Building Electrical Installation

Level-III

Based on November 2018, Version 5 Occupational standards

Module Title: - Performing Maintenance of Electrical Equipment

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LG #39	LO #1-Plan and prepare for maintenance of electrical equipment

Instruction sheet

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

- Sequencing and planning maintenance schedules
- Consulting appropriate personnel for effective and coordinated maintenance work
- Preparing necessary materials
- testing devices needed to carry out maintenance work

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:

- Sequence maintenance schedules
- plan maintenance schedules
- Consult appropriate personnel for effective and coordinated maintenance work
- Prepare necessary materials
- test devices needed to carry out maintenance work

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”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Sequencing and planning maintenance schedules

1.1 What is maintenance?

Maintenance is a set of organised activities that are carried out in order to keep an item in its best operational condition with minimum cost acquired. Activities of maintenance function could be either repair or replacement activities, which are necessary for an item to reach its acceptable productivity condition or these activities, should be carried out with a minimum possible cost

Maintenance activities can basically be divided into two types: planned maintenance activities and unplanned maintenance activities.

1. Planned maintenance is maintenance that is organized and carried out with thought to the future, control and recording in accordance with the plans that have been determined previously
2. Unplanned Maintenance:-Maintenance performed unexpectedly

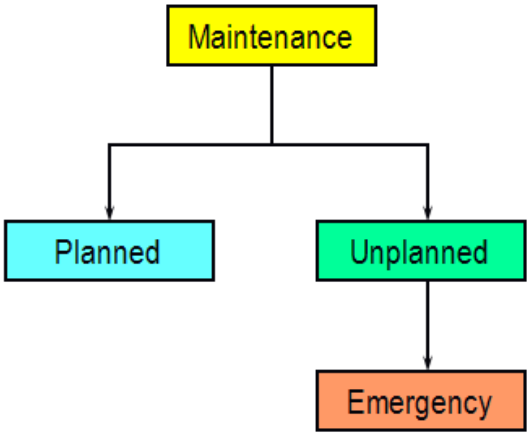


Figure 1. maintenance classification

The type of maintenance cannot be equated for each equipment type, which depends on the method, cost and critical level. The following types of maintenance methods are commonly used in several industries.

1. Preventive Maintenance
2. Predictive Maintenance
3. Corrective Maintenance
4. Breakdown Maintenance

Preventive Maintenance:

It is a method for preventing damage to equipment by periodically replacing parts based on time of use and carrying out minor maintenance and inspections to find out the current state of the equipment / machinery. There are a set of activities that are performed on plant equipment, machinery, and systems before the occurrence of a failure in order to protect them and to prevent or eliminate any degradation in their operating conditions.

Example: Cleaning, checking, lubricating, bolt tightening Periodic inspection Periodic and small over haul restorations

Predictive Maintenance:

Predictive maintenance is a method for doing maintenance by replacing parts based on predictions using a tool. The point is if the preventive method is only based on the schedule, then the predictive method is based on the results of the measurement.

This method can also use the five senses, for example in bearing inspection can be distinguished from the sound produced. Or checking temperature, by touching it we can feel the difference or abnormality of the equipment.

Corrective Maintenance:

It is a method intended to improve the reliability of equipment/machines by improvising. In addition to equipment, it is also intended for parts that have a short life cycle (reduce the frequency of damage) and speed up repair time.

Breakdown Maintenance

It is a method where inspection and replacement of parts are not carried out, so with this method we leave the equipment damaged and then we fix it or replace it

Usually this method is applied to equipment / machines with consideration:

- Equipment is only optional (additional) so that if it is damaged it does not interfere with production
- The cost of repairing / replacing cheap parts
- Insignificant damage
- Easy and fast repair.

Maintenance Objectives

Maintenance objectives should be consistent with and subordinate to production goals.

- Maximising production or increasing facilities availability at the lowest cost and at the highest quality and safety standards.
- Reducing breakdowns and emergency shutdowns.
- Optimising resources utilisation.
- Reducing downtime.
- Improving spares stock control.
- Improving equipment efficiency and reducing scrap rate.
- Minimising energy usage.
- Optimising the useful life of equipment.
- Providing reliable cost and budgetary control.
- Identifying and implementing cost reductions.

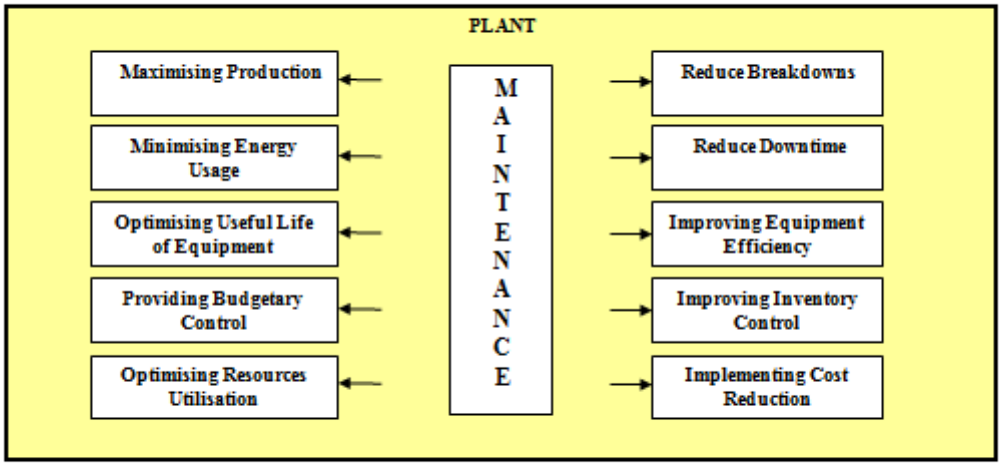


Figure 2. Maintenance Objectives Chart

1.2 Planning maintenance work

Many electrical accidents are due to a failure to plan ahead. Planning should consider the management, supervision, implementation and completion of the work, and should lead to a formal system of work based on information in the safety rules and a task-specific risk assessment. You should consider the following:

- The work to be done;
- The hazards of the system or equipment to be worked on and the risks associated with the work;
- The people doing the work, their competence and the level of supervision necessary;
- The precautions to be taken and the system of work to be employed;
- The possibility that the nature of the work may change, eg a testing job may turn into fault finding.

There must be adequate information available about the electrical system and the work to be done. In the case of a newly constructed electrical system (or newly installed equipment), there should be drawings and schedules relating to the design and these should have been updated, if necessary, by the people carrying out the installation.

Advantages of a Planned Maintenance

Planned maintenance is the routine of performing inspections, minor repairs, cleaning, and upkeep, rather than waiting until something breaks down to take action. In fewer words, planned maintenance, also known as preventive maintenance, is a proactive rather than reactive approach**.**

Failure to timely diagnose any potential malfunction and operational issues with machines or buildings can have dire costs, both in terms of time and money.

1. Transparency and Predictability

While juggling a set of complex duties, a regular and fixed maintenance schedule can ease some of workloads. It can bring transparency and predictability to their day-to-day operations, allowing focusing on excellent service.

2. Enhancing Building Safety

If not maintained properly, even the most user-friendly and high-tech devices and machinery can be safety hazards. However, adhering to a planned maintenance schedule ensures that all equipment and machinery operate smoothly, without posing any risks to people interacting with them.

Moreover, during planned maintenance, technicians can identify if the building is compromised in terms of risks such as fires or burglary.

3. Optimizing the Workflow

If there's a technical malfunction in a building or a facility, it might abruptly stop the work, and interrupt any ongoing plans and processes. The unpredictable nature of the damage, or the repair schedule, might force facility managers or executives to alter business decisions. Undoubtedly, this interruption can cost a great deal of money, time, and even reputation.

However, a planned maintenance schedule prevents bad surprises stemming from technical malfunction. It helps people and companies to remain productive and keeps the workflow optimal.

4. Increasing Equipment Longevity

When a technician can identify the beginnings of a problem before it accelerates, it's easier to treat it and prevent it from worsening.

Thus, a planned maintenance schedule can increase equipment longevity, which can benefit businesses in many different ways.

5. Environmentally Responsible

Increased equipment longevity not only reduces time and costs, but it's also more environmentally responsible. Once companies don't need to renew or replace equipment frequently, there'll be less harmful electronic waste piling up in landfills.

Furthermore, a regular maintenance schedule is an excellent opportunity to save resources, electricians can analyze whether there are excess energy usage. This way, they can give recommendations to building or facility managers to tackle these.

What are the steps of the maintenance planning process?

Six steps of the maintenance planning and control cycle are as follows:

1. Identify the problem.
2. Plan the maintenance task
3. Schedule the work.
4. Allocate the task to specific people
5. Ensure the work is executed properly

1.3 Sequencing in maintenance

Maintenance Work sequence is also commonly referred to as the sequence of maintenance operations. Note that there is often push back when the work sequence is

mandated on tasks that don't have an obvious advantage to being done in a particular order. Electrical accidents often occur during fault-finding after a plant breakdown when pressure to repair the equipment results in risks being taken. To anticipate this, you should plan and establish safe fault-finding procedures to be implemented during breakdown maintenance.

What is the purpose of the sequencing plan?

Planning your work sequence is an essential part of the overall maintenance process. It ensures that the minimum amount of time is spent collecting, organizing and understanding the information related to the maintenance

A Sequence Plan documents a planned project. It takes factual, logical and scheduling aspects into account, including the project objective, boundary conditions and results.

Effective maintenance planning is essential to the overall maintenance environment. The maintenance plan includes the actual work, instructions, schedule, workers, spare parts, and contractors, guide all the maintenance work activities

What are the steps to sequence maintenance the activities?

These six processes are performed in chronological order and represent the 6-step process in developing a maintenance schedule.

1. Step 1: Plan Schedule Management
2. Step 2: Define Activities that must have done during maintenance.
3. Step 3: Sequence Activities in consecutive order
4. Step 4: Estimate Activity Resources needed to accomplish the task
5. Step 5: Estimate Activity Durations to finish maintaining the equipment/system
6. Step 6: Develop Schedule

1.4 Maintenance schedule

A maintenance schedule can be defined as an important document that can be used for recording the weekly, monthly and yearly schedule of the maintenance if home or office and their possessions. It is usually found in offices and homes that are huge and need a schedule to maintain them properly. A maintenance schedule represents the routine services and or inspections that are to be performed on a plant item. Each maintenance schedule consists of multiple intervals which are assigned a service or inspection procedure. The maintenance schedule is a useful tool that keeps cost down and property function and appearance up. This allows work to get done in the most efficient, economical way.

Table1. maintenance schedule

Maintenance Schedule

Date: _____

Prepared By: _____

Submitted To: _____

Approved By: _____

No.	Task Description	Task Duration	Due Date	Target Date	Resource Names	Person Responsible	Predecessor

Self-check -1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I: Choose and write the letter of the correct answer on the space provided (3 point)

_____ 1. Which of the following is the type of maintenance performed as scheduled?

A. Planned maintenance C. unplanned maintenance

B. . both D. none of the above

_____2. Which of the following is the type of Maintenance performed unexpectedly?

A. Planned maintenance C. unplanned maintenance

B. both D. none of the above

_____3. Important document that can be used for recording the weekly, monthly and yearly schedule of the maintenance.?

A. Schedule C. Consultation

B. coordination D. risk control

Instruction II: Give short answer for the following Questions not more than one page using your separate answer sheet (3 point)

1. What is maintenance?
2. What is the objective of maintenance ?
3. Define maintenance schedule?

Note: **Satisfactory rating – Greater than or equal to 3 points** **Unsatisfactory - below 2points**

Information Sheet 2- Consulting appropriate personnel for effective and coordinated maintenance work

2.1 Consultation for maintenance work

Qualification of personnel

The maintenance and inspection of installations should be carried out by personnel whose training has included instruction on the various types of installation practices, relevant rules and regulations and on personnel safety. Qualified personnel responsible for inspection and maintenance works should be appointed by owners and builders, in accordance with the applicable rules and regulations.

