CHAPTER 2: WORKSHOP TECHNOLOGY

Unit of learning code: ENG/CU/EI/CC/03/4/A

Related Unit of Competency in Occupational Standard; Perform Workshop Practices

2.1 Introduction to the unit of learning

This unit covers the competencies required to perform workshop process. Competencies include applying workshop Safety, use of workshop tools and instruments, preparation of workshop for electrical installation, Storage of Electrical tools and materials, troubleshoot and repair/replace workshop tools and equipment

2.2 Summary of Learning Outcomes

1. Apply workshop safety
2. Use of workshop tools, Instruments and equipment
3. Prepare workshop tools and instruments for an Electrical installation
4. Prepare the workshop for an Electrical installation
5. Store Electrical tools and materials
6. Troubleshoot and repair workshop tools and equipment

2.2.1 Learning Outcome 1: Apply Workshop Safety

2.2.1.1 Introduction to the learning outcome

This learning outcome specifies the content of competencies required in applying workshop safety. By the end of the lesson the trainee should be able to carry out and do the learning activities given in the learning guide. Also, it is provided with a self-assessment question with responses
All workshops and stores must be under the direct control of a supervisor, who is responsible for ensuring they are maintained and used in a safe and healthy manner. Only those authorized to do so may enter or work in workshops or stores, and must comply with the requirements of the supervisor whilst in that area.

All persons using workshops and stores should apply good housekeeping practices, wear appropriate clothing and footwear, and use the workshop or store only for its intended purpose.

A tidy workplace makes it easier to spot and avoid hazards, and does not interfere with normal work operations. Good housekeeping is fundamental to workshop safety management, and the time allocated to a job must include cleaning up afterwards. This applies to both individual and shared areas.

Personal items, food, drink or cigarettes are not to be taken into workshops and stores, unless a clean work-free area has been set aside for this purpose. Where necessary, lockers should be provided and used.

The store or workshop must be suited to the proposed task. The supervisor shall make the decision as to what tasks are appropriate for each situation.

2.2.1.2 Performance Standard

1. Proper use of PPE is adhered to as per standard operating procedure
2. Workshop rules are followed as per standard operating procedure
3. Proper use of safety equipment are followed as per the manufacturer's recommendations
4. First Aid procedures are adhered to

2.2.1.3 Information Sheet

Learning outcome 1: Apply workshop safety

Apply workshop safety

A Hazard is something with the potential to cause harm; for example, electric tools, working above ground level, wet or uneven floors, rotating parts.

Meaning of PPE (Personal Protective Equipment)

Personal Protective Equipment (PPE) Personal Protective Equipment (PPE) are:

- Gadgets to protect workers from injury or illness caused by having contact with the dangers/hazards in the workplace whether they are chemical, biological, radiation, physical, electrical, mechanical and others.
- It is protective clothing helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection.
- All equipment designed to be worn, or held, to protect against a risk to health and safety.

This includes most types of protective clothing, and equipment such as eye, foot and head protection, safety harnesses, life jackets and high visibility clothing.

The hazards addressed by protective equipment include physical, electrical, heat, chemicals, biohazards, and airborne particulate matter. Protective equipment may be worn for job-related occupational safety and health purposes, as well as for sports and other recreational activities. "Protective clothing" is applied to traditional categories of clothing, and "protective gear" applies to items such as pads, guards, shields, or masks, and others. PPE suits can be similar in appearance to a cleanroom suit.

The purpose of personal protective equipment is to reduce employee exposure to hazards when engineering controls and administrative controls are not feasible or effective to reduce these risks to acceptable levels.

PPE is needed when there are hazards present. PPE has the serious limitation that it does not eliminate the hazard at the source and may result in employees being exposed to the hazard if the equipment fails.

Any item of PPE imposes a barrier between the wearer/user and the working environment. This can create additional strains on the wearer; impair their ability to carry out their work and create significant levels of discomfort. Any of these can discourage wearers from using PPE correctly, therefore placing them at risk of injury, ill-health or, under extreme circumstances, death. Good ergonomic design can help to minimize these barriers and can therefore help to ensure safe and healthy working conditions through the correct use of PPE.

https://en.wikipedia.org/wiki/Occupational_safety_and_health

Care for PPEs

Personal protective equipment should be taken cared as of the other tools and equipment.

1. Wipe your helmets, gloves, safety shoes before keeping it.
2. It should also be cleaned, kept in proper tool rack/ cabinet.
3. It should be stored in dry places so that it will not have mold build-up.
4. Over-all suites should be washed regularly so that perspirations and other dirt will be washed clean.

Standard operating procedure in PPE

This standard operating procedure incorporates the requirements for use of Personal Protective Equipment (PPE) for project staff, co-operators, volunteers, contractors, and those under the project's operational control.

PPE listed in this SOP shall be used to provide protection and safety necessary for those participating in a project activity with PPE requirements. Additional information on the purpose and type of PPE may be available through the SOP for that activity.

