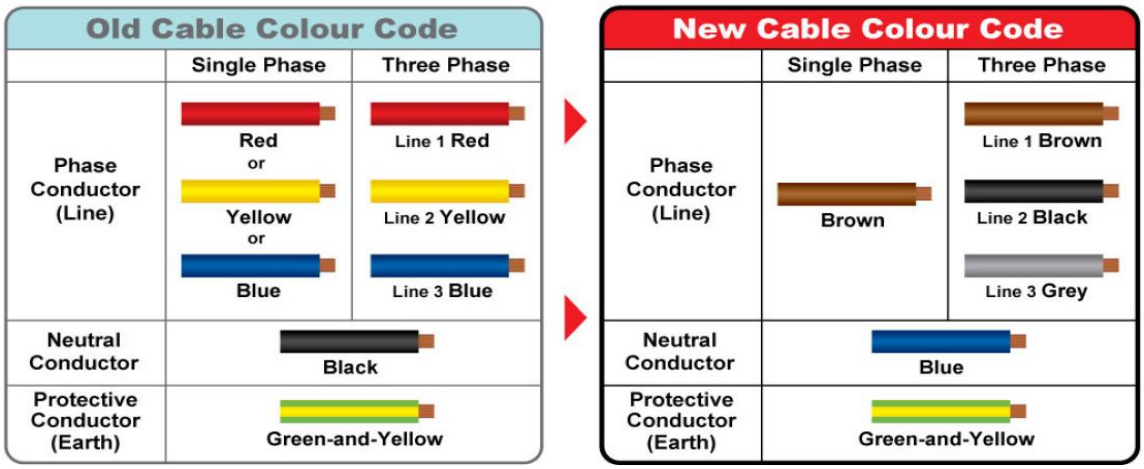

Figure 1.8 cable color

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.
    - ✓ Tools should be cared for and maintained in good condition if they are to be used efficiently and remain serviceable.
    - ✓ Screw drivers: should have a flat squared off end and wood chisels should be very sharp.
    - ✓ Wire stripper: that is used to remove insulation from conductor. Steel rule is used to scribe straight line.
    - ✓ 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.
    - ✓ Additionally, wood chisels will require sharpening on an oilstone to give them a very sharp edge.

1.3.1 Tools and Equipment

Figure 1.9 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 1.10 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 1.11 Screw driver

Drilling Equipment

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

Figure 1.12 portable drill machine

Sawing and Cutting Tools

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

Figure 1.13 Saw

Soldering Equipment

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

Figure 1.14 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 1.15 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 1.16 tape rule

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 1.17 electrician 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 1.18 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.

Figure 1.19 fish tape

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 Tap

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 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 later

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

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 voltmeter

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.

1.3.2 Wiring enclosures and equipment

Electrical equipment: any item for such purposes as generation, conversion, transmission, distribution or utilization of electrical energy, such as machines, transformers, apparatus, measuring instruments, protective devices, wiring materials, accessories, appliances and luminaries.

Enclosure: a part providing an appropriate degree of protection of equipment against certain external influences and a defined degree of protection against contact with live parts from any direction.

SELV*:* an· extra-low voltage system which is electrically separated from Earth and from other systems in such a way that a single fault cannot give rise to the risk of electric shock.

1.3.3 Identifying and Selecting the Wiring Materials

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:

- ✓ Conducting materials
- ✓ Insulating materials
- ✓ Semiconductor materials

A. Conducting Material

- ❖ **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 (Fig. 3.16). It is used in wiring and cable making.

Figure 1.25 Copper wires

- **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 (Fig. 3.17).

Figure 1.26 Copper wires

- **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 3.18 shows PVC insulated and sheathed cable. The type used for domestic installations.

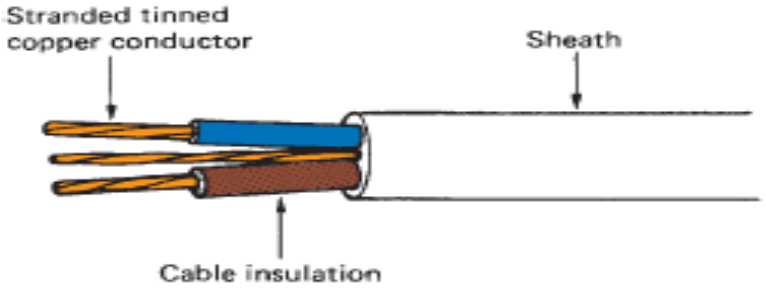

Figure 1.27 PVC insulated and sheathed cable

❖ **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. 3.19).