Inspection

An action comprising careful scrutiny of an item carried out with or without dismantling as required, supplemented by means such as measurement, in order to arrive at a reliable conclusion as to the condition of this item.

Consultation between duty holders

All persons conducting a business or undertaking at a workplace have a duty to manage electrical risks at the workplace while electrical work is being carried out, not just those carrying out the electrical work.

Electrical work will often be carried out at a place that is not under the management or control of the person conducting the business or undertaking carrying out the electrical work. For example, the place where work is carried out may be under the management or control of:

- If the place is a permanent workplace the person conducting a business or undertaking from that workplace
- If the place is a public place the relevant local or state authority.

These persons will also have duties in relation to the health and safety of the electrical worker(s) and other persons at the place where the electrical work is being carried out.

All duty holders must, so far as is reasonably practicable, consult, cooperate and coordinate activities with each other to ensure compliance with their work health and safety duties.

In addition to the general duty to consult, the person conducting a business or undertaking carrying out the electrical work must ensure the electrical work is only authorized (among other things) after consulting with the person with management or control of the workplace.

Consultation should ensure that all relevant persons are aware of any scheduled electrical work to be carried out and also any relevant risks to health and safety arising from that work.

ELECTRICAL PREVENTIVE MAINTENANCE CHECKLIST

☐	Verify that wiring methods are securely fastened in place, supported independently
☐	Verify that boxes are installed at junction, splice, outlet, switch, and pull points
☐	Identify wet and damp locations and the suitability of boxes and fittings
☐	Verify that cabinets or cutout boxes are suitable and properly installed in any wet or damp locations
☐	Verify that cables are secured to cabinets and cutout boxes or that the conditions for cables with nonmetallic sheaths are met
☐	Verify that any switches in wet locations are properly installed in waterproof enclosures
☐	Verify that the point of attachment for an overhead service drop is adequate and will provide minimum clearances
☐	Verify that GFCI protection is provided for receptacles in bathrooms, near sinks, outdoors, on rooftops, indoor wet areas, outdoor areas and in garages
☐	Check transformer installations for adequate ventilation and spacing from walls and obstructions
☐	Periodic transformer oil testing

In regard to maintenance and inspection practices, manufacturer's recommendations should be followed if they exist, unless operating experience dictates otherwise. The following information should be viewed as general guidelines only, and should be modified to suit the situation.

Furthermore, it is understood that not all sections of the cable runs can be inspected due to the routing of the circuit through ducts or conduits, or because it is direct buried or installed in a heavily utilized cable tray.

Therefore, decisions based on inspections of accessible areas may have some associated risk since the “bad” section of the cable may not be visible or easily accessible. It may be assumed that if one section is in poor shape, then the non accessible sections could be in worse shape. Testing, coupled with inspections, is the best way to reduce this risk.

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instructions*:* Choose and write the letter of the correct answer on the space provided(3points)

_____1. Which of the following is responsible for inspection and maintenance works?

A. Qualified personnel C. technician

B. competent personnel D. all

_____2. ……will often be carried out at a place that is not under the management or control of the person conducting the business or undertaking carrying out the electrical work.

A. Electrical work C. maintenance work

B. Inspection work D. consultation

_____3. What is the use of consulting appropriate personnel for effective and coordinated maintenance work?

A. To reduce electrical fault C. to do safe maintenance system

B. to reduce maintenance time D. all

Note: **Satisfactory rating - Greater than or equal to 3 points** **Unsatisfactory – below2 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet 3- Preparing necessary materials

3.1 Materials necessary for maintenance work

3.1.1 MAINTENANCE AIDS

As a technician you required to read blueprints and drawings during the performance of many maintenance actions required to maintain the operational readiness of the Electrical installation and equipment. As you advance in rating you may also be required to make sketches and drawings, which will assist you in the training of less-experienced maintenance personnel by making it possible for them to visualize the system or object you are explaining.

3.1.2 BLUEPRINTS AND DRAWINGS

Blueprints are exact copies of Electrical or other types of drawings and employ a language of their own.

It is a form of sign language or shorthand that uses lines, graphic symbols, dimensions, and notations to accurately describe the form size, kind of material, finish, and construction of an object. It can be said that blueprint reading is largely a matter of translating these lines and symbols into terms of procedure, materials, and other details needed to repair, maintain, or fabricate the object described on the print.

Usually you can look at a blueprint and recognize the object if you are familiar with the actual part. But when you are required to make or check on a certain part, the applicable blueprint must be referred to in order to get dimensions and other pertinent information. The important thing is to know what the different symbols stand for and where to look for the important information on a blueprint. Some of the important facts listed on all blueprints are discussed in the following paragraphs.

To protect you from danger, protective equipment such as safety shoes, goggles, hard hats, and gloves are issued. The use of this equipment is mandatory on certain jobs. Their use is

a MUST, and there is no question about that. Be sure to USE THEM on any job WHERE they are REQUIRED. They can protect you from a lot of harm.

3.1.3 *Personal protective equipment (PPE)*

PPE for electrical work, including testing and fault finding must be suitable for the work, properly tested and maintained in good working order. The PPE must be able to withstand the energy at the point of work when working energized.

Safety shoes

Some safety shoes are designed to limit damage to your toes from falling objects. A steel plate is placed in the toe area of such shoes so that your toes are not crushed if an object impacts there.

Other safety shoes are designed for use where danger from sparking could cause an explosion. Such danger is minimized by elimination of all metallic nails and eyelets and by the use of soles that do not cause static electricity.

Goggles

Proper eye protection is of the utmost importance for all personnel. Eye protection is necessary because of hazards posed by infrared and ultraviolet radiation, or by flying objects such as sparks, globules of molten metal, or chipped concrete and wood. These hazards are ever-present during welding, cutting, soldering, chipping, grinding, and a variety of other operations. It is IMPERATIVE for you to use eye protection devices, such as helmets, face shields, and goggles (fig. 1-1), during eye-hazard operations.

Appropriate use of goggles will limit eye hazards.

Some goggles have plastic lenses that resist shattering upon impact. Others are designed to limit harmful infrared and ultraviolet radiation from arcs or flames by use of appropriate filter lenses.

Remember, eye damage can be excruciatingly painful. PROTECT YOUR EYES.

Gloves

Use gloves whenever you are required to handle rough, scaly, or splintery objects. Special flameproof gloves are designed for gas and electric-arc welding to limit danger and damage from sparks and other hot flying objects (fig. 1-2). Personnel in the electrical fields are usually required to wear insulating rubber gloves.

Be sure to follow all regulations prescribed for the use of gloves. Gloves must not be worn around rotating machinery unless sharp or rough material is being handled. If such is the case, EXTREME CARE SHOULD BE EXERCISED to prevent the gloves from being caught in the machinery.

Safety belts and straps

The safety strap and body belt shown in figure 1-3 are what might be called your extra hands when you work aloft. The body belt, strapped around your waist, contains various pockets for small tools. The safety strap is a leather or neoprene-impregnated nylon belt with a tongue-type buckle at each end. While you are climbing you will have the safety strap hanging by both ends from the left ring (called a D-ring because of its shape) on the body belt. When you are at working position, you unsnap one end of the safety strap, pass it around the supporting structure so there is no danger of its slipping (at least 18 inches from the top of the part on which it is fastened), and hook it to the right D-ring on the body belt.

The safety strap must be placed around a part of the structure that is of sufficient strength to sustain an Abs weight and his or her equipment, and must rest flat against the surface without twists or turns. It must not be placed around any part of a structure that is being removed.

Before placing your weight on the strap, determine VISUALLY that the snap and D-ring are properly engaged. Do not rely on the click of the snap-tongue as an indication that the fastening is secure.

The body belt and safety strap require inspection before use. Look for loose or broken rivets; cracks, cuts, nicks, tears or wear in leather; broken or otherwise defective buckles, such as enlarged tongue-holes, defects in safety-belt snap hooks and body belt D-rings.

If you discover any of these or other defects, turn in your equipment and replace it.

Perform maintenance periodically according to applicable procedures. Remember that leather and nylon belts are treated in different manners.

PPE for electrical work, including testing and fault finding must be suitable for the work, properly tested and maintained in good working order. The PPE must be able to withstand the energy at the point of work when working energized.

Training must be provided in how to select and fit the correct type of equipment, as well as training on the use and care of the equipment so that it works effectively.

Depending on the type of work and the risks involved, the following PPE should be considered:

Face Protection—use of a suitably arc rated full face shield may be appropriate when working where there is potential for high current and arcing.

Eye Protection—metal spectacle frames should not be worn.

Gloves—use gloves insulated to the highest potential voltage expected for the work being undertaken. Leather work gloves may be considered for de-energised electrical work.

Clothing—use non-synthetic clothing of non-fusible material and flame resistant. Clothing made from conductive material or containing metal threads should not be worn.

Footwear—use non-conductive footwear, for example steel toe capped boots or shoes manufactured to a suitable standard.

Safety Belt/Harness—safety belts and harnesses should be checked and inspected each time before use with particular attention being paid to buckles, rings, hooks, clips and webbing.

Protective gear items are not considered tools, because they do not directly help perform work, just protect the worker like ordinary clothing. Personal protective equipment includes such items as gloves, safety glasses, ear defenders and biohazard suits.

Safety

Safety should ALWAYS be the foremost concern for anyone who is working on or around electricity. It is critical to recognize and distinguish between those repairs that you are qualified to undertake and those that only a professional electrician should handle.

If you do decide to undertake a basic home electrical project, consider the following important safety tips:

1. Always turn off the power to the circuit that you plan to work on by switching off the circuit breaker in the main service panel.
2. Be sure to test wires before you touch them to make sure that the power has been turned off. Test from the black wires to both the grounded box and the white wires, and test from the white wires to the grounded box.
3. Never touch plumbing or gas pipes when performing your electrical project.
4. Make sure that you are not standing on a damp floor.
5. Be sure to unplug any lamp or appliance before working on it.
6. Take an active role in understanding the condition of your current electrical system, its capacity, limitations, and potential hazards.
7. Before you begin knocking down walls or drilling into them, turn off the circuits that are close to where you're working. Only turn these circuits back on once you've completed all work. If the backs of wall switches, power points or other electrical parts are left exposed do not turn the power back on until the wall has been repaired to protect the electrical parts
8. Circuit breakers and safety switches should only be reset after first checking for damaged or unsafe electrical appliances or a reason why the safety switch or circuit breaker was triggered.
9. To be as safe as possible, home owners and landlords should consider having safety switches installed on all circuits including lights, air conditioners, stoves, hot water systems and pool equipment, even if they are on a separate tariff

Follow these simple tips to ensure the safe use of electrical appliances near water and the safety of your family:

1. Never use any electrical appliance near water or touch anything electrical with wet hands.
2. In the bathroom, switch off and unplug all portable electric appliances after use and store in a location where they will not get wet or damaged.
3. Do not use portable heaters in bathroom wet areas it is best to have a strip heater or a ceiling unit installed by your electrician?
4. Do not use portable power boards or double adaptors in laundries or bathrooms.
5. If an electrical appliance that is not designed for use in water gets wet, or gets water inside it, have it checked by an electrician or manufacturer's authorized repairer.
6. Low cost equipment may not be repairable and should be disposed of safely so it cannot be reused.
7. Do not use extension leads or power leads near outdoor wet areas, unless they are specifically designed for external use.
8. Wear rubber or plastic-soled shoes when using electrical appliances in laundries, on concrete floors or outdoors.

Self-Check – 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below**.**

Instructions: Choose and write the letter of the correct answer on the space provided(6points)

_____1. ……..use of a suitably arc rated full face shield may be appropriate when working where there is potential for high current and arcing

A. Face Protection B. Gloves C. Footwear D. Safety Belt/Harness

_____2. ……metal spectacle frames should not be worn.

A. Footwear B. Eye Protection C. Face Protection D. clothing

_____3. …….. insulated to the highest potential voltage expected for the work being undertaken. Leather work gloves may be considered for de-energized electrical work.