Roles and responsibilities

- Projects need to tailor the Roles/Responsibilities based on their staffing level
- Project Manager (PM) is responsible for the overall safety of the project staff and those participating in a project activity and must provide the appropriate PPE for those activities.
- Project Safety Officer (PSO) is responsible for issuing project PPE, for training project staff on the proper use and care of the PPE, and to ensure compliance with this SOP.
- Supervisor is responsible for ensuring project staff and others participating in a project activity are properly wearing their issued PPE. After temporarily issuing the appropriate PPE to non-project personnel, train them on how to use the PPE and retrieve the PPE upon completion of the activity.

- Project Staff is responsible for properly wearing their issued PPE for that activity. They must also properly maintain their issued PPE and when needed request a new PPE to replace worn out or damaged PPE. They will assist the Supervisor when non
- Project people are participating in an activity requiring specific PPE.
- Others participating in the activity must be trained in the proper use of the assigned PPE and wear it properly when directed by project staff.

Training

The PSO or Supervisory staff will train project employees on the use and care of the PPE.

PPE selection

PPE shall be provided, used, and maintained wherever hazards exist (e.g., processing, environmental, chemical, mechanical) or are encountered in a manner capable of causing injury or impairment in the function of any part of the body. Injury can occur though absorption, inhalation, or physical contact with these hazards. The designated PPE person shall set a good example by donning PPE and following Program policy. The following provides guidelines for hazard assessment and PPE selection.

Eye and face protection. Appropriate eye or face protection shall be worn if exposures to potentially injurious hazards exist (e.g., flying particles, liquid chemicals, corrosives, chemical gases, vapors, UV rays). All eyewear shall provide:

- eye and side protection (detachable or permanent)
- protective devices to be worn over prescription eyewear, if needed
- a proper and comfortable fit.

Foot hazards

1. OSHA requires that staff wear protective footwear if the potential for foot injuries exist, including exposure to:
    - compression, squeezing, smashing, falling, or rolling objects
    - electrical hazards
    - slipping
    - chemicals

- temperature extremes
- repeated wetness which may result in fungal infections
- puncturing from objects which may pierce the sole of footwear

2. Engineering and work-practice solutions shall be utilized, including wearing footwear correctly (fully laced, etc.) to receive maximum protection. The Program shall prohibit the use of sandals or open shoes.

Hand and body protection

1. Glove manufacturer specification charts provide guidance in selecting proper PPE. Appropriate hand and body PPE shall be worn when potential hazards exist, including exposure to:
    - Cuts and punctures—severe cuts and lacerations, abrasions or punctures from tools, machines or from handling sharp objects
    - Thermal exposure—caused by extreme cold or heat or hot work
    - Blood borne pathogens—caused by first-aid or clean-up of blood, body fluids, or other infectious agents.
    - Chemical exposure—skin contact from working with chemicals
    - Repetitive motion disorders—caused by computer use or jobs requiring repetitive motion may cause carpal tunnel syndrome
    - entanglement—caused from wearing gloves, clothing, or jewelry near moving equipment
2. Potential engineering and work-practice solutions may include:
    - machine guards—protects against cuts, punctures, abrasion, and chafing
    - job rotation—protects against repetitive motion hazards
    - good housekeeping and clean-up—protects against chemical and blood borne hazards

- workstation design—protects against repetitive motions and provides accident prevention
- evaluating waste prior to handling—aids staff in determining appropriate PPE and process method
- splash guards—protects against chemical contact with skin or eyes

Head protection Head protection (e.g., hard hat) shall be worn if potential for injury from falling objects exist. All head protection shall:

Be used according to manufacturer's instructions

Not be altered in any way include bump caps as an appropriate alternative (if exposure to scalp injuries exist)

Hearing protection Facility staff shall wear hearing protection when exposed to noise levels in excess of 85 dB (A) for an eight-hour time-weighted average.

Respiratory protection Site specific ventilation or exhaust systems are effective engineering control tools.

Workshop safety

The safety in Workshops has been written not only to provide appropriate safety procedures but also to assist trained workshop personnel with the provision of a reference document outlining the general principles of safe working practices relevant to the mechanical engineering aspects. It relates to specific areas where definite safety measures are required for workshop operations

Factories Act and Accident

Various acts relating to accidents are spelt out in workmen's compensation Act-1923. The factories act-1948 and Fatal Accidents Act-1855. These acts describe the regulations for fencing and guarding the dangerous machinery, items and employer's liabilities.

Introduction to workshop safety

A workshop is where you learn to use tools and machines to make things; It can be a dangerous place, so you must learn the safety rules for the workshop.

The safety rules tell you how to dress appropriately and how to behave whilst working with tools that may cause harm. You must never play in the workshop, run around or throw equipment to one another.

Personal safety:

The basic dress rules that you should always follow are:

1. **Proper clothing.**
   You must not wear loose clothes that can be caught in moving machinery. You must wear tight fitting overalls
2. **Proper eye protection.**
   You must always wear goggles to protect your eyes while you are working in the workshop.
3. **Remove tie and jewellery**.
   Ties, watches, rings and other jewellers increase the chance of getting caught by moving machinery. You must remove them before entering the workshop.
4. Cut or secure long hair. Long hair is also dangerous as it may be caught by the machine and pulls you into it.
5. **Proper shoes**. You must not wear sandals or soft shoe inside the workshop as they will not protect your feet from falling objects. A safety shoes (steel-toe shoes) will protect your feet if you accidentally drop something.
   The way you dress in the workshop is very important for your safety, always be sure to wear properly and encourage your friends to do the same.