Figure 1.28 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

✓ One-way switch

✓ Two-way switch

- ✓ 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 1.29 one-way switch pictorial diagram

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 1.30 two-way switch pictorial diagram

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 1.31 Intermediate switch pictorial diagram

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

Batten holder

Pendant holder

Figure 1.32 types of lamp holders

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 1.33 Ceiling rose

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

Figure 1.34 Socket out let

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 1.35 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. 3.26 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.

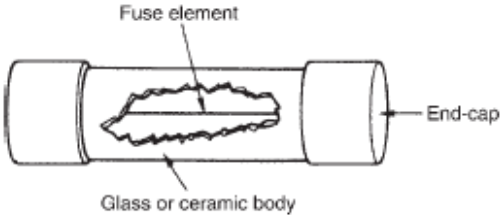

Figure 1.36 Cartridge fuse

Miniature 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. 1.37 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 1.37 MCBs Breaker.

The IEE Regulations state that the protective device must operate very quickly to remove the danger and within a time of:

- 0.4 seconds for portable equipment supplied by socket outlet circuits
- seconds for fixed equipment
- 0.2 seconds for construction sites, agricultural and horticultural premises

1.4 Work plans and drawing

The electrical layout should be considered after proper locations of all outlets for lamps, fans, appliances - both fixed and transportable, motors, etc., have been selected and best methods of wiring determined. All runs of wiring and exact positions of all points of switch-boxes and other outlets shall be first marked on the plans of the building and approved by the engineer in charge or the owner before the actual commencement of the work.

1.4.1 Marking of equipment

Each piece of electrical equipment shall bear such of the following markings as may be necessary to identify the equipment and ensure that it is suitable for the particular installation:

- The maker's name, trademark, or other recognized symbol of identification.
- Catalogue number or type.
- Voltage.
- Rated load amperes.
- Watts, volt-amperes, or horsepower.
- Whether for AC, DC or both.
- Number of phases.
- Frequency in Hertz.
- Rated load speed in revolution per minute.
- Designation of terminals.
- Whether for continuous or intermittent duty.
- Evidence of approval.
- Such other marking as may be necessary to ensure safe and proper operation

Each service box, at the time of installation, shall be marked in a conspicuous, legible, and pen anent manner to indicate clearly the maximum rating of the over current device which may be used for this installation. At each distribution point, circuit breakers, fuses, and switches shall be marked, adjacent thereto, in a conspicuous and legible manner to indicate clearly:

- which installation or portion of installation they protect or control;
- The maximum rating of over current device that is permitted.

1.4.2 Submission of the Plans, Drawings and Specifications

Regulation 65 of the Electricity Regulations 1994 states that the eligibility to submit plans is as follows: -

- ✓ Wireman with Single Phase Restriction Low voltage single phase up to 60 amperes.
- ✓ Wireman with Three Phase Restriction Low voltage up to 60 amperes.

- **Checking materials for correct specifications.**

- ✓ Working with minimum supervision
- ✓ Preparation of work area for receipt of materials
- ✓ Receiving materials

- ✓ Confirming the status of the materials
- ✓ Resolving problem within the limits of your responsibility
- ✓ Completing any necessary documentation accurately and legibly
- ✓ Working in ways which maintain the safety of yourself and others

❖ **Undertaking /inspecting/ preparation of work for correct location and specifications.**

All portable electric equipment will be handled in such a manner that will not damage or reduce service life.