A. Gloves B. Clothing C. Footwear D. Safety Belt/Harness

_____4. ……use non-synthetic, non-fusible material and flame resistant. Clothing made from conductive material or containing metal threads should not be worn.

A. Gloves B. Clothing C. Footwear D. Safety Belt/Harness

_____5. ……..use non-conductive steel toe capped boots or shoes manufactured to a suitable standard.

A. Footwear B. Clothing C. Face Protection D. Safety Belt/Harness

_____6. …… should be checked and inspected each time before use with particular attention being paid to buckles, rings, hooks, clips and webbing.

A. Gloves B. Footwear C. Safety Belt/Harness D. gloves

Note: **Satisfactory rating - Greater than or equal to 4 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet 4- Selecting and checking the required tools, equipment, and testing devices

4.1 Electrical Tools and Equipment

Electrical Tools

Electrical task can be accomplished systematically to save time, effort, and resources. Most of the work cannot be done using bare hands. To do the task, electrical tools or equipment are needed to perform the job. tools are valuable items that make work become quicker, simpler, and more convenient. They have made tasks like repairing and building much easier, turning some of the most tedious projects into something that only takes a short while to accomplish.

1. **Screw driver:**-he screwdriver is a device specifically designed to insert and tighten, or to loosen and remove
2. **Pliers**:-are hand tools, designed primarily for gripping objects by using leverage. Pliers are designed for numerous purposes and sometimes require different jaw configurations to grip, turn, pull, or crimp a variety of things. They are a tool common to many dexterous trades and occupations. Many types of pliers also include jaws for cutting.
3. **Cutting tools**:-such as the knife, scythe or sickle, are wedge-shaped implements that produce a shearing force along a narrow face. Ideally, the edge of the tool needs to be harder than the material is being cut or else the blade will become dulled with repeated use. But even resilient tools will require periodic sharpening, which is the process of removing deformation wear from the edge. Also gouges and drill bits.
4. **Hammer**:-A modern hammer is directly descended from ancient hand tools. Moving tools move huge and tiny things, e.g. concentrating force tools like the hammer moves a nail, the maul moves a stake, or a whip moves flesh on a horse. These operate by applying physical compression to a surface.

4.2 Electrical Testing equipment

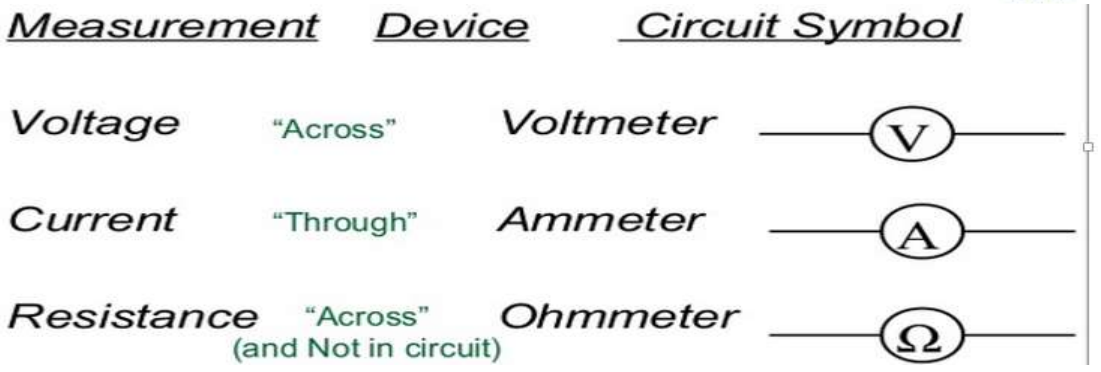
Testing devices

1. **Multi-meters:-**It works like an ammeter; ohmmeter and voltmeter for it can measure current, voltage as well as resistance. A multi-meter or a multi-tester, also known as a VOM (Volt-Ohm meter or Volt-Ohm-mill ammeter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multi-meter can measure voltage, current, and resistance. Analog multi-meters use a micro ammeter with a moving pointer to display readings. Digital multi-meters (DMM, DVOM) have a numeric display, and may also show a graphical bar representing the measured value. Digital multi-meters are now far more common but analog multi-meters are still preferable in some cases, for example when monitoring a rapidly varying value.

   A multi-meter can be a hand-held device useful for basic fault finding and field service work, or a bench instrument which can measure to a very high degree of accuracy. They can be used to troubleshoot electrical problems in a wide array of industrial and household devices such as electronic equipment, motor controls, domestic appliances, power supplies, and wiring systems.

   A multi-meter is a combination of a multi-range DC voltmeter, multi-range AC voltmeter, multi-range ammeter, and multi-range ohmmeter. An un-amplified analog multi-meter combines a meter movement, range resistors and switches.

Figure 3. Analoge and digital multimeter



Safety

Some multi-meters include a fuse, which will sometimes prevent damage to the multi-meter if it is overloaded. However the fuse often only protects the highest current range on the multi-meter. A common error when operating a multi-meter is to set the meter to measure resistance or current and then connect it directly to a low-impedance voltage source; meters without protection are quickly damaged by such errors, and can sometimes explode causing injury to the operator.

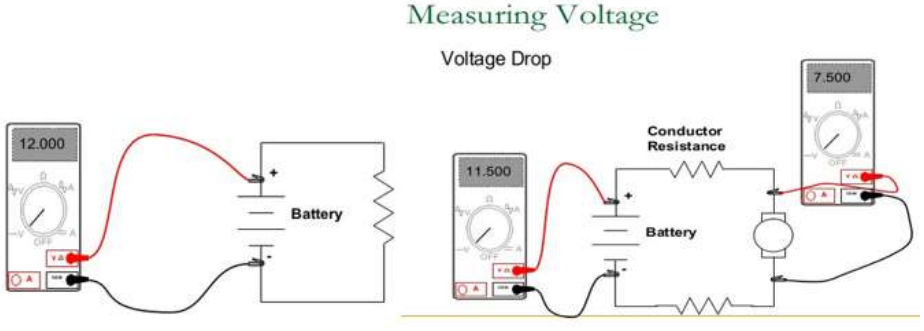


Figure 4. Measuring voltage

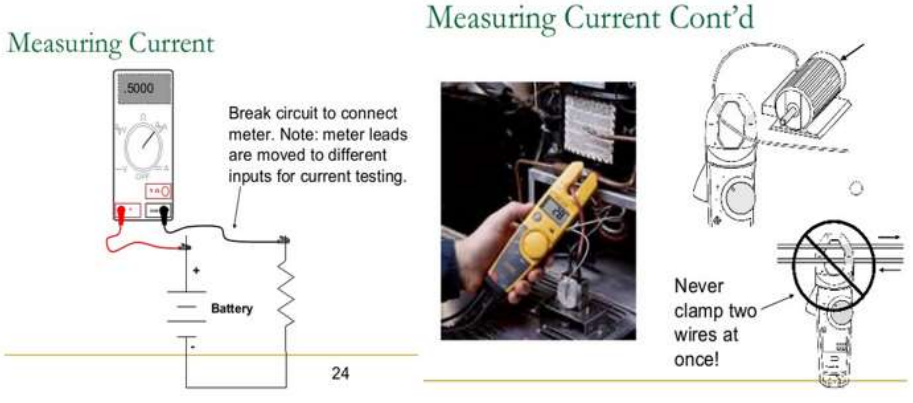


Figure 5. Measuring current

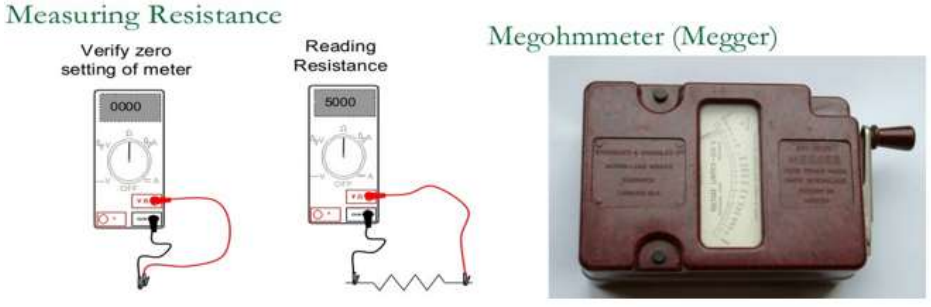


Figure 6. Measuring resistance

2. **Insulation resistance tester (meager):-**Megger is basically a DC generator operated manually and ammeter calibrated as kilo-ohm and mega ohm is generally used to measure the insulation. Megger has become the generic description for a high voltage, low current insulation tester.

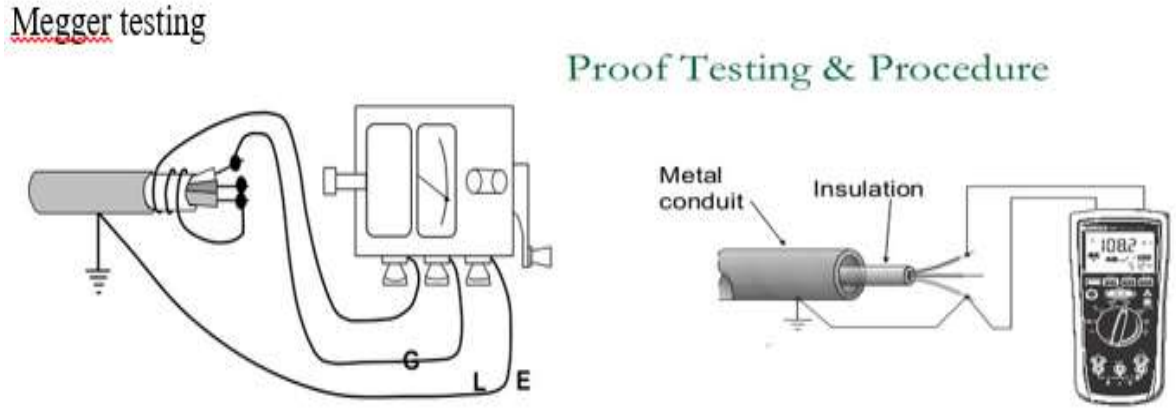


Figure 7.insulation tester

3. **Clamp meters:-** Meters which measure high voltages or current may use non-contact attachment mechanism to trade accuracy for safety. Clamp meters provide a coil that clamps around a conductor in order to measure the current flowing through it.

Figure 8. clamp meter

4. 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 9. wattmeter

5. **Test light:-**A test light, test lamp, or mains tester is a very simple piece of electronic test equipment used to determine the presence or absence of an electric voltage in a piece of equipment under test.

The test light is simply an electric lamp connected with one or two insulated wire leads. Often, it takes the form of a screwdriver with the lamp connected between the tip of the

screwdriver and a single lead that projects out the back of the screwdriver. By connecting the flying lead to an earth (ground) reference and touching the screwdriver tip to various points in the circuit, the presence or absence of voltage at each point can be determined and simple faults detected and traced to their root cause.

For low voltage work (for example, in automobiles), the lamp used is usually a small, low-voltage incandescent light bulb. These lamps usually are designed to operate on approximately 12 V.

Figure 10 .Neon test lamp

6. **Tachometer:-**Tachometer showing engine RPM (revolutions per minute), and a red-line from 6000 and 7000 RPM. A tachometer is an instrument that measures the rotation speed of a shaft or disk, as in a motor or other machine. The device usually displays the revolutions per minute (RPM) on a calibrated analog dial, but digital displays are increasingly common.