General workshop safety

It's essential to be aware of and able to foresee the dangers which exist in the workshop and are likely to affect your health and safety.

You should make sure that your workspace is as safe as possible so that few dangers arise.

i) Use the appropriate protective clothing and equipment to minimize the risk of accident

ii) Act in a safe manner at all times.

General Safety Precautions while Working in a Workshop

1. One should not leave the machine ON even after the power is OFF and until it has stopped running completely. Someone else may not notice that the machine is still in motion and be injured.
2. Operator should not talk to other industrial persons when he is operating a machine.
3. One should not oil, clean, adjust or repair any machine while it is running. Stop the machine and lock the power switch in the OFF position.
4. One should not operate any machine unless authorized to do so by the authorize person in the shop.
5. Always check that work and cutting tools on any machine are clamped securely before starting.
6. The floor should be kept clean and clear of metal chips or curls and waste pieces. Put them in the container provided for such things. Scraps and chips or curls may cut through a shoe and injure the foot.
7. Defective guards must be replaced or repaired immediately.
8. One should not operate any machinery when the supervisor or instructor is not in the shop.
9. All set screws should be of flush or recessed type. Projecting set screws are very dangerous because they catch on sleeves or clothing.
10. One should not try to stop the machine with hands or body.
11. Only trained operator should operate machine or switches as far as possible.
12. Always take help for handling long or heavy pieces of material.
13. Always follow safe lifting practices

14. No one should run in the shop at work time.
15. Always keep your body and clothes away from moving machine parts. Get first aid immediately for any injury.
16. Never talk to anyone while operating the machine, nor allow anyone to come near you or the machine.
17. Stop the machine before making measurements or adjustments.
18. Operator should concentrate on the work and must not talk unnecessarily while operating the machines.
19. Never wear necktie, loose sweater, wristwatch, bangles, rings, and loose fitting clothing while working in workshop.
20. Always wear overcoat or apron.
21. Stop machines before attempting to clean it.
22. Make sure that all guards are in their place before starting to operate a machine.
23. Do not attempt to operate a machine until you have received operating instructions.
24. Be thoroughly familiar with the 'stop' button and any emergency stop buttons provided on the machines.
25. Remove burrs, chips and other unwanted materials as soon as possible. They can cause serious cuts.
26. Do not leave loose rags on machines.
27. Wash your hands thoroughly after working to remove oils, abrasive particles, cutting fluid, etc.
28. Report all injuries to the foreman, howsoever small. Cuts and burns should be treated immediately.
29. Keep the work area clean.
30. Keep your mind on the job, be alert, and be ready for any emergency.
31. Always work in proper lighting.
32. On should not lean against the machines.

Concept of accident

It is very difficult to give a definition of the word 'Accident'. However, a generally accepted conception that an accident is a mishap, a disaster that results in some sort of injury, to men, machines or tools and equipment and in general loss to the organization.

The said injury or loss may be of minor or major nature and the accident is termed as non-reportable or reportable. For example, a small cut on the body will be reportable accident in a training workshop. It can be treated by first aid and does not involve any appreciable loss of time, and will not be considered a reportable accident in a production unit.

Causes of accidents

The 98% accidents could be easily avoided provided due precautions are taken well in time. A very familiar slogan goes on to say that accidents do not just happen but are caused due to the failure of one element or the other, and the most unfortunate factor is that the human element is the most pronounced of all which fail.

The common causes which lead to accidents are the following:

1. Unsafe working position.

2. Improper or defective tools or their improper use.

3. Improper acts- which result in violation of safety rules and non-observance of safety precautions.

Causes of accidents

1. Causes due to human beings

a) Carelessness

This is due to overconfidence, loss of interest, fatigue (continuous work without rest), monotony, unnecessary emotion which diverts concentration on the work being done hence resulting to accidents.

b) Ignorance

An operator must understand the users and the function of his machine equipment.

c) Unsuitable clothing in working areas,

Personnel should wear clothing which will provide protection against dangers in areas where they work. That is:

Safety Shoes/boots. They should be a type which provides protection against slippery conditions.

They should be strong enough in the feet to prevent injury from hurting objects e.g. safety boots.

Gloves- They should be worn where there are risks when harming sharp objects whether inside or outside buildings.

Safety glass

- Safety glasses or goggles should be worn where there's likely of danger to the eyes, such as using drills, grinding machines etc.

d) Untidiness

- Keep all passage ways clear and clean.

Circular rods if stepped upon can cause nasty falls.

- Keep the workshop floor free from grease and oils.