- ✓ Flexible cords connected to equipment may not be used for raising or lowering equipment and will not be used if damage to the outer insulation is present. Additionally, visual inspections are required and unauthorized alterations of the grounding protection are not allowed to ensure the safety of employees. Visual inspection will be performed for external defects and for possible internal damage
- ✓ Attachment plugs and receptacles may not be connected or altered in a manner that would prevent proper continuity of the equipment grounding conductor.
- ✓ Devices may not be altered to allow the grounding pole of a plug to be inserted into slots intended for connection to the current-carrying conductors.
- ✓ The hazardous locations should be aware of include, wet locations and locations where combustible or flammable atmospheres are present. Unplugging energized equipment. For wet locations, employees' hands will not be wet when plugging
- ✓ Energized plug and receptacle connections will be handled only with protective equipment.
- ✓ For combustible/flammable atmospheres, all electric equipment and wiring systems in classified locations must meet The National Electric Code requirements for that particular classification.

1.4.3 Interpreting electrical Diagrams and drawings

Site Plans or Layout 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 Diagrams. The

Layout drawing or site plan of a small domestic extension is shown in Fig. 3.28. 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.

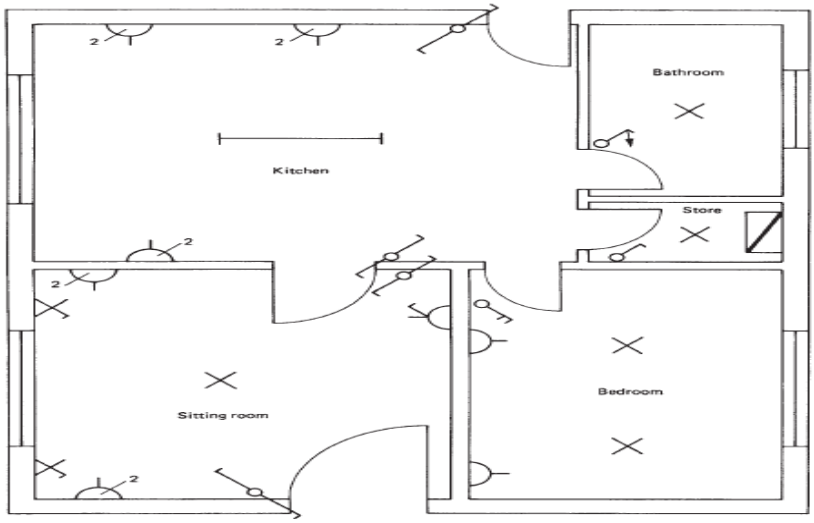

Figure 1.38 Layout drawing or site plan of a small electrical installation

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 3.29 shows the block diagram of Light circuit control.

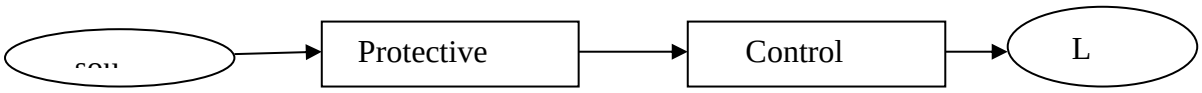

Figure 1.39 Block diagram

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 1.40 shows the wiring diagram for a space heating control system