Figure 11. Tachometer

Self-Check –4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I: Give short answer for the following Questions not more than one page using your separate answer sheet (8point)

1. _____ are hand tools, designed primarily for gripping objects by using leverage.(2pts)
2. _____ used to determine the presence or absence of an electric voltage in a piece of equipment under test.(2pts)
3. _____ an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit. (2 points)
4. Insulation resistance measured by_____ (2 points)

Note: **Satisfactory rating – Greater than or equal to 4 points Unsatisfactory – below 4 points**

Part one: short answer

LG #40	LO #2- Maintain electrical equipment and associated circuits

Instruction sheet

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

- Ascertaining normal operating principles of the equipment and associated circuits
- Maintaining maintenance records and instructions of the Equipment.
- Achieving necessary circuit isolation.
- Testing and confirming in accordance current regulation for safe reconnection.
- Responding unplanned events

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**:

- Ascertain normal operating principles of the equipment and associated circuits
- Maintain maintenance records and instructions of the Equipment.
- Achieve necessary circuit isolation.
- Test and confirm in accordance current regulation for safe reconnection.
- Respond unplanned events

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”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Ascertaining normal operating principles of the equipment and associated circuits

1.1 Electrical circuit Maintenance

Electrical Preventive Maintenance (EPM) is the practice of conducting routine inspections, tests, and the servicing of electrical equipment so that impending troubles can be detected and reduced, or eliminated. Maintenance is mainly needed because of the following reasons

- Electrical installation is the collection of branch circuits and electrical devices Connected together to perform electrical functions
- Each electrical devices and branch circuits have their own play in the operation of the electrical installation
- If any electrical device or wire should fail, then the operation will be drastically changed.
- A faulty electrical device and wire indicates a set of symptoms which can be used to indicate the device and wire fault.
- When the user doesn't get the desired performance, he expects from the circuit it has a problem.
- There is a conflict b/n circuit performance and expectation of the user.
- The question of maintenance arises when the installation is not performing as per its design; this May be due to fault developing in the circuit due to various reasons.

Maintenance is an activity under take to keep equipment, devices, circuits, etc. in a performance condition or to return such performance conditions.

Maintenance is a total approach aimed to reduce downtime but repair is one of the steps in their total approach E.g.-Repair is compared to firefighting, maintenance consists of various steps aimed at minimizing fire hazards

1.2 Fault finding

Electrical safety is primarily dependent upon appropriate job planning and correct testing procedures and techniques. No electrical equipment should be assumed to be de-energized after isolation. **Always test prior to touching**.

Persons required to work in association with electrical equipment must be appropriately trained and competent in test procedures and in the use of testing equipment.

Isolating power should always be the first choice, however, there may be instances when fault finding or obtaining test results is only possible whilst equipment is live, and other safety measures need to be taken.

(a) The electrical worker must be competent in the work and familiar with the equipment involved and the requirements for working on live electrical equipment contained in section 15 must be adhered to.
(b) Where testing for faults within plug-in electrical equipment, whilst live, an RCD or an isolating transformer should be used.

Fault Current

The current that can flow in a circuit as a result of a undesired short circuit.

Repair Only

A term used in the secondary telecom equipment business. Equipment is repaired to original working condition, but does not include refurbishment or recycling except where required to bring equipment to working condition.

Common Faults and rectification of florescent lamp

Faults	**Rectification**
1. Lamp doesn't glow but flicks	a) Replace after testing
Cause: - lamp is defective	
Low voltage	b) Check up the voltage

Defective starter c) Test the starter.

2. Lamp doesn't start

Cause: - Open circuit in the filament..... a) Test the filament.

Loose or broken connections..... b) Test the wire and

tighten the loose connections.

3. Lamp burns out often

Cause: - High voltage..... ..... Check the voltage

4. Lamp filament glow but not light up.

Cause: - short - circuit of the starter contacts..... test the starter

Capacitor short circuited ..... test and replace condenser

5. Lamp goes out and on

Cause: - low voltage ..... check the voltage

Spoiled chock ..... check the chock

Loose connection in the holder and starter ..... check the lamp holder, connections, and the starter contact.

6. Blackening of the lamp at the ends after short use,

Cause: - High voltages ....checks and reduce the voltage

Choke coil is shorted ..... test and replace the choke

Fault Finding – Three Phase Induction Motors

Table 2. Common faults on electrical system

Problem	Possible Cause	Tests	Solution
Motor will not start.	1. Fault with supply. 2. Motor or load locked up. 3. Wrong connections in control circuit.	1. Check for correct voltage at motor terminals. 2. Make sure motor and load are free to turn. 3. Check to ensure contactors operate.	1. Fit new fuses, reset circuit breakers, etc. 2. Remove clamps, locks, etc. 3. Sort out control circuit.
Supply or Started trips out at start.	1. Wrong or loose connections. 2. Motor overloaded. 3. Intertia of load to high. 4. Low Voltage due to volt drop in cables 5. Overload or circuit breaker incorrectly set or sized.	1. Check all lugs are properly crimped or soldered, and connections are tight. 2. Check load performance data against motor performance data. 3. Measure voltage at motor terminals while motor starting.	1. Fix up connections. 2. Change motor for correct size. 3. Change cables for correct size. 4. Correct setting of overload or breaker or change.

		4. Check settings of overload and circuit breaker and allow for starting current	
Motor starts but has no torque. Motor does not reach full speed or takes a long time to accelerate.	1. Incorrect connection. 2. Delta wound motor connects in star. 3. Star/Delta starter staying in Star. 4. Inertia of load to high. 5. Motor overloaded. 6. Low voltage due to volt drop in cables.	1. Check connection diagram and nameplate data. 2. Check load performance data against motor performance data. 3. Measure voltage at motor terminals while motor starting	1. Sort out and correct connections. 2. Check timer and starter control circuit. 3. Change motor for correct size. 4. Change cables for correct size.
Motor Overheating.	1. Motor overloaded. 2. Ineffective cooling. 3. Excessive ambient. 4. Wrong connection. 5. Delta wound motor in star. 6. Motor “Single Phasing”. 7. Wrong voltage or frequency. 8. Supply voltage unbalanced.	1. Check load performance data. 2. Check fan and air flow and temperature of air. Look for build up of dirt. 3. Check connection diagram and nameplate data. 4. Check volts and amps in all three phases. 5. Check nameplate 6. Measure phase to	1. Fix problem with load or fit larger motor. 2. Clean motor. Sort out cooling of air temp. and flow. 3. Sort out connections. 4. Restore supply to all phases. 5. Correct voltage or frequency. 6. Balance supply or accept

		phase voltage accurately	unbalance.
No load amps in excess of Full load amps	1. Incorrect connection 2. Star wound motor connection Delta. 3. Voltage in excess of nameplate. 4. Motor supplied for different voltage or frequency.	1 & 2. Check connection diagram and nameplate data. 3. Measure voltage at motor terminals. 4. Compare supply voltage and frequency to nameplate.	1 & 2. Sort out and correct connections at motor terminals. 3. Correct supply voltage 4. Change motor for correct voltage and frequency
Mechanical Noise or Vibration. Noisy bearings. Bearings overheating.	1. Thrust from load or misalignment. 2. Damaged bearings, too much grease, no grease, or foreign matter in grease. 3. Rotor pulling or foreign matter in air gap. 4. Out of balance load, coupling or pulley. 5. Excessive belt pull. 6. Motor foundations not rigid.	1. Check gap between coupling halves and alignment. 2 & 3. Turn shaft slowly by hand and feel for roughness or stiffness. Check for bent shaft or fan rubbing. 4. Run motor disconnected from load and then with pulley or coupling removed. 5. Run motor without belts. 6. Check design and construction foundations	1. Re-align couplings 2 & 3. Clean bearing housing, change bearings and repack with fresh grease. 4. Fix up out of balance items 5. Loosen belt tension 6. Increase strength of foundations
Motor amps in excess of nameplate full load amps on load	1. Motor overloaded. 2. Low supply voltage. 3. Wrong voltage or	1. Check load and performance data. 2. Measure voltage at	1. Fix problem with load or fit larger motor.

	frequency. 4. Wrong Connections. 5. Motor 'Single-Phasing'. 6. Supply voltage unbalanced. 7. Motor Speed not matched to load.	motor terminals 3. Check nameplate. 4. Check nameplate 5 & 6. Check volts and amps in all three phases. 7. Measure motor speed and check load speed requirements.	2. Fix problem, maybe with larger cables. 3. Correct voltage or frequency. 4. Sort out and correct. 5 & 6. Restore balanced supply to all three phases. 7. Change motor for correct motor speed.
Excessive electric noise	1. Wrong connections. 2. Wrong voltage. 3. Motor 'Single-Phasing'.	1. Check connections 2. Check voltage with nameplate 3. Check volts with amps in all three phases.	1. Fix up connections 2. Correct voltage. 3. Restore supply to all three phases.
Unbalanced amps in different phases when motor loaded	1. Unbalanced supply voltage	1. Measure phase to phase voltage accurately	1. Balance supply or accept unbalance
Motor runs in wrong direction	1. Wrong connections.	1. Watch shaft rotation	1. Swop and two phases of supply.

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below

Instruction I: Give short answer for the following Questions not more than one page using your separate answer sheet (4 point)

1. List and explain Common Faults of florescent lamp?
2. What are the common causes of Unbalanced amps in different phases when motor loaded?

Note: **Satisfactory rating - Greater than or equal to 2 points** **Unsatisfactory - below 2 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet 2- Maintaining maintenance records and instructions of the Equipment

2.1 Maintaining different equipments

Personal Protective Equipment

Personal protective equipment is used by maintenance workers to provide protection from hazardous electrical energy. Integrity of this equipment is paramount, so maintenance should be scheduled and accomplished similar to equipment maintenance

2.1.1 Circuit Breaker maintenance

Role of a Circuit Breaker

Most electrical systems in flats have a circuit breaker which ensures that users do not overload the power circuits and that wires do not carry more power than the wires can safely handle. When excessive power is drawn from a given circuit (due to a defective electrical appliance or when too many devices are plugged into the same circuit), the circuit breaker will trip the circuit and cut off all electricity to prevent damage to the device, electrocution of the user, and overheating of the device or even electrical fires. Circuit breakers and fuses both provide the same protection. During a power surge, they stop the power flow. However, the downside of fuses is that they have to be replaced every time they have been operated in an open circuit, while a circuit breaker simply needs to be reset.

Typical Circuit Breakers Problems

1. **Bad Wiring or loose connections**- This could cause flickering lights and power failures. Loose connections may be caused by general wear and tear of the electrical wiring, which can cause increased resistance. This increased resistance then generates heat that can lead to overheating of the wires. If faced with such problems, look for visible loose wiring.

Figure 12. Bad Wiring or loose connections

2. **Overloaded circuit** –This can lead to power failures, electrical fires which could put people at risk of injury.

3. **Short circuit** – Live electrical wires may overheat and melt the outer insulation case protecting the wire, leading to short circuits. Also, when live wires touch a grounded or neutral wire or other unintended conductors, a short circuit might occur, and this might lead to electrical fires.

4. **Defective electrical devices** – These devices may draw excess electricity in surges, tripping circuit breakers.

Replacing a Faulty Circuit Breaker

Circuit breakers tend to last a long time, but circuit breakers can get worn out over time and after several reuses and can break or malfunction. It is very dangerous to replace the blown fuse or faulty circuit breaker with a circuit breaker that has a higher rating. If the wiring in that circuit is not the appropriate rating/size for that higher rating, the excessive current carried will cause overheating or electrical fires. When replacing a circuit breaker, you will need: New circuit breaker (same brand, make, model and size as the one you're removing)

Test the breakers with a voltage tester to make sure everything is in order

Figure 13. Correct circuit breaker installation

How to prevent circuit breaker trips

1. Unplug electrical appliances that are not being used. Electricity can still flow through electrical wirings in an appliance even when turned off.
2. During hotter weather, be aware of the number of electrical appliances plugged in as it may worsen the problem of overheating.
3. Look for damaged, melted, scorched or frayed wires/cords for appliances. Keep the cords in the best condition possible. Avoid overstretching wires, bending them or placing heavy or sharp objects in contact with them.