2. Contributing causes

a) Unsatisfactory hand tools

E.g. being worn out without handles

- Hammers with loose handles or crippled faces should never be used.
- Chisels with burred heads are dangerous as broken pieces from the edges may fly off and cause injury.
- Files should have tight handles to prevent accidents to the hands.
- Spanners which fit incorrectly will slip and can result I n damaging fingers.
- When drilling always ensure that the work is securely held in a vice or otherwise securely clamped.

b) Unsatisfactory machines

- That is being insufficiently spaced, unguarded, broken, improperly adjusted, insufficiently lubricated and being too small or weak for the job being undertaken.
- So see that all machines are properly guarded, all abrasive wheels are kept in good condition and run at safe speeds.
- Don't attempt to adjust or remove by hand a belt on a rotating shaft.

- don’ t allow idle belt to rest on rotating shaft and don’ t attempt to oil overhead shafting while it’ s in motion.

c) Physical condition of personnel while working

E.g. before lifting equipment ensure that the weight is within your capability to handle. A base that anything used for lifting is serviceable and in good working condition chains, hooks etc.

Should never be overloaded.

Common sources of accidents

The large number of machines in use and an even larger number of parts. This can be regarded as sources of danger and require guarding for protection against accidents.

Some common sources of accident are listed below:

Projecting nips between sets of revolving parts, viz, gears, rolls and friction wheels, etc.

1. Projecting fasteners on revolving parts.

2. Revolving cutting tools, circular saw blades.

3. Revolving drums, crushers, spiked cylinder and armed mixers, etc.

4. Revolving shafts, spindles, bars and tools like drills, reamers, boring bars and chucks, etc.

5. Projecting sharp edges or nips of belt and chain drives viz., belt, pulleys, chains, sprockets and belt fasteners.

6. Reciprocating tools and dies of power presses, drop hammers, and revolving presses, etc.

7. Grinding wheels and stones.

8. Reciprocating knives and saw blades such as cutting and trimming machines and power hack-saws, etc.

9. Revolving drums and cylinders without casing, such as concrete and other mixers.

10. Intermittent feed mechanisms.

11. Projecting nips between various links and mechanisms, like cranks connecting rods, piston rods, rotating wheels and discs, etc.

Common Methods of Protection

The common methods of protection against accidents are the following:

1. Safety by position.

2. Safety by construction.

3. Safety by using interlock guards.gg

4. Safety by using fixed guards.

5. Safety by using automatic guards.

6. Safety by using distance guards.

Safety by construction

When a new machine is designed, it should be ensured that all its dangerous parts are either enclosed in suitable housings or provided with suitable safety guards. For example, the belt drive and motor in a lathe or milling machine are enclosed; the back gears in a lathe are either enclosed or provided with cast iron guards or covers. Lubricating points are provided on the outer surfaces so that the interior parts are not required to be opened every time.

Safety by position

The machine design is in such a way that the dangerous parts are located such that they are always beyond the reach of the operator. The dangerous parts of all the machines should invariably be guarded and undertaking should be made to make them enclosed in the body or housing of the machines.

Safety by using interlock guards

It is a very efficient and sound method of guarding in that the guard cannot be removed and dangerous parts exposed until and unless the machine is totally stopped. Similarly, the machine cannot be started to work unless the guard returns in position and protects the dangerous parts.

An interlocking guard may be mechanical, electrical or some sort of a combination of these. It is essential that it should:

1. Prevent the starting and operation of the machine in case the interlocking device fails.

2. Always acquire its position to guard the dangerous part before the machine can be started.

3. Remain closed in position until the dangerous part is completely at rest.

Safety by using fixed guards

These guards either for man integral part of the machine or are tightly secured to them. They should be made to have rigid construction and should be so placed that any access to the dangerous parts of the machine is totally prevented in the running condition of the machines.

Steel sheets can be advantageously used and they facilitate an easy fabrication of guards and are lighter in weight.

In some cases the fixed guards are made adjustable in order to accommodate different kinds of works or sets of tools. In some cases the fixed guards are provided at a distance from the danger point.

Safety by using distance guards

The principle of a distance guards is that a fencing, enough high, is made of bars, at a suitable distance from the machine such that even if the operative, by chance, extends his hands over it, his fingers, clothes or any part of the body does not reach within the area of dangerous parts. An

additional measure of safety, some sort of tripping device is also usually incorporated to stop the machine quickly in case of an accident.

Safety by using automatic guards

The principle of an automatic guard is that its operation is actuated by some moving part of the machine.

It may link that the part will automatically bring the guard in protecting position before the operation of the machine starts. The design of the guard is such that it automatically forces the operative away from the dangerous area of work before the operation starts and does not permit his access to the area again until and unless the machine stops. It may be noted that due to enough time being required for their operation, this type of guards are not suitable for quick-acting and fast-running machines. Their use is largely favored for heavy and slow acting machines like heavy power presses.

Industrial safety

The factory act 1961 states that:

i) Floors steps stairs passages and gang ways must be soundly constructed properly maintained and kept free from obstruction and any substance likely to cause a person to slip.

ii) Hand rails must be provided for stairs.

iii) All ladders must be soundly constructed and properly maintained.

iv) Opening in floors shall, wherever practicable be securely fenced.