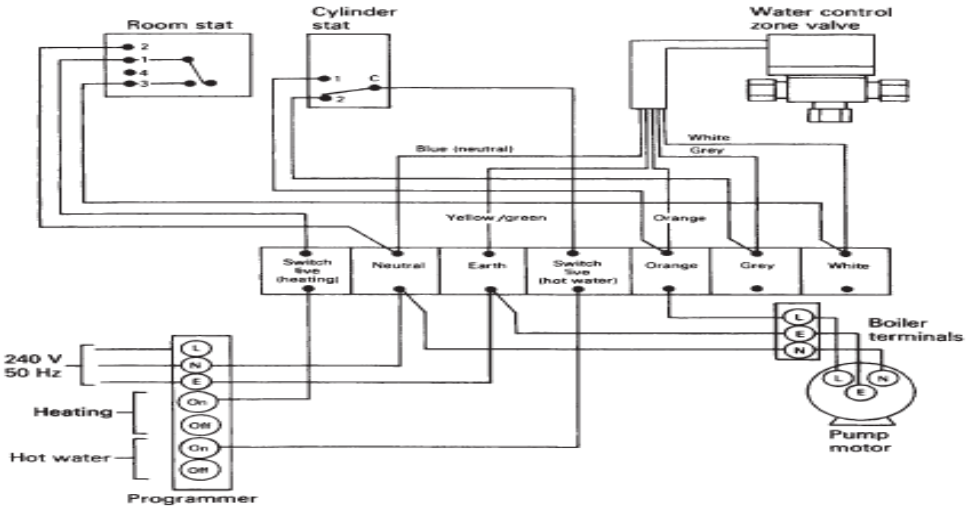

Figure 1.40 Wiring diagram of space heating control system

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

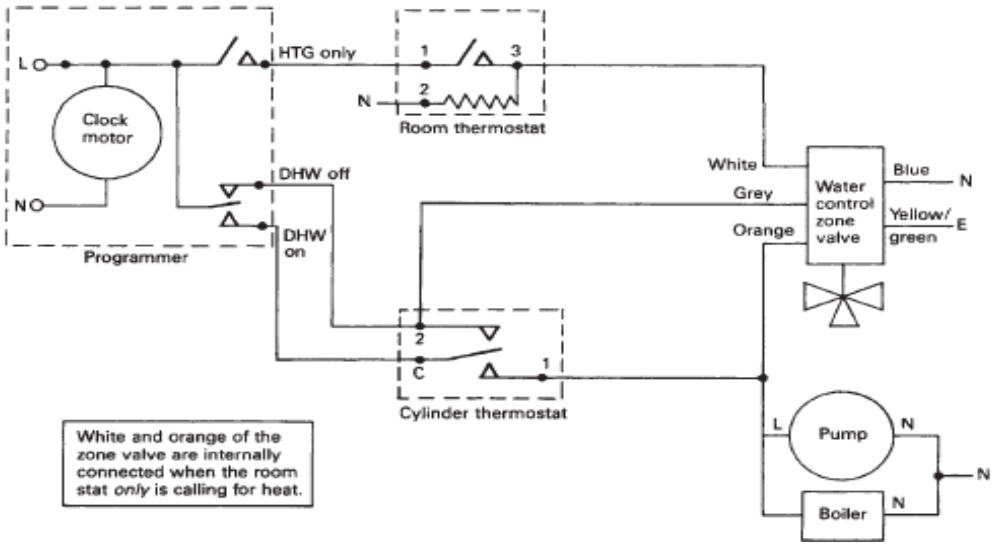

Figure 1.41 Circuit diagram of space heating control system

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 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 Potential hazards and prevention

A, 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

B, 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.

C, 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.

1.5.1 Dangers of Electrical Shocks

A. 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.

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

Why Electric Shocks Occur?

- **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.
- **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

1.5.2 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.

B. 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.

C. 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.

1.6 Prepare work areas

The work area in order to carry out the maintenance of plant and equipment. You will be involved in activities such as clearing materials and equipment from the worksite, providing service supplies and completing isolations. You will be following your organization's safe working practices and working within the work permit procedures. This unit is common to the Electrical and Instrumentation & Control disciplines.

During this work you must take account of the relevant worksite operational requirements, procedures and safe working practices AS THEY APPLY TO YOU.

Scope/range:

1. The level and extent of responsibility will involve you being responsible for ensuring the preparations are carried out safely by following company defined procedures. You will be

accountable for the integrity of the work and ensuring the work is recorded in a formal manner. Authorization for proceeding with the work will be given by authorized signatories within the Permit to Work system.

2. The type of work area to be prepared would include:

- ❖ Chemicals manufacturing and petroleum sites
- ❖ Controlled operational areas
- ❖ Offshore installations

3. The type of work area preparations could involve ensuring that the location and condition of work environments are appropriate in terms of:

- ❖ Layout
- ❖ Security
- ❖ Safety
- ❖ Isolations (where relevant)
- ❖ Accessibility

4. The type of work area protection and safety requirements will take into account any hazards due to the particular working conditions that could also include:

- ❖ Working on access structures (scaffold)
- ❖ At height
- ❖ Inside systems and plant
- ❖ Adverse weather conditions
- ❖ Confined spaces
- ❖ In shafts

Scope/range relating to knowledge and understanding:

The Knowledge and Understanding levels expressed indicate the minimum level of knowledge and understanding sufficient to perform your role in a manner that would normally be associated with the minimum acceptable performance of a competent person undertaking your role. The expression" working knowledge and understanding" indicates you are able to:

- ❖ Identify and apply relevant information, procedures and practices to your usual role in your expected working environments needing only occasional recourse to reference materials

- Describe, in your own words, the principles underlying your working methods. This does not mean the ability to quote “Chapter and verse”. Rather you must know what supporting information is available, how and where to find it and from whom to seek further guidance and information confirm any additional required detail
- Interpret and apply the information obtained to your role, your working practice and in your expected working environment

SELF CHECK 1

Directions 1: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Which one of the following is Electrical Safety?
   a. Plan every job and think about what could go wrong.
   b. Use the right tools for the job.
   c. Use procedures, drawings, and other documents to do the job.
   d. Isolate equipment from energy sources.
   e. All
2. ---------- is that might be needed for protection against electric shock.
   a. Personal Protective Equipment
   b. Equipment
   c. First aid
   d. A and b
3. Pliers, cutters, a knife and a range of screwdrivers are the tools required in the electro-technical industry for:
   a) erecting conduit c) stripping and connecting conductors
   b) assembling tray d) terminating an MI cable
4. All of the following instruments are electrical quantity measuring instruments except:
   a) Ammeter b) voltmeter c) ohmmeter D. Measuring Tape
5. The angle of a ladder to the building upon which it is resting should be in the proportions of:
   a) 1 up to 4 out c) 4 up to 1 out
   b) 4 up to 75 out d) 75 up to 4 out
6. A fish tape or fishing tools is used in electrical wiring for:
   a) Pulling the wires through the conduit c) splicing wire
   b) Electrical conductor d) wire connection
7. The angle which a correctly erected ladder should make with level ground is:
   a) 41^0 c)57^0
   b) 45^0 d) 75^0
8. Ladders must extend above the landing place or highest rung on which the user will stand by:
   a) 1.00m c)4.00m

b) 1.05m d)75.00m

Directions 2: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List five General Rules of Wiring?
2. List five Wiring Accessories?

Directions 3: fill the blank space

1. _____is an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit.
2. _____is a measuring instrument used to measure the electric current in a circuit.
3. _____are hand tools, designed primarily for gripping objects by using leverage.
4. _____are forms of protective eyewear that usually enclose or protect the eye area in order to prevent particulates, water or chemicals from striking the eyes.
5. _____are cutting tools used to create holes.
6. _____is a tool with a rotating drill bit used for drilling holes in various materials.
7. Drills are commonly used in _____, _____ & _____
8. _____ is an instrument used in geometry, technical drawing and engineering/building to measure distances and/or to rule straight lines.
9. _____is a saw for cutting metal or bones.
10. _____ is a hand tool for drilling small holes, mainly in wood, without splitting

Note: **Satisfactory rating - 20 points Unsatisfactory - below 20 points**

Answer Sheet

Score = _____

Name: _____ Date: _____

Unit Two: Minor maintenance

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

1. Minor maintenance
2. Minor adjustments
3. Reporting faults

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:

1. Conduct minor maintenance
2. Undertake minor adjustments
3. Reporting faults

2.1 Minor maintenance

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.
- Check the Cords. Look for tear/cut insulator on the power cords on your electric tools.
- Use the right tool correctly. Use tools correctly and for their intended purposes. Follow the safety directions and operating procedures recommended by the manufacturer.

2.1.1 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.

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

2.2 Minor adjustments

Socket outlets, installed in locations other than those referenced in 9.2, 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 by RCDs.

RCD protection may be at circuit or socket level, with the preference being socket level particularly in situations where increased risk exists. This allows for resetting and testing of the RCD without the need to leave the teaching environment.

A. Electrical products and equipment

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.