Signs of a Faulty Circuit Breaker

1. It stays in the “ON” position but supplies no current to the circuit. Use a multi-meter to measure the voltage at the circuit breaker. There will be no voltage if the circuit breaker is bad.
2. It trips, and after reset, trips again immediately.
3. It trips, and after reset, stays on, then trips again within a few hours
4. It is hot in temperature or giving a burning smell
5. It is showing signs of damage such as charred material or frayed wires.

2.1.2 Light installation, relocation or fitting services maintenance

Appropriate lighting enables homeowners to complete tasks efficiently, feel safer and create an aesthetically-pleasing haven after a long day at work. However, based on the size of each room in the house, there are specific lighting needs. Faulty installations may sum up to a larger amount than the installation cost you saved while doing it yourself.

Different types of light installation for different parts of your house

This is a general guide on the types of light installations for various parts of your house. Based on the functionalities or aesthetic purpose of the lights, Here are some lighting inspirations:

It is crucial for lightings in the kitchen and bathroom to be well-lit at any time of the day since we are constantly completing tasks in that area. Having multiple lights would serve to complete the aesthetic look of the area, while providing sufficient lightings to remove any dark areas which could lead to injuries. Light installations here would include LED light installation, ceiling light installation and wall lighting at the corners. However, lights installation at this area is tricky since these lights will be exposed to water. It is crucial to have a certified professional electrician to ensure that the electrical wiring is done with caution. electricians are well-trained in handling electrical wirings to ensure no breach of safety for lightings in areas that will be exposed to water.

Common Light Installation problems

These are some of the common light installation and fixture problems you should be aware of:

1. Faulty Wiring

Lighting components comprises of many parts, including the wires and tube casings. These wires are usually very delicate, which might be prone to damage upon any mishandling. Electricians must be extremely careful when dealing with these light bulbs even when they are brand new removed from the package. During installation, it is crucial to check that the

wirings are in their original placing. Should the wires be out of their places, there are possibilities that they can get frayed, bent, broken or detached from their terminals, causing the common household phenomenon of “my lights are not working”.

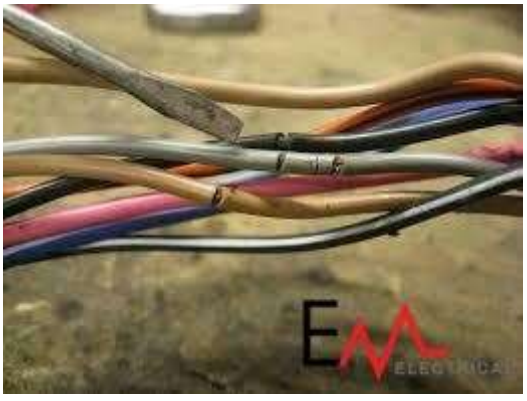


Figure 14. broken lines

2. **Light Bulbs burning out quicker**

Light bulbs are supposed to be quite long lasting, providing you with lights for many years without replacements. Hence, regular burning out of light bulbs is a serious issue which is not supposed to happen. Reasons include low quality bulbs usage, switch problems or wiring issues. After a proper and comprehensive troubleshooting, provide the diagnostic of the problem, recommend the most suitable repairs and replacement of light fixtures.

3. **Flickering and Dim lights**

It is common for households to experience flickering and dim lights one fine day when you’ve turned on the switch. There are various reasons why the lights will be flicker, including poor wiring, damaged starters and faulty switches. If your lights are flickering, you should troubleshoot the actual cause and the light fixture for proper replacement.

4. **Damaged light switch**

These light fixtures are controlled by various types of switches, which should also be functioning well to ensure the lights are working. Switches can be damaged because of

various reasons including loose wires, overheating, wear and tear after a prolonged period of usage. It is advisable to fix the damaged light switches to ensure smooth running of your lights again.

Replacement of light fixtures

However, do take note of the safety precautions to take prior to fixing. The great part about light fixtures replacement is that it's a pretty universal process. These are the steps to take:

1. Turn off power to the old fixture
2. Remove the canopy to expose the wiring and fixture hardware
3. Unscrew the three wires (Black, white and copper)
4. Remove the old light fixture
5. Install the new bracket
6. Connect new fixture wires
7. Secure the new fixture
8. Restore power and test out the new fixture

Note that at any point of the replacement of light fixtures, ensure that your hands are totally dry and always standby for sufficient lighting such as torch lights should you be replacing the lights at night. After attempting to replace the light fixtures, should complications arise from the unsuccessful installations,

2.1.3 Power Socket/Power point installation services

Faulty power sockets are one of the most common and inevitable issues faced. Since it is the only viable way for us to get our electrical appliance to work, it is definitely troublesome whenever one stops working. Although the most common problem occurs from an electrical wiring issue, it is not surprising to see a power point malfunctioning just for no apparent reason. As complicated as it sounds, replacing the electrical outlet may or may not solve the problem entirely and you might need to take an extra step: A complete rewiring of your electrical switch. This is to prevent any fire hazards or any trigger of a shock.

Different kinds of electrical outlets

Type G:

A standard voltage of 230V and a frequency of 50 Hz.This plug has 3 pins and it is grounded.

Figure 15. Type G Outlets

Type C:

The type C plug (Or known as Euro plug) is a two-wire plug that has 2 round pins. It fits into any sockets that accepts 4.0 – 4.8mm round contacts on 19mm centres. This plug is not grounded and thus, needs to be used with caution. It requires an electrical current of 2.5A.

Figure 16. Type C Outlets

Type A:

The type A plug (or known as the flat blade attachment plug) is an ungrounded plug with 2 flat pins. It carries an electrical voltage of 100 – 127 V and an electrical current of 15A.

Figure 17. Type A Outlets

Type B:

The type B plug has two flat parallel pins and a round grounding pin. The earth pin is longer than the other two so the plug can be grounded before the other 2 is attached. An identical voltage and current with Type A, both electrical outlets that are type A and B can be used with these plugs.

Figure 18. Type B Outlets

Type D:

The type D plug has 3 large round pins in a triangular pattern. Sometimes, it is used together with **Type M plugs** for larger appliances. This plug carries an electric current of 5A and a standard voltage of 220 – 240 V.

Figure 19. Type D Outlets

Type E:

The type E plug has 2 4.8mm round pins and a hole for the socket's earth pin. It is a rounded plug and the socket has a round recess. It carries a standard voltage of 220 – 240 V, with an electrical current of 16A. It is mainly used in European countries.

Figure 20. Type E Outlets

Type I:

The type I plug has two flat pins in a V shape form as well as a grounding pin. A version of the plug with only two flat pins also exists. It carries an electrical current of 10A and a standard voltage of 220 – 240 V.

Figure 21. Type G Outlets

Reasons of power socket failures:

It comes as a shock when you find out that your power socket stopped working without knowing what is the underlying reason. These are some of the most common reasons behind power socket failures:

Open circuits:

An open circuit is an electrical circuit that is not completed. The most common cause of open circuits is loose wires, leading to the incompletion of the entire electrical circuit. Poor socket installation can also result in a gap or break in the electrical wiring.

Overloaded circuits:

An overloaded circuit is an electric circuit that is carrying more current that it is designed to handle, creating a danger through overheating Whenever a circuit is overloaded, the circuit breaker trips, causing the flow to fuse, to prevent the overheating of electrical wires. As a result, the connection breaks and the circuit fail.

Short circuits:

A short circuit is a low resistance connection between 2 conductors supplying electrical power to any circuit. It results in excessive current flow through the 'short', and may cause the power source to be destroyed. This also occurs when a hot wire accidentally touches a ground wire. This eventually leads the current to the circuit breaker, tripping the circuit.

Faulty outlets:

If the above does not describe any of the problems that you are currently facing, it is possible that the outlet was faulty to begin with. It is easy and cheap to replace the outlets. However, it is important to shut off any circuit before doing replacement works as it is dangerous to do so with the circuit running.

Possible consequences of faulty power sockets usage:

It is important to know the consequences of using a faulty power socket. Electrical outlets provide such constant and convenient use that it is easy to forget that it is only protected by a thin layer of rigid plastic beneath the outlet receptacle. Over time, the plastic could melt or crack, exposing the current.

Shock risk:

It is most commonly known to all that exposed hazards can provide a shock risk to the user especially if you're not careful with the sockets. These shocks can be deadly, and it is extremely dangerous.

Fire hazard:

Whenever a socket is faulty, overheating is commonly the plausible problem underlying in the socket. When it is overheated, the socket can prove to be a potential fire hazard. At the work place, safety is our utmost priority.

Fixing power socket problems:

Remember, it is very **IMPORTANT** to switch off all power to your circuits before attempting any of the solutions.

Circuit Breaker:
Switch off the circuit breaker and switch it back on after 5 minutes. If you're unsure which is the faulty ones, turn them all off and experiment to see which causing the problem.

Ground Fault:
This could occur due to damaged wiring, faulty power tools or even through water damage. This fault is usually cleared after it dries completely.

Faulty electrical power points:
When a power point is faulty, there is no other choice but to replace it since a power point is bound to weaken gradually due to wear and tear.

Loose or broken wires:
When an installation to a power point is not done properly, wires will loosen up and eventually causing the current to get disconnected. It may lead to overheating and ultimately, a fire hazard at home. Thus, it is important to consider rewiring the entire electrical installation to mitigate any risks.

2.1.4 Re-wiring solutions

What is re-wiring?

Rewiring is a process to replace the electrical wiring of a house or flat. Old or faulty wiring can cause the entire electrical system to trip frequently and is a common cause of electrical

fires. Common signs of faulty wiring are dimming or flickering lights, frequently blown breakers or fuses, and charred or blackened switches.

Signs that you need electrical wiring repair

1. Wiring appears to be damaged (Signs of cracking, peeling, getting exposed or frayed)

Electric wires are prone to frays due to heat, age, corrosion, and general wear-and-tear. Sharp objects such as nails can also damage the wires. Pets or rodents can also be a cause of fraying as they can chew on the wires.

Figure 22. damaged wires

2. Circuit breakers which trip often

This most likely happens due to a case of overloading, where you draw too much electricity that a circuit cannot safely handle. An electrical panel replacement should be done If there is critical damage on your electrical wires or circuit breaker, or a check conducted if your circuit breaker trips frequently.

Figure 23.damaged circuit breaker

3. Frequently blown fuses

4. Charred or burnt power sockets, power outlets or switches

The wiring might not be properly installed. If the electrical switches and outlets are hot upon touching, they might be overheated. Your wiring points should also not be darkened, or black, as electrical wiring should be white or gray.

5. Burning smell with a sizzling sound within walls close to electrical outlets

Buzzing sounds may happen due to improper connections or frayed wires when electrical current is passed through them. These buzzing sounds are a clear indication of a safety problem with your wiring, and you should contact an electrician immediately.

6. Loose Connections

Connections between electrical switches and wires may loosen up due to frequent usage, old age and general wear and tear.

Figure 24. Loose Connections

7. Dimming lights

Overloading may cause your lighting to be dim. Large appliances like air conditioner or fridge may be connected to the circuit as lights. the brightness of your lighting changes significantly.

8. Smoke

Any instances of smoke are a sign of an immediate sign of danger

. It is extremely important to have a properly installed electrical wiring system,

How to prevent wires from damage?

– Protect wires with tubing to prevent rodents or pets from chewing on cables
– Protect wires with spiral wrap
– Use of electrical tapes
– Use of heat-shrinking tubes
– Pull on the plug instead of pulling on the cable to unplug an electrical device
– Make sure to locate electrical wires before drilling a hole in the wall
– Avoid making sharp bends or kinks on the wires

How to DIY your damaged electrical wiring

However, some things to take note before getting started ensure that:

1. You are well equipped with the skills and knowledge to handle electrical wiring
2. The power is turned off
3. You are not working where conductors or terminals could become live.
4. For certain re-wiring (for HDB occupants), it is recommended to refer to the site for requirements. In certain re-wiring projects, electrical permits are required, and it is recommended to get licensed electrical workers to handle the rewiring

2.1.5 Faulty/Broken light switches Repair

Switches are found in many household appliances, generally used to control common household appliances such as the lights, television, air conditioning, and hairdryer. The main types of switches used in homes to activate electrical appliances are the toggle switch and rocker switch. Light switches are often mounted on the wall near a doorway, allowing a person entering a room to flip the switch to turn on the lights.