Special regulations

The following precautions should be observed

i) Always work never runs

ii) Never throw rubbish on the floor

iii) Keep gang ways and work areas free of metal bars, components, etc.

v) Keep to gangways when moving about never takes short cuts.

vi) If oil water or grease is spilled wipe it up immediately

vii) Wear safety shoes- shoes are available with until slip soles and with metal toe caps to protect the feet from falling objects.

viii) Always check ladders for damage before use.

ix) Always position ladders on firm base at the correct angle.

Aims and objectives

The major objectives of the factory act are;

1. To provide protection to the workers employed in factories against industrial hazards and to ensure safe and better working conditions.

2. It regulates and maintains properly various safety health and welfare activities in the factories.

3. It regulates & maintains working hours of workers, employment of children and adolescents, employment of women, annual leave with wages etc.

The salient features of this act regarding safety are as follows;

1. Fencing of machinery

-Every prime mover like engine or motor, moving part of the machinery is fenced properly.

2. Work on or near the machinery in motion.

Only specially trained workers wearing tight fitting clothes should carry out inspection of any part of the machinery in motion.

3. Employment of young persons on dangerous machines.

No young person should be allowed to work on dangerous machine unless he is properly trained and carefully supervised

4. Hoist and lifts

- Every hoist and lifts should be of god mechanical construction, adequate strength and must be protected by enclosure and fitted with gates.
- Every hoist and lift should be adequately maintained and periodically examined

5. Listing machinery, chains, ropes and lifting tackles

Lifting machines such as cranes, crab, etc should be of good construction, adequate strength should be maintained.

6. Revolving machinery

It should always be ensured that safe working peripheral speed is not exceeded for every revolving machinery.

7. Pressure plants

- The pressure plant should not be operated at a pressure higher than the specified safe working pressure.

8. Floors stairs and means of access to different places

All floors, steps, stairs, passages should of sound construction and free from obstructions

9. Pits sumps, opening in floor etc.

-Every pit, sumps, opening in floor, fixed vessels, tanks etc should be securely covered or fenced.

10. Excessive weights

- No person should be asked to lift carry or move any load so heavily that's likely to cause him injury.

- Protection of eyes.

- **Causes of fire**

A house can easily catch fire from the misuse of appliances and heating equipment to smoking in bedrooms.

However you can take measures to avoid fire in home and ensure the safety of your family. Below are some of the most common causes of house fires, and some tips to take precautions.

1. Cooking equipment

Pots and pans can overheat and cause a fire very easily if the person cooking gets distracted and leaves cooking unattended. Always stay in the room, or ask someone to watch your food, when cooking on hotplates.

2. Heating

Keep portable heaters at least one metre away from anything that could easily catch fire such as furniture, curtains, laundry, clothes and even yourself. If you have a furnace, get it inspected once a year to make sure it is working to safety standards.

3. Smoking in bedrooms

Bedrooms are best to be kept off limits for smoking. A cigarette that is not put out properly can cause a flame, as the butt may stay a lit for a few hours. It could burst into flames if it came into contact with flammable materials, such as furniture.

4. Electrical equipment

An electrical appliance, such as a toaster can start a fire if it is faulty or has a frayed cord. A power point that is overloaded with double adapter plugs can cause a fire from an overuse of electricity. A power point extension cord can also be a fire hazard if not used appropriately. Double check the appliances and power points in your home.

5. Candles

Candles look and smell pretty, but if left unattended they can cause a room to easily burst into flames. Keep candles away from any obviously flammable items such as books and tissue boxes. Always blow a candle out before leaving a room.

6. Curious children

Kids can cause a fire out of curiosity, to see what would happen if they set fire to an object. Keep any matches or lighters out of reach of children, to avoid any curiosity turned disaster. Install a smoke alarm in your child's room and practice a home escape plan with your children and family in case there was a fire.

7. Faulty wiring

Homes with inadequate wiring can cause fires from electrical hazards. Some signs to see if you've bad wiring are:

1. Lights dim if you use another appliance;
2. For an appliance to work, you have to disconnect another;
3. Fuses blow or trip the circuit frequently.

Have a licensed electrician come and inspect you house, or contact your landlord if you have any of the above occurrences.

8. Barbeques

Barbeques are great for an outdoor meal, but should always be used away from the home, tablecloths or any plants and tree branches. Keep BBQs regularly maintained and cleaned with soapy water and clean any removable parts. Check the gas bottle for any leaks before you use it each time.

9. Flammable liquids

If you have any flammable liquids in the home or garage such as petrol, kerosene or methylated spirits, keep them away from heat sources and check the label before storing. Be careful when pouring these liquids.

10. Lighting

Lamp shades and light fittings can build up heat if they are very close to light globes. Check around the house to make sure. Lamp bases can become a hazard if they are able to be knocked

over easily, and so should be removed if they are. Check that down lights is insulated from wood panelling or ceiling timbers.

The above tips are a good guide to avoiding a fire in your home. However it's a good idea to protect yourself with adequate home insurance cover to ensure you are covered in the unlikely event a fire were to happen

http://www.cfs.sa.gov.au/site/fire_safety/house_fire_safety/common_causes_of_fire.jsp

Classification of fires

Fire can cause loss of lives, jobs equipment, materials and buildings.

For all practical purposes there are three main classes of fires; A B &C

Class A fires (Solids)

Fires involving ordinary combustible materials such as wood, paper & cloth.