2.2.1 Adjustments of Switches, socket outlets and fixed outlets

- Switches, sockets and fixed outlets shall be:
  - ✓ Flush type
  - ✓ Standard manufactured type, commonly available with clip-on metal or plastic colored over plates
  - ✓ Standard manufactured type, commonly available plastic or polycarbonate color faceplates.
- Surface Type

  Surface type shall have:
  - ✓ Enclosures of the impact resistant, corrosion resistant, surface mounted type, as per PATHWAYS AND SPACES
  - ✓ entries permanently plugged
  - ✓ An earth connection if metal clad.
- Light Switches
  - ✓ Light switches shall be rated at 10A minimum unless specified otherwise. Adjacent light switches on different phases shall be housed in separate or approved partitioned enclosures. Lighting switches shall be mounted at 1m above the floor level, and within 200mm of the doorframe on the handle side unless indicated otherwise.
- Socket Outlets

  Socket outlets shall be:
  - ✓ Flat three-pin socket type incorporating a suitably rated switch for single-phase applications
  - ✓ Round five-pin socket type incorporating a suitably rated switch for three phase applications.

Note the requirements of NZS 4121 which requires outlets to be mounted 500mm above the floor for disability access. Switched socket outlets shall be located in relation to the equipment or appliance such that the isolation point is readily accessible.

All newly installed RUPOs installed in schools shall be labeled to indicate their purpose and that RCD protection is provided, for example 'ICT USE ONLY – RCD PROTECTION' for ICT related RUPOs. All socket outlets (RUPOs and GPOs) shall be labeled with switchboard and circuit identification.

- Industrial Outlets

  Single and poly-phase industrial socket outlets shall be:

  - ✓ To AS/NZS 3123, or IEC 60309
  - ✓ Supplied with matching plug
  - ✓ Mounted 1000mm above floor level, unless indicated otherwise.

2.3 Reporting faults

A fault is any abnormal condition in a power system. The steady state operating mode of a power system is balanced 3-phase AC. 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.

2.3.1 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

2.3.2 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 faults

2.3.3 Notify or report work completion

Inform or report to supervisor after completion of Install and terminate wiring system work.

- ✓ Inform or report to supervisor the matter to his/her supervisor or through his/her Union Representative or such other person as may be subsequently defined.

SELF CHECK 2

Directions 1: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1) To verify or prove a successful electrical isolation you would use a:
   a) voltage indicator c) set of GS 38 test leads
   b) voltage proving unit d) small padlock
2) To secure an electrical isolation you would use a:
   a) voltage indicator c) set of GS 38 test leads
   b) voltage proving unit d) small padlock
3) Where a test instrument or voltage indicator is used to prove a supply dead, the same device must be tested to show that it still works using a:
   a) voltage indicator c) set of GS 38 test leads
   b) voltage proving unit d) small padlock
4) To give adequate protection to the person carrying out a safe isolation procedure, the test instrument must incorporate a:
   a) voltage indicator c) set of GS 38 test leads
   b) voltage proving unit d) small padlock

Directions 2: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What kind of matter you report on your work or on large jobs to supervisor?
2. On the site work who's is control your work?

Directions 3: write true if the statement is correct, write false if the statement isn't correct

1. Voltage indicator is used to secure an electrical isolation
2. A fault is any abnormal condition in a power system. The steady state operating mode of a power system is balanced 3-phase AC.
3. In the design, construction and installation of an electrical installation, consideration must be given to its subsequent maintenance.

Operation Sheet 2.1	Maintain your work shop Electrical Tools and Equipment

Operation Title; Maintain your work shop Electrical Tools and Equipment

Instruction: Go to your workshop and maintain your work shop Electrical Tools and Equipment

Purpose; the purpose is to understand the way to maintain electrical tools and equipment

Required tools and equipment

Screw driver, multi meter, volt meter, nasetero

Precaution

Use personal protective equipment and follow the work shop safety rule

Procedures

Step 1- observe the workshop tools and equipment

Step 2- look up the problems of the tools or equipment

Step 3- identify the problems and record it

Step 4- solve the problem by taking action

Step 5- report the maintenance progress

Step 6- clean the work area

Quality criteria: follow the rule of maintaining tools and equipment

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2:00 hours.