Different types of light switches and how they work

1. Single-Pole Light Switch – Has two terminals that can only be switched on or off from one location. Flipping this switch on single-pole models either connects or disconnects the circuit.
2. Double Way Switch – uses an on/off toggle and controls devices such as receptacles and lights from a single location
3. Three-Way Light Switch (single pole, double throw switch) – has three terminals and is connected to two other switches located in two different locations (i.e. top or bottom of the staircase)
4. Four-Way Light Switch (double pole, double throw switch) – can control a light fixture with three or more switches. 4-way light switches are basically combined with 3-way switches in order to control lights from three or more locations.
5. Push Button Switch – Buttons to be pushed interchangeably to turn the lights on and off. In certain models, the buttons are fitted with springs that enable them to smoothly return to the original position after pressing.

6. Selector Switch – Usually designed with a circular unique/turning knob that controls the light intensity by rotating it. Besides, selector switches also allow for two-mode light control, making them quite versatile.
7. Toggle Switch – Usually designed with a lever that is strategically positioned to instantly connect or break the circuit when moved up or down.
8. Sliding Dimmer Switch – Allows you to turn the light back on to the same intensity you had previously
9. Touch Light Dimmer Switch – Touch control functionality
10. Other additional features – Some switches have a small light that comes on when the switch is off, making it easy to find the switch in the dark. Another type of switch operates with a photoelectric cell, turning the light on at night and off during the day. Some switches are activated with sounds (e.g. clapping sounds), timer, motion sensors, and even from handheld devices.

Whether you are considering which type of switch to install in your new house, or replacing faulty electrical switches, you have to aim to minimize the downtime of any electrical-related problem by providing responsive electrical switches repair in and mitigating future occurrences of such electrical problems.

Signs that your light switches are faulty

1. **Light Switch Produces a Large Spark**

Small sparks on light switches might not be a big concern if they rarely occur. However, a large spark or a spark that produces noise is a sign of a faulty light switch. It needs immediate repair and replacement.

2. **Light Fixture doesn't turn on immediately**

This phenomenon occurs when metal parts inside the switch are overused. The electrical wirings are not able to drive electricity around the circuit to complete an electrical path like before, leading to a required replacement of the light switch.

3. **Noisy Light Switches**

Loose electrical wiring may lead to the production of certain buzzing noises which indicates

that the switch is worn out. This suggests that a light switch repair or replacement is due. However, if such noises are produced by a dimmer switch, the source of buzzing is highly likely coming from the light bulb. The effect of dimming lights usually makes such buzzing sounds.

Cautions when replacing faulty light switch

1. Trying to troubleshoot a wall switch may be difficult as its parts are enclosed inside plastic casing. The solution is usually to contact an electrician to replace the switch. Switches are usually inexpensive and can be replaced for a low cost. However, it is important to know if the switch itself is faulty, or if there is a problem with the wiring such as a loose connection.
2. Protect yourself by ensuring the wires to the switch are dead before you service it. It is important to protect yourself by ensuring that there is no electricity running to the switches that you are trying to troubleshoot. Check your circuit breaker to ensure that power to that section of your house is turned off (Circuit breakers usually have a label for which part of the house they supply electricity to, e.g. Master Bedroom, Kitchen).
3. When troubleshooting the switch, take note of what signs it displays. If the light comes on but is dim or it flickers, it probably is a loose connection. If the light is completely off, the circuit breaker might be tripped.
4. Using a screwdriver, unscrew the switch and slowly pull it out. You will notice that there are still wires attached to it. Next, unscrew the wires connected to the switch with a screwdriver. Note which wire goes into which terminal as it is important to connect it back in the right order.
5. With the new switch, match up the correct wires to their terminals and screw them in. The white, neutral wire goes with the silver screw. The black (or red), hot wire connects to the brass screw. The green (or copper), ground wire goes with the green screw or the electrical box.
6. Screw the new switch back and replace the wall plate (the plastic casing).

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I: Give short answer for the following Questions not more than one page using your separate answer sheet (4 point)

1. What is the use of Personal protective equipment in maintenance works?
2. What is the advantage of selector switch?

Note: **Satisfactory rating - Greater than or equal to 2 points** **Unsatisfactory – below2 points**

You can ask you teacher for the copy of the correct answers.

Operation Sheet 1- Troubleshooting circuit breaker

Sequence for troubleshooting faulty circuit breaker

General Troubleshoot Steps

1. Ensure that customer is safe and evacuate them outside the house in the worst case of an electrical fire. Ensure that children are not in the vicinity while trying to troubleshoot your circuit breaker.
2. Look for a Distribution Box – which is usually on the collider, and then look for the circuit breaker.
3. Turn off the lights and all other appliances.
4. Test the electrical breaker – The circuit breaker might have labels for which part of the house it supplies the electricity to (e.g. Bedroom, Kitchen). Switch to the ON position for the relevant lever. A loose lever might indicate that your circuit breaker should be replaced.
5. Please be careful that the floor is not wet when touching any electrical panels as there may be a risk of electrocution.
6. Typically, circuit breakers trip because of excess energy drawn from too many appliances and overloading of the circuit happens. If the circuit breaker trips regularly, try disconnecting heavy power consuming appliances like the fridge to see if it helps.
7. If the circuit no longer trips, try to connect the heavy power consuming appliances to a different source to resolve the problem of overloading.

Operation Sheet 2- replacing circuit breaker

Steps on how to replace damaged circuit breaker:

1. Shut off the branch circuit breakers one at a time.
2. Shut off the main circuit breaker.
3. Test all the wires with a voltage tester to make sure they're dead before proceeding.
4. Remove the panel cover.
5. Disconnect the wire of the breaker you're removing from the load terminal.
6. Carefully pry out the old breaker, paying careful attention to how it's positioned.
7. Insert the new breaker and push it into position.
8. Attach the circuit's wire to the load terminal. Strip a bit of insulation off the wires, if necessary.
9. Inspect the panel for any other problems. Tighten any loose terminals.
10. Replace the panel cover.
11. Turn on the main breaker.
12. Turn on the branch breakers one by one.

LAP TEST	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: By Using necessary resources, templates, tools and materials you are required to perform the following tasks within **2** hour. The project is expected from each trainee to do it.

Task-1 Troubleshoot faulty circuit breaker

Task-2 Replace damaged circuit breaker

Information Sheet 3 - Achieving necessary circuit isolation

3.1 Isolation

Electrical Isolation meaning the main reason for isolating the circuit is to protect the circuit from dangerous voltages and currents. Isolation also protects sensitive circuits from the high voltages present in industrial applications. Isolation has the purpose of protecting against electrical hazards electric shock, burn and ballistics, the effects of arc flash. The points of electrical supply isolation must be marked and must be known by all necessary people in the organization

Safe isolation has long been a procedure carried out by a competent person in order to safely isolate electrical circuits or equipment before electrical work is undertaken. Despite this, every year people within the construction industry suffer electrical shock and serious burns of which some are sadly fatal

isolated equipment (or part of an electrical system) which is disconnected and separated by a safe distance (the isolating gap) from all sources of electrical energy in such a way that the disconnection is secure, ie it cannot be re-energised accidentally or inadvertently;

Disconnect the equipment from every source of electrical energy before working on, or near, any part which has been live or is likely to be live. On equipment that is capable of storing charge, such as capacitors and high-voltage cables, ensure that any stored charge has been safely discharged.

Secure isolation

For adequate isolation, the disconnecting device should have an isolating gap sufficient for the voltage levels present or likely to occur. Make sure that any switch disconnector or other means of disconnection is secure. Switches, including circuit breakers, should be locked in the OFF position preferably using a ‘safety’ lock, ie a lock or padlock having a unique key or combination. Lockout devices that can be attached to the actuators of circuit breakers are

available and should be used where appropriate. All keys should be retained in a secure place. If a plug has been withdrawn, make sure that it cannot be reconnected to the electrical supply while work is taking place on the circuits or apparatus – the use of proprietary lock-out devices for this purpose is encouraged.

Safe isolation of supplies

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

3.2 Electrical Hazards

We must first understand the hazards of electricity. All of the studies reviewed have revealed three major hazards of electricity, which are:

1. Electrical shock,
2. Electrical arc flash and
3. Electrical arc-blast.

Each of these hazards will be addressed as to the physiological effect on the human body and the analysis needed to determine the extent of the hazard.

3.2.1 *Electrical shock*

It takes a very low value of current, flowing through the human body, to cause death or serious physical harm. Many studies have been performed in this area with different values of current that causes each effect. The following chart shows average values of current and the effects as taken from the published studies:

Table3. effect of current on humans

Current	*Effect*
1 mA	Barely perceptible
1 _ 3 mA	Perception threshold (most cases)
3 _ 9 mA	Painful sensations
9 _ 25 mA	Muscular contractions (can't let go)
25 _ 60 mA	Respiratory paralysis (may be fatal)
60 mA or more	Ventricular fibrillation (probably fatal)
4 A or more	Heart paralysis (fatal)
5 A or more	Tissue burning (fatal if vital or gan)

3.2.2 *Electrical arc-flash*

There are two different issues with this hazard, the arc temperature and the incident energy. The main concern with the arc temperature is the flash flame and ignition of clothing. At approximately 2030F (960C) for one-tenth of a second (6 cycles), the skin is rendered incurable or in other words a third-degree burn. With only 1.2 cal/cm2 of incident energy, we have the onset of a second-degree burn. It does not take a very high temperature or very much energy to cause extreme pain and discomfort to the worker.

3.2.3 *Electrical arc-blast*

The pressures developed by an electrical arc can be extremely high. One study noted that copper, when vaporized, expands at a factor of 67,000 times, which one expert estimated was the same expansion as that produced by dynamite. Doors or covers must be securely latched before operating a switch or circuit breaker. Technicians or operators must place their body in the safest position possible before operating the equipment.

Self-Check – 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I- Choose and write the letter of the correct answer on the space provided (5 point)

_____1. _____takes a very low value of current, flowing through the human body, to cause death or serious physical harm.

A. Electric Shock
C. Electric Blast
B. Electric Flash
D. Electric Hazard

_____2. The amount of electric current that can cause muscular contraction of the human body.

A. 9 _ 25 mA
C. 60 mA or more
B. 25 _ 60 mA
D. d. 4 A or more

_____3. The amount of electric current that can cause respiratory paralysis of the human body.

A. 9 _ 25 mA
C. 60 mA or more
B. 25 _ 60 mA
D. 4 A or more

_____4. 5. The amount of electric current that can cause tissue burning of the human body.

A. 9 _ 25 mA
B. 25 _ 60 mA
C. 60 mA or more
D. 5 A or more

Information Sheet 4- Testing and confirming in accordance current regulation for safe reconnection

4.1 electrical measuring instruments

A. Ammeters

Ammeters are electrical instruments utilized to measure current in a circuit. The evaluation it does in the flow of current is read in “amps” as the unit. Ammeters are available in various designs which allow them to test the presence and amount of current in electrical devices of different sizes. They are used in various applications both residential and commercial use. The wiring system of new buildings needs to be checked to make sure they are properly working. This can be done with the use of ammeter. It is also used by electricians to see if there are problems on the wiring system of older buildings. Manufacturing companies involve in the production of electrical equipment also utilize this electrical measuring instrument to test the products before they are supplied to the market for sale. There are ammeters that can measure direct current, alternating current or both. They have to be properly set to avoid short circuit or the device to malfunction as **ammeters tend to have low resistance.**

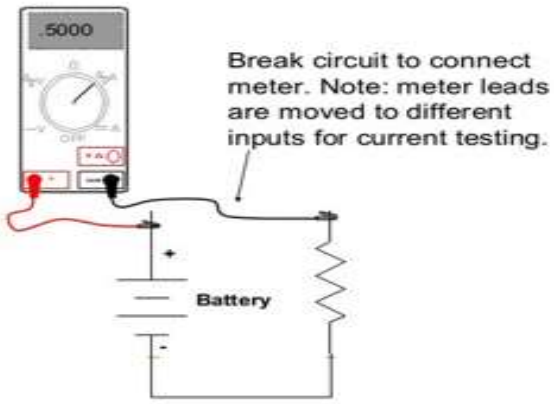


Figure 25. current measuring

B. Voltmeter

Voltmeters are electrical devices that measure the voltage or potential difference between two points in a circuit. The units of measure of voltmeters are expressed in “volts”. Voltage works by connecting it parallel to the circuit. There are analog and digital voltmeters which difference can be distinctly recognized by how the readings are presented. Analog voltmeters show the voltage through a pointer that moves across the scale while digital voltmeters provide a numerical display of voltage. Voltmeters are also made available in a variety of styles. There are portable voltmeters, also known as multi-meter for its ability to measure current and resistance, applied in testing electrical and electronics work. The ability of multi-meter to measure voltage, resistance and current is made possible by Ohm’s Law. Fixed apparatus such as generators need instruments that can be mounted in a panel permanently.