This is one of the most common types of fire because solids are the most common type of fuel and one that is hard to eliminate.

Good housekeeping should help to keep materials like packaging and waste reduced, minimizing risks Water extinguisher is one of the most popular types of extinguishers used class A fire. It can handle most fires involving solids.

The majorities of fires are in this class and can be most effectively extinguished by cooling with water.

Class B fires(liquids)

Fires from flammable liquids such as paraffin, petrol, paint, varnishes, oil and from greases and fats.

Many of the fluids, liquids and chemicals used in workplaces can be flammable or explosive. Like cleaning fluids, solvents, fuels, inks, adhesives and paints.

Make sure you know what flammable liquids are used in your workplace, and carry out a Control of Substances Hazardous to Health' (COSHH) assessment Control of Substances Hazardous to Health assessments are a legal requirement, for any hazardous substances. This about safe storage and use of these substances, keep them in labeled containers and away from sources of ignition. Should a class B fire ignite, foam or powder extinguishers are the best types of extinguishers to attack this type of fire.

Class C fires (gases)

Class C fires are fires involving gases. This could be natural gas, Liquefied petroleum gas (LPG) or other types of gases forming a flammable or explosive atmosphere.

Work with gas is dangerous, and increases fire risk. Keep stored gases in sealed containers in a safe storage area, and ensure that gas work is carried out by competent persons.

While extinguishers can be used on class C gas fires, the only safe method to attack this type of fire is to shut off the gas supply. The best type of extinguisher to put out the fire when the supply of gas is off is a dry powder extinguisher

Fires involving live electrical equipment and wiring. The safest method of extinguishing is to displace the oxygen by projecting a gas or dry powder into the vicinity of the fire.

Class D fires (Metals)

Metals are not often thought of as a combustible material, some types of metal can be, like sodium. Metals are also good conductors, helping a fire spread. All metals will soften and melt at high temperature, which can be a big problem when metal joists and columns are present in a fire as structural elements.

Water can actually act as an accelerate on metal fires, so how would you tackle a class D fire? There are dry powder extinguishers developed to tackle metal fires. The powder inside the extinguisher may vary depending on the type of metal risk it is designed for. Small metal fires can sometimes be smothered with dry earth or sand.

Electrical Fires

This is not strictly a class (class E) of fire, because electricity is more or a source of ignition than a fuel. However, fires in live electrical equipment are an additional hazard. You don't want to be using water, or any other conductor as that could be fatal.

Electrical fires are not given their own full class, as they can fall into any of the classifications. After all it is not the electricity burning but surrounding material that has been set alight by the electric current.

To avoid electric fire;

Making sure electrical equipment and installations are installed correctly, and inspected and maintained, will help to reduce the risk of this type of fire.

Class F (Cooking Fats & Oils)

Deep fat frying and spillages of flammable oils near to heat sources in kitchens can result in a class F fire.

Never leave food or frying equipment unattended during use. The only type of fire extinguisher approved for use on cooking oils and fats is the wet chemical extinguisher. For small class F fires, you could also use a fire blanket.

While you shouldn't use water to attack an electrical fire, you can use other types of fire extinguishers. Like carbon dioxide, and dry powder in low voltage situations. Always turn off the power supply if you can.

In the event of a fire:

The following precautions should be observed at all times.

i) Know the correct fire drill and the positions of fire alarms, firefighting equipment and emergency exits.

ii) Know the correct appliance to use for a particular type of fire and know how to use t.

iii) Don’t bock fire exits.

iv) Don’t use fire appliances for any purpose other than intended.

v) Never smoke in no smoking areas

vi) Always ensure that matches and cigarettes are put out before throwing them away

vii) Avoid spillage of flammable liquids.

Extinguishers and fighting procedures

1) Water type

These are usually operated by striking a plunger to release a gas which pressures the water and forces it out of the nozzle. They are stable only for class-A fires.

- The jet should be directed at the base of the fire and be kept moving across the area of the fire.

2. Chemical foam type

- These may be operated by inverting the extinguisher or by releasing a plunger allowing two solutions to mix and produce foam.
- They are used on class B fires involving flammable liquids.
- The jet is directed with a gentle sweeping movement, allowing the foam to drop down and lie on the Surface of the liquid.
- This smothers the fire by excluding oxygen.

3. Carbon-dioxide (Co_2) type

These are operated by squeezing the discharge lever which allows the liquid co2 to be discharged as a gas. They are used on class c fires where after the current has been switched off the discharge horn is directed straight at the fire.

4. Dry powder pressure type.

This type contains a pressurized as and a dry chemical agent. After the release lever has been operated discharge is controlled by a nozzle at the end of the nose.

These are used on class c fires in the same way as the Co_2 type.

Use of fire extinguishers

Class of fire		Type of fire extinguisher			
		Water	Foam	Co_2	Dry powder
A	Ordinary fires: wood , paper ,cloth	Yes	Yes	No	No
B	Flammable liquids: petrol ,paraffin	No	Yes	Yes	Yes
C	Electrical equipment	No	No	Yes	Yes

Table 1: Uses of fire extinguishers

Fire precautions

Fire is a great danger in a workshop and care must be taken not to start a fire. The main causes of fire are:

1. Careless storage of flammable materials.
2. Careless electrical maintenance.
3. People throwing away cigarettes.

Electrical safety

- Electrical can't be seen we only see the effect due to it.
- Because of this care must be taken when using electricity. There are two main causes of accidents due to electricity.