Task 1. Maintain your work shop Electrical Tools and Equipment

Unit Three: Work quality

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

1. Completing work
2. Making final checks
3. work area, storing shops, 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:

1. Complete work
2. Make final checks
3. Clear work area, storing shops, tools and equipment

3.1 Completing work

The IEE Wiring Regulations (BS 7671) is the Electricians' Bible and provides the authoritative framework for anyone working in the electro-technical industry. To assist workers in the electro-technical industry with their understanding of the relevant regulations many guidance booklets have been published, particularly:

- The On-Site Guide published by the IEE
- Guidance Note 1: Selection and erection of equipment
- Guidance Note 2: Isolation and Switching
- Guidance Note 3: Inspection and Testing
- Guidance Note 4: Protection against Fire
- Guidance Note 5: Protection against Electric Shock
- Guidance Note 6: Protection against Over current
- Guidance Note 7: Special Locations

All the above publications are published by the IEE and are available from IEE Publications
Good communication is about transferring information from one person to another. How many hours or days did you spend on a particular job last week?

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 five 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.

❖ Job Sheets

A job sheet or job card 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.

- ❖ **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.

- ❖ **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 Making 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 checking methods in wiring installation. Two of these are:

- ✓ Continuity Test
- ✓ Polarity Test

Continuity Test

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

- ✓ Protection Conductor Continuity Test.
- ✓ Final Ring Circuit Conductor Continuity Test.
- ✓ Live and Neutral Conductor Continuity Test.

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 3.1;
  - ✓ The meter reading shall be less than 1 ohm.

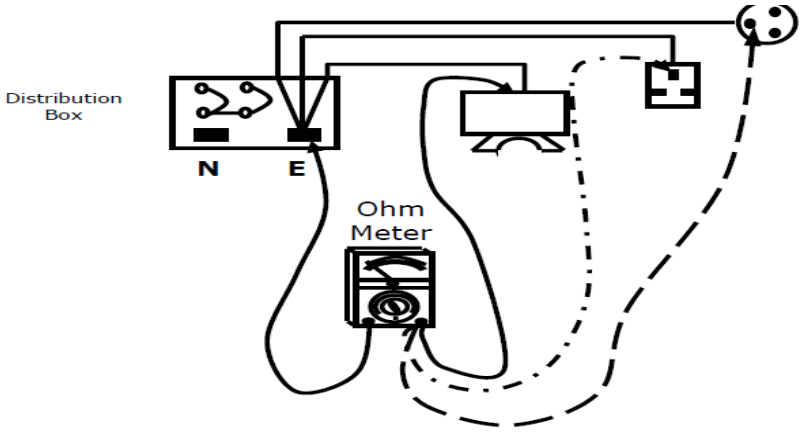

Figure 3.1 Protection Conductor Continuity Test

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 3.2 (EE);

- ✓ Repeat the procedure for (L-L) and (N-N);
- ✓ The meter reading value shall be less than 1 ohm.

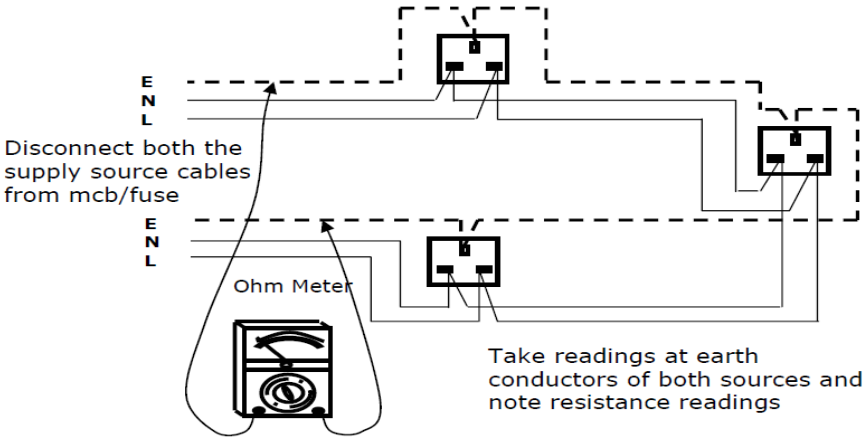

Figure 3.2 Final Ring Circuit Conductor Continuity Test

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 3.3;
  - ✓ The meter reading value shall be less than 1 ohm.

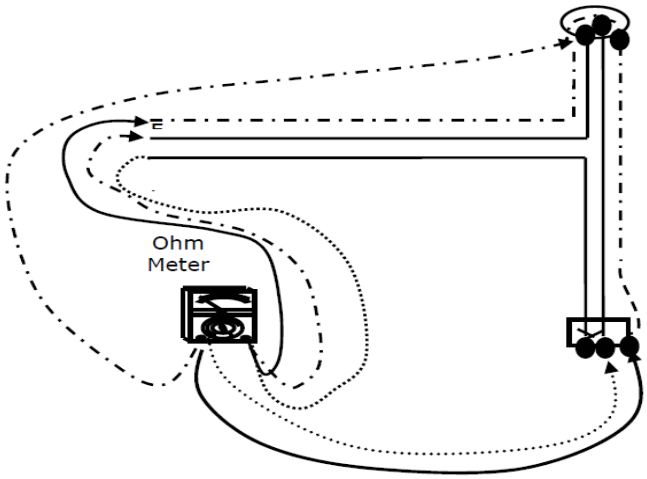

Figure 3.3 Live and Neutral Conductor Continuity Test

Inspection

Check the following items to ensure:

- ❖ All mechanical connections are tight, as factory connections may loosen during shipment and storage.
- ❖ All accessible electrical connections are tightened to the torque specifications on the panel labeling.
- ❖ All screws connecting and tight switches, breakers, socket outlets, lamps, etc. are properly installed and tightened.
- ❖ Connections between branch circuits and breakers are properly secured.
- ❖ All ground connections are properly made (Note: ground wire must be installed after the panel box is mounted on the wall).
- ❖ All foreign materials have been removed from the panel and enclosure before installing the dead front and trim.

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): _____

No	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

3.3. work area clean, check, maintain and store Plant, tools and equipment

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

Electrical Emergencies

- Injury could be minimized and many lives saved if proper rescue techniques and treatment are used.
- Electrical accidents may occur at almost any time or place. Timely response and treatment of victims is a major concern. You must use your best judgment in an electrical emergency.
- Do you know the proper actions to take? Do you know what dangers could be encountered?
- When an electrical accident occurs, due to the effect of muscle clamping, a victim is often incapable of moving or releasing the electrical conductor.
- Attempts to rescue an accident victim may pose as great a hazard for the rescuer as it does for the victim. Caution should be a primary consideration during any electrical accident or emergency. There should always be an emergency response plan for scheduled electrical maintenance or work.

Electrical Rescue Techniques

- **Approaching the accident:**
  - ✓ Never rush into an accident situation.
  - ✓ Call to emergence workers as soon as possible.
  - ✓ Get the aid of trained electrical personnel if possible.
  - ✓ Approach the accident scene cautiously.
- **Examining the scene:**
  - ✓ Visually examine victims to determine if they are in contact with energized conductors.
  - ✓ Metal surfaces, objects near the victim or the earth itself may be energized.

- ✓ You may become a victim if you touch an energized victim or conductive surface.
- ✓ Do not touch the victim or conductive surfaces while they are energized.
- ✓ De-energize electrical circuits if at all possible.

3.3.1 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:

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

Power tools:

- ❖ Read and follow the maintenance schedule in the owner's manual for each piece of power equipment.
- ❖ Change the oil.
- ❖ Clean the air filter.
- ❖ Lubricate moving parts.
- ❖ Sharpen dull blades or replace worn blades according to the owner's manual.
- ❖ Replace spark plugs
- ❖ Drain oil and gasoline before long-term storage.
- ❖ Check electric cords and connections on electric-powered tools.
- ❖ Store tools in a clean dry storage area.

Equipment:

- ❖ Store equipment in a clean dry storage area.
- ❖ Rinse and clean spray equipment after each use.

- Clean spreaders and check wheel-driven gears.
- Clean carts and wheelbarrows after use

SELF CHECK 3

Directions 1: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1) A Time 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
2) 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
3) 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
4) 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
5) 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) d) has been trained to do a job or task successfully

Directions 2: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List the three continuity tests method?
2. Write the dispose materials
3. Write the reuse materials

Directions 3: write true if the statement is correct, write false if the statement isn't correct

1. All mechanical connections are tight, as factory connections may loosen during shipment and storage
2. Day work is one way of recording variations to a contract, that is, work done which is outside the scope of the original contract.
3. Good communication is about transferring information from one person to another.

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MINISTRY OF LABOR
AND SKILLS