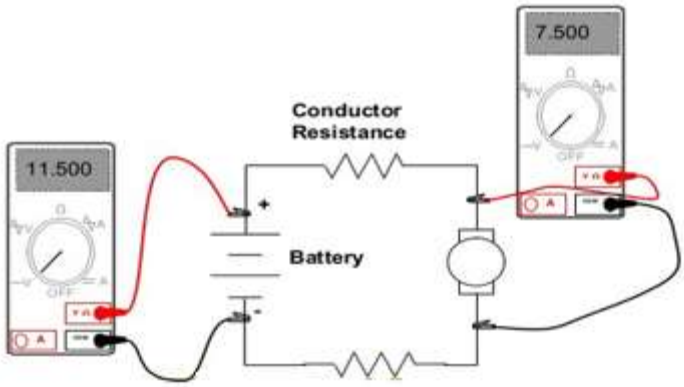


Figure 26 voltage measuring

C. Ohmmeter

Ohmmeters, which uses ohm as unit of measurement, are devices that measure the electrical resistance through a circuit. This equipment is important on installations that require correct resistance in order to function properly such as speakers. Ohmmeters also check the flow of current to make sure that it is running continuously. Today, ohmmeters

come with digital displays which can provide much more accuracy on the readings. To ensure the precision of the result, an ohmmeter should be used on checking the resistance of a device that generates its own current. For this electrical measuring instrument to work properly, it should measure resistance according to the flow of current coming from its own battery. Interference from an external current source may result to false readings.

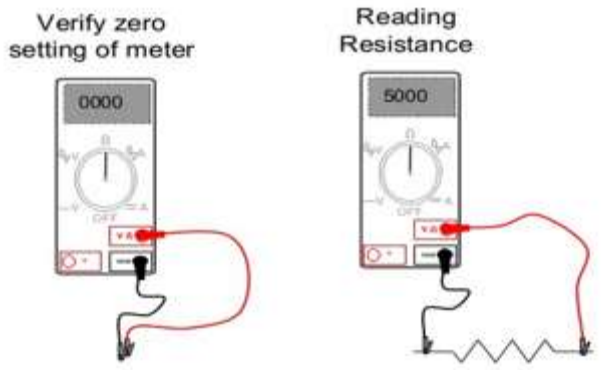


Figure 27. resistance measuring

Although a good initial level of safety can be achieved by correct selection and use of equipment and its connectors and cables, lasting safety can only be attained by ongoing and effective maintenance. Users should treat their equipment reasonably, including stopping it if defects occur and reporting them.

In many the safety of portable electrical equipment depends on the continued integrity of the earthing, and correct connections, of the fixed electrical installation up to and including the socket supplying the equipment.

Maintenance can include visual inspection, testing, repair and replacement. Maintenance will determine whether equipment is fully serviceable or remedial action is necessary. Routine inspection and appropriate testing, where necessary, are normally part of any overall strategy for ensuring that work equipment is maintained in a safe condition.

Cost-effective maintenance of portable electric equipment can be achieved by a combination of:

- checks by the user;
- formal visual inspections by a person trained and appointed to carry them out;
- Combined inspection and tests by an electrically competent person or by a contractor.

Management should follow up these procedures by monitoring the effectiveness of the system and taking action where faults are found, particularly when faults are frequent.

Self-Check -4	Written Test

Name: _____ Date: _____

Time started: _____ Time finished: _____

Directions: Answer all the questions listed below.

Instructions:- Choose and write the letter of the correct answer on the space provided (5 point)

_____1. Which of the following are electrical instruments utilized to measure current in a circuit?

A. Voltmeters B. Ammeters C. ohmmeters D. energy meter

_____2. Which of the following are electrical instruments utilized to measure voltage or potential difference between two points in a circuit?

A Voltmeters B. Ammeters C. ohmmeters D. energy meter

_____3. Which of the following are electrical instruments utilized to measure electrical resistance through a circuit?

A Voltmeters B. Ammeters C. ohmmeters D. energy meter

_____4. Cost-effective maintenance of portable electric equipment can be achieved by a combination of:-

A. checks by the user

B. formal visual inspections by a person trained and appointed to carry them out

C Combined inspection and tests by an electrically competent person or by a contractor

D all

Information Sheet 5- Responding unplanned events

5.1 Unplanned events or conditions

Accidents, malfunctions and unplanned events refers to events or upset conditions that are not part of any activity or normal operation of the Project as has been planned. Performing maintenance on electrical equipment can be hazardous. Electrical and mechanical energy can cause injury and death if not managed properly.

5.1.1 Most Common Causes of Electrical Accidents

When it comes to electrical hazards, prevention depends on safe equipment, safe environment and safe work practices. The Occupational Safety and Health standards cover many electrical hazards in a variety of industries.

These OHs regulations focus on the design, use, safe servicing and maintenance of electrical equipment and systems. The standards cover only the exposed or operating elements of an electrical installation such as lighting, equipment, motors, machines, appliances, switches, controls and enclosures, requiring that they be constructed and installed to minimize workplace electrical dangers.

Most electrical accidents result from one of the following three factors:

- Unsafe equipment or installation
- Unsafe environment or
- Unsafe work practices

These accidents can be prevented with the use of safe equipment, guarding, grounding, circuit protective devices and safe work practices.

5.1.1.1 Safe Equipment

All electrical workplace conductors and equipment must be deemed “acceptable” by OHs standards To be deemed acceptable, equipment must be marked as tested by a Nationally Recognized Testing Laboratory. OHs standards will look for these markings on the equipment to deem it safe. The equipment must be installed and used within its labeled capacity so as to not exceed the limitations of the equipment (e.g., putting the wrong switch for too much load, causing it to overheat).

Matching the equipment specifications to the load expectations of the installation will help prevent unsafe conditions. Always use a qualified electrician to perform all electrical work.

5.1.1.2 Guarding

Guarding involves locating or enclosing electrical equipment to make sure people don’t accidentally come into contact with its live parts. Effective guarding requires equipment with exposed parts operating at 50 volts or more to be placed where it is accessible only to authorized people qualified to work on it.

5.1.1.3 Grounding

Grounding intentionally creates a low-resistance path that connects to the earth. This will prevent the buildup of voltages that could cause an electrical accident that could result from a worker being in the ground path. A properly designed grounding system creates a low-resistance path away from workers. When designed correctly, grounding substantially reduces the risk of an electrical accident if combined with safe work practices.

Grounding falls into two types:

- Service or system ground or
- Equipment ground

A service or system ground is designed primarily to protect machines, tools and insulation against damage. This involves the neutral or grounded conductor, typically white or gray, that is grounded at the generator or transformer at the building’s service entrance.

Equipment grounding helps protect the operator by furnishing a second path for current to travel if a fault occurs. It will react much faster to prevent shock and serious injury to the operator. This is accomplished by use of circuit protection devices.

5.1.1.4 Circuit Protection Devices

These devices limit or stop the flow of current automatically in the event of a ground fault, overload, or short circuit in the wiring system. Common examples include fuses, circuit breakers and GFCIs.

Fuses and circuit breakers open or break the circuit automatically when too much current flows through them, and will melt or trip to open the circuit. These are acting devices that are used primarily for protection of conductors and equipment. They typically open fast enough to prevent shock or further injury. They prevent overheating situations from occurring that result in damage to the conductors or equipment.

GFCIs are used typically in wet locations, construction sites, factory maintenance, and other high-risk areas to protect the equipment user. These devices react much faster than fuses and circuit breakers to interrupt the flow of current before shock and injury results.

5.1.1.5 Safe Work Practices

Electrical accidents are largely preventable through safe work practices. Examples include:

- De-energizing electrical equipment before inspection or repair,
- Lockout/tag out procedures to prevent accidental or unexpected startup of electrical equipment,
- Keeping electric tools properly maintained,
- Exercising caution when working near energized lines and
- Using appropriate personal protective equipment.

The first step before beginning any inspection, repair or maintenance of any equipment is to follow the written procedure to isolate all energy sources to prevent accidental startup of the equipment.

The responsibility of an electrical safety program should not be taken for granted. It should be assigned to someone with a complete knowledge of electricity, electrical work practices and the appropriate OHs standards to administer the program. It is everyone's responsibility to follow the program to make it effective.

Equipment maintenance is a set of organized activities that are carried out in order to keep an item in its best operational condition with minimum cost acquired.

Self-Check -5	Written Test

Name: _____ Date: _____

Time started: _____ Time finished: _____

Directions: Answer all the questions listed below**.**

Instruction I: Give short answer for the following Questions not more than one page using your separate answer sheet (4 point)

1. What are unplanned events?
2. List grounding types?
3. what are the factors for electrical accidents?
4. what are circuit protection devices?

Note: **Satisfactory rating - Greater than or equal to 3 points** **Unsatisfactory - below 2 points**

You can ask you teacher for the copy of the correct answers.

LG #41	LO #3- Notify completion and document results of maintenance of electrical equipment

Instruction sheet

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

- Notifying completion of the maintenance work
- Updating maintenance records

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**:

- Notify completion of the maintenance work
- Update maintenance records

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”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go

back to “Operation sheets”.

Information Sheet1- Notifying completion of the maintenance work

1.1 Completion of the Maintenance Work

A properly completed work order will benefit many departments within an organization. For example, good housekeeping practices align with a facility's safety and environmental directives. Storeroom & purchasing personnel will use this information to streamline their inventories and improve their services to the craft person. Detailed and accurate job plan feedback will improve the planning & scheduling process. Reliability engineering personnel will use this information to improve asset reliability. Incorporating the aforementioned work order closeout activities as a part of the work control process is crucial for a facility if they're to achieve their overall asset management and reliability initiatives.