These are

(i) Carelessness: this arises because of laxity. When electricians have worked for long period they tend to assume the high standards of safety required and start to maintain equipment when it' s live and as a result an accident can easily occur.

(ii) Ignorance and inexperience. Most of the electrical tasks appear very simple when carried out by well-trained electricians. When unqualified personnel attempt to do the same they are usually unable and they leave the tasks uncompleted. This is dangerous to the others. The safety precaution in any electrical installation is to:

i) Prevent electric shock.

ii) Prevent the occurrence of fire due to electrical fires.

Electric shock

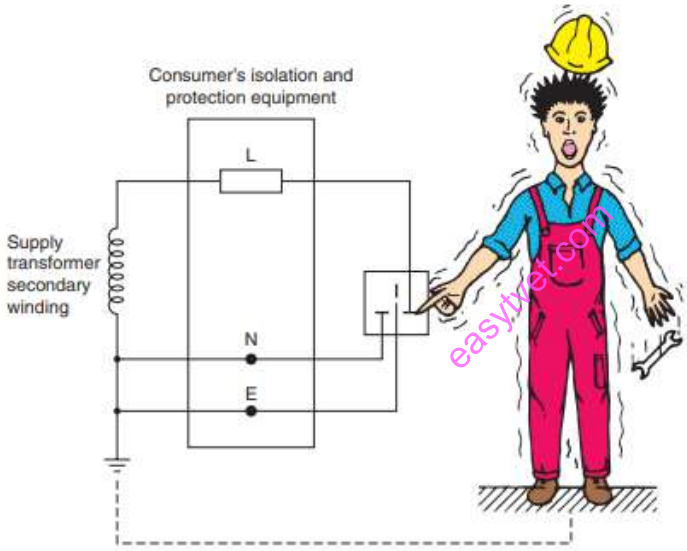

Figure 1:Touching live and earth or live and neutral makes a person part of the electrical circuit and can lead to an electric shock.

- Electric shock occurs when a person becomes part of the electrical circuit.
- One gets electric shock when he or she is in contact with two objects that are at different potentials.
- The person complete the circuit to earth and the current flows through him/or her.

The damage done to the human body will depend on the following factors:

i) Voltage between the two points

ii) The amount of current flowing

ii) The time taken for the current to flow

Also the level or intensity of the shock will depend upon factors, such as age, fitness and the circumstances in which the shock is received. The lethal level is approximately 50 mA, above which muscles contract, the heart flutters and breathing stops. A shock above the 50 mA level is therefore fatal unless the person is quickly separated from the supply. Below 50 mA only an unpleasant tingling sensation may be experienced or you may be thrown across a room, roof or ladder, but the resulting fall may lead to serious injury.

- The methods used to prevent electric shock are;

i) Earthing the metallic and any equipment within the installation

ii) Using all the insulated wiring systems

Treatment of electric shock

If somebody get electric shock, the immediate action should be:

i) Switch off the supply

ii) If necessary start artificial respiration

iii) Seek medical assistance

iv) Treat the burns or injuries.

v) Keep the victim warm.

If the person is in contact with the live conductors then the first thing is to break the contact .care must be taken in order not electrocute yourself.

Try to switch off the supply or to unplug the equipment incase it's a portable tool e.g. a drill. Under no circumstances should you attempt to touch the person. It may be possible to detach the person by pulling or pushing him/her by using insulated object e.g. an insulated cable looped rounded the victims arm or body using a dry wooden pole.

- After the victim is removed from the live contacts provide artificial respiration by using any of the following methods

i) Mouth to mouth

ii) Holger-Nelson

i) Mouth -mouth

- In this method, the patient must be on his back and his mouth should be inspected for any obstructions e.g. false teeth.
- The patient head should be extended by placing one hand on his crown and the other immediately beneath his chin.
- Gently bend his head backwards and then using his both hands, lift his jaw forward.
- Place your lips over the patients' mouth and make a good seal with the thumb and one fore finger of one hand gently close the patient nostrils.
- Take a deep breath and exhale into the patient using little force.
- Watch and feel the patient's chest rise. Remove your lips and let the lungs deflate.
- The above procedure should be repeated twelve times per minute remembering to turn away your head as you don't fill your own lungs with the patients expired air.
- Continue inflation and depletion of the lungs until spontaneous breathing is maintained.

ii) Holger and Neilson.

- The patient should be placed face downwards with the arm overhead, the elbows flexed so that one hand rests on the other in turn.
- Turn the patients head to one side so that the neck rests on his upper most hand. Kneel to one side of the patients head and put the foot of your other leg near his elbow.

- Place your hands on his back just below the shoulder blades and rock forwards with your elbow straight until your arms are approximately vertical, exerting- steady pressure on his chest.
- Grasp the patient's arms just above the elbow and rock backwards raising his arms until tension is felt at the patients shoulder lower his arms.
- The complete cycle should be repeated twelve times a minute.
- This method is practical only when there's no gross injury to the arms shoulder and the ribs.

First aid

Definitions

First aid is the initial assistance or treatment given to a casualty for any injury or sudden illness before the arrival of an ambulance, doctor or other medically qualified person.

A **first aider** is someone who has undergone a training course to administer first aid at work and holds a current first aid certificate.

An **appointed person** is someone who is nominated to take charge when someone is injured or becomes ill, including calling an ambulance if required. The appointed person will also look after the first aid equipment, including re-stocking the first aid box.

First aid

Despite all the safety precautions taken on construction sites to prevent injury to the workforce, accidents do happen and you may be the only other person able to take action to assist a workmate. If you are not a qualified first aider limit your help to obvious common sense assistance and call for help, but do remember that if a workmate's heart or breathing has stopped as a result of an accident he has only minutes to live unless you act quickly.

The Health and Safety (First Aid) Regulations 1981 and relevant approved codes of practice and guidance notes place a duty of care on all employers to provide adequate first aid facilities appropriate to the type of work being undertaken.

The regulations state that:

Employers are under a duty to provide such numbers of suitable persons as is adequate and appropriate in the circumstances for rendering first aid to his employees if they are injured or become ill at work.

For this purpose a person shall not be suitable unless he or she has undergone such training and has such qualifications as the Health and Safety Executive may approve.

This is typical of the way in which the health and safety regulations are written. The regulations and codes of practice do not specify numbers, but set out guidelines in respect of the number of first aiders needed, dependent upon the type of company, the hazards present and the number of people employed.

First aid is the treatment of minor injuries which would otherwise receive no treatment or do not need treatment by a doctor or nurse or In cases where a person will require help from a doctor or nurse, first aid is treatment for the purpose of preserving life and minimizing the consequences of an injury or illness until such help is obtained. A more generally accepted definition of first aid might be as follows: first aid is the

- Initial assistance or treatment given to a casualty for any injury or sudden illness before the arrival of an ambulance, doctor or other medically qualified person.

A first aider is someone who has undergone a training course to administer first aid at work and holds a current first aid certificate. The training course and certification must be approved by the HSE.

- The aims of a first aider are to preserve life, to limit the worsening of the injury or illness and to promote recovery.
- A first aider may also undertake the duties of an appointed person. An appointed person is someone who is nominated to take charge when someone is injured or becomes ill, including calling an ambulance if required.
- The appointed person will also look after the first aid equipment, including re-stocking the first aid box.
- Appointed persons should not attempt to give first aid for which they have not been trained, but should limit their help to obvious common sense assistance and summon professional assistance as required.
- First aid personnel must be available at all times when people are at work, taking into account shift working patterns and providing cover for sickness absences.

Bleeding

If the wound is dirty, rinse it under clean running water. Clean the skin around the wound and apply a plaster, pulling the skin together.

If the bleeding is severe apply direct pressure to reduce the bleeding and raise the limb if possible. Apply a sterile dressing or pad and bandage firmly before obtaining professional advice.

To avoid possible contact with hepatitis or the AIDS virus, when dealing with open wounds, first aiders should avoid contact with fresh blood by wearing plastic or rubber protective gloves, or by allowing the casualty to apply pressure to the bleeding wound.

Burns

Remove heat from the burn to relieve the pain by placing the injured part under clean cold water. Do not remove burnt clothing sticking to the skin.

Do not apply lotions or ointments. Do not break blisters or attempt to remove loose skin. Cover the injured area with a clean dry dressing.

Broken bones

Make the casualty as comfortable as possible by supporting the broken limb either by hand or with padding.

Do not move the casualty unless by remaining in that position he is likely to suffer further injury. Obtain professional help as soon as possible.

Contact with chemicals

Wash the affected area very thoroughly with clean cold water. Remove any contaminated clothing. Cover the affected area with a clean sterile dressing and seek expert advice. It is a wise precaution to treat all chemical substances as possibly harmful; even commonly used substances can be dangerous if contamination is from concentrated solutions.

When handling dangerous substances, it is also good practice to have a neutralizing agent to hand.

Disposal of dangerous substances must not be into the main drains since this can give rise to an environmental hazard, but should be undertaken in accordance with local authority regulations.

Exposure to toxic fumes

Get the casualty into fresh air quickly and encourage deep breathing if conscious. Resuscitate if breathing has stopped. Obtain expert medical advice as fumes may cause irritation of the lungs.

Sprains and bruising

A cold compress can help to relieve swelling and pain. Soak a towel or cloth in cold water, squeeze it out and place it on the injured part. Renew the compress every few minutes.

Breathing stopped

- Remove any restrictions from the face and any vomit, loose or false teeth from the mouth. Loosen tight clothing around the neck, chest and waist.
- To ensure a good airway, lay the casualty on his back and support the shoulders on some padding.
- Tilt the head backwards and open the mouth.
- If the casualty is faintly breathing, lifting the tongue, clearing of the airway may be all that is necessary to restore normal breathing.
- However, if the