Work orders and job completion

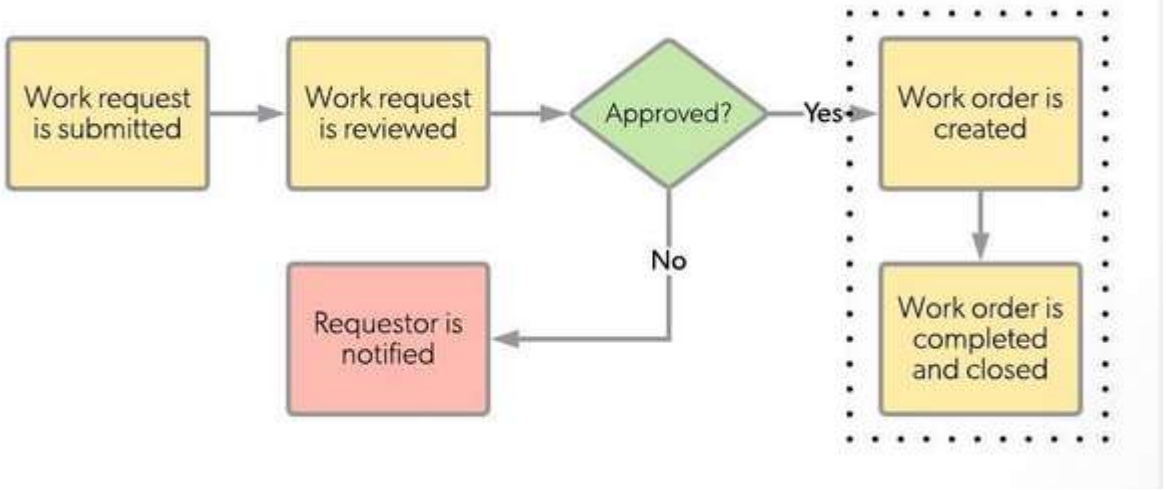


Figure 28. work orders and job completion Chart

Close the gap between all work orders and job completion. Completing work as quickly as possible, while causing no disruption to the instructional day, is critical to overall productivity, both trainees and trainer personnel. With this maintenance work order template, you can control the process of the necessary maintenance work in your property in an orderly fashion. This maintenance work order form will help the work to be organized in a tidy and up to date way. The amount of the money spent, the contact information, explanation of the completion information and many other aspects of the maintenance work can be specified in these maintenance work order forms.

Work Order Completion Maintenance Tip

When is a work order truly complete? There's more to work order completion than simply performing the actual maintenance tasks and changing the Work order status. Although tasks will vary depending on the type of work performed, consider the following activities to ensure a successful Work order completion.

- Perform general housekeeping activities and return the work area to an operating condition. Work area should be clean of rags, grease/oil, trash, etc. and all items

have been properly disposed. Ladder, safety barrier tape, etc. is removed as required.

- The Craft have notified Operations personnel that the equipment is ready for Post Maintenance Testing (PMT) and equipment PMT is satisfactorily performed.
- All unused job material/parts are returned to stores.
- All specialty tools and equipment are returned to their proper location.
- All work permits are closed-out as required.

    - ✓ Work Order completion information is captured (hardcopy/electronically in CMMS)
    - ✓ Detailed description of work performed
    - ✓ Proper Failure Code information is documented (Failure/Cause/Remedy)
    - ✓ As Found/As Left conditions
    - ✓ Any materials not originally issued/purchased against the Work Order. Compare against the asset BOM and Job Plan to see if these materials should be added.
    - ✓ Labor hours for all craft
    - ✓ Start/Finish time
    - ✓ Job Plan feedback such as missing material, inaccurate procedures and improvements.
    - ✓ Recommendations for adjusting PM frequency

- ➢ If follow-up work is required (additional repairs, modifications, etc.), a separate Work Order should be entered into the CMMS.
- ➢ If the nature of the work met the requirements to trigger a Root Cause Failure Analysis (RCFA), all documentation, failed parts, etc. should be provided to individuals responsible for conducting the RCFA.

- If a repairable spare was removed, ensure the spare is returned to the appropriate location for repairs and the "move" history of this spare is captured using the CMMS rotating item/asset functionality.
- If a new asset was installed, ensure all related information is captured and updated in the CMMS including nameplate information, the asset BOM, Job Plan and PM/PdM information, etc.
- New PdM baseline readings are taken as required.
- Drawings and schematics are updated to reflect any changes.
- All change control documentation is completed as required

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I: Choose and write the letter of the correct answer on the space provided (4 point)

_____1. Detailed and accurate job plan feedback will improve the_____ process.

A. Planning B. scheduling C. working D. a and b

_____2. A properly completed work order will benefit the following.

A. Storeroom personnel C. purchasing personnel

B. owner of work order D. all

_____3. Which of the following is the Work Order Completion Maintenance Tip?

A. All unused job material/parts are returned to stores.

B. All specialty tools and equipment are returned to their proper location.

C. All work permits are closed-out as required.

D. All change control documentation is completed as required

E. All of the above

_____4. Maintenance work order forms include.

A. The amount of the money spent

B. the contact information

C. explanation of the completion information

D. other aspects of the maintenance work

E. all of the above

- ***Note:*** **Satisfactory rating - Greater than or equal to 2 points** **Unsatisfactory - below 2 point**

Information Sheet 2- Updating maintenance records

2.1 Maintenance records

In order to keep accurate maintenance records, a recording or reporting system should be developed, implemented and maintained .Documenting every repair or maintenance work done on your equipment will help you process warranty claims much easier. Keep a record of the type of maintenance work done to your equipment as well as the exact time and date repairs were done as this information will help determine your rights for the warranty claims.

2.2 Planning an electrical maintenance program

There are management, economic, and technical considerations along with other requirements that need to be understood in order to develop an effective maintenance program..

The planning of electrical maintenance programs should then include the advantages of a well-planned maintenance along with cost data for lost production due to equipment failure versus cost of budgeted PM. Any maintenance program should prove that it is cost effective and minimizes equipment failure. The planning of the program should include considerations for proper test equipment, tools, trained personnel to carry out maintenance tasks, and time required to perform inspections, tests, and maintenance routines. Also, consideration should be given to record keeping systems, which can range from fully computerized to manual file systems. To set up an EPM and test program, the following steps may be undertaken:

After the program has been set up, it is essential that it consist of elements that will prove it to be a success such as responsibilities, inspection, scheduling, work orders, and record keeping.

2.2.1 Responsibilities

The responsibilities of the maintenance organization should be clearly defined by organization charts with functional work statements for each unit. The functional work statements must be established by management as a matter of policy. Every other department must be informed of the responsibilities assigned to maintenance organizations. The effectiveness of the maintenance departments will depend upon how well they are organized and how well personnel are utilized.

2.2.2 Inspection

Inspection is the key to the success of any maintenance program. Sufficient time should be allocated for inspection to verify the condition of new and installed equipment. The purpose of inspection is to provide advance warning as to the condition of the equipment under investigation. When inspection is performed on definite cycles by qualified people, impending deterioration can be detected in advance so that repair or replacement can be made before failure of the equipment occurs.

2.2.3 Scheduling

To perform maintenance, a definite schedule of work to be performed must be established. Maintenance schedules must be based upon minimum downtime for the various operating segments. The schedule for inspection, routine maintenance, and other work may vary for different equipment and will depend upon many factors. These factors can be age of equipment, frequency of service, hours of operation, environmental conditions, damage due to abuse, and safety requirements. Frequency of scheduling of all tasks should be adjusted as data on various equipmens are recorded and analyzed to provide a balance between cost of maintenance and replacement cost of the equipment.

2.2.4 Work Orders

Work orders are job requests that need action for completion. Work orders can be established for all inspection service and other work on equipment in terms of routines. Any of these routines should include information on when such work is to be performed, where it is to be performed, and exactly what has to be done. These routines can be generated by

a computer-based maintenance system. The routine should include all the pertinent information concerning the equipment.

2.2.5 Record Keeping

The success of a planned maintenance program depends upon the interest of the maintenance personnel in the program. To have an effective program, it is imperative that maintenance and test inventory data on all equipment should be complete and readily available throughout the service life of the equipment. To that end, record keeping is very important. All forms and reports should be organized to provide ready accessibility to data when needed and to flag down problem areas. Such data may also be used over the years to analyze trends for equipment deterioration. If data are not recorded and maintained properly, the whole purpose of planned maintenance is lost.

Records do not necessarily have to be on a paper system. Test instruments are available that store the data electronically, which can then be downloaded directly onto a computer database. Duty holders with large amounts of equipment will find it useful to label equipment to indicate that the equipment has been tested satisfactorily ie has been passed as safe, and when the date for the next test is due. Otherwise, individual items may be missed on consecutive occasions.

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below

Instruction I: write true if the statement is correct or write false if the statement is incorrect and write the answer on the space provided (2pts)

1. In order to keep accurate maintenance records, a recording or reporting system should be developed, implemented and maintained?
2. Records do necessarily have to be on a paper system?

Note: **Satisfactory rating - Greater than or equal to 2 points** **Unsatisfactory - below 2 points**

You can ask you teacher for the copy of the correct answers.

Reference Materials

Book:

1. Trevor linsley**, (**2005 GC**).*Basic Electrical Installation Work,*** Fourth Edition Senior Lecturer Black pool and the Fylde College.
2. Paul gill, **(**2008G.C**).*Electrical Power Equipment Maintenance and testing*,** second Edition, New York.
3. Health and safety executive, **(**2013GC**). *Electricity at Work Safe Working Practices*,** Third Edition London.

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LO #1-Plan and prepare for maintenance of electrical equipment

Information Sheet 1- Sequencing and planning maintenance schedules

Self Check 1 Answers

Instruction I

1. A. Planned maintenance
2. C. Unplanned maintenance
3. A. Schedule

Instruction II

1. Maintenance is a set of organised activities that are carried out in order to keep an item in its best operational condition with minimum cost acquired
2. Maintenance objectives should be consistent with and subordinate to production goals.
    - Maximising production or increasing facilities availability at the lowest cost and at the highest quality and safety standards.
    - Reducing breakdowns and emergency shutdowns.
    - Optimising resources utilisation.
    - Reducing downtime.
    - Improving spares stock control.
    - Improving equipment efficiency and reducing scrap rate.
    - Minimising energy usage.
    - Optimising the useful life of equipment.
    - Providing reliable cost and budgetary control.
    - Identifying and implementing cost reductions.
3. A maintenance schedule can be defined as an important document that can be used for recording the weekly, monthly and yearly schedule of the maintenance

Information Sheet 2- Consulting appropriate personnel for effective and coordinated maintenance work

Self Check 2 Answers

1 . D. all

2. A. Electrical work

3 D. all

Information Sheet 3- Preparing necessary materials

Self Check 3 Answers

1. A. Face Protection
2. B. Eye Protection
3. A. Gloves
4. B. Clothing
5. A. Footwear
6. C. Safety Belt/Harness

Information Sheet 4- Selecting and checking the required tools, equipment, and testing devices

Self Check 4 Answers

1. Pliers
2. Test light
3. Wattmeter
4. Megger

LO #2- Maintain electrical equipment and associated circuits

Information Sheet 1- Ascertaining normal operating principles of the equipment and associated circuits

Self Check 1 Answers

1. Common Faults and rectification of florescent lamp
   - Lamp doesn't glow but flicks
   - Lamp doesn't start
   - Lamp burns out often
   - Lamp filament glow but not light up.

- Lamp goes out and on
- Blackening of the lamp at the ends after short use,

2. Unbalanced supply voltage

Information Sheet 2- Maintaining maintenance records and instructions of the Equipment

Self Check 2 Answers

1. Personal protective equipment is used by maintenance workers to provide protection from hazardous electrical energy. Integrity of this equipment is paramount, so maintenance should be scheduled and accomplished similar to equipment maintenance
2. selector switch controls the light intensity by rotating the knob

Information Sheet 3 - Achieving necessary circuit isolation

Self Check 3 Answers

A. A. Electric Shock
B. A. 9 _ 25 mA
C. B. 25 _ 60 mA
D. D. 5 A or more

Information Sheet 4- Testing and confirming in accordance current regulation for safe reconnection

Self Check 4 Answers

1 B. Ammeters
2 A Voltmeters
3 C. ohmmeters
4.D all

Information Sheet 5- Responding unplanned events

Self Check 5 Answers

1. unplanned events refers to events or upset conditions that are not part of any activity or normal operation of the Project as has been planned
2. Service or system ground and Equipment ground

3. Unsafe equipment or installation

   Unsafe environment or

   Unsafe work practices

4. circuit protection devices open or break the circuit automatically when too much current flows through them, and will melt or trip to open the circuit.

LO #3- Notify completion and document results of maintenance of electrical equipment

Information Sheet1- Notifying completion of the maintenance work

Self Check 1 Answers

1. D. a and b
2. D. all
3. E All of the above
4. E All of the above

Information Sheet 2- Updating maintenance records

Self Check 2 Answers

1. True
2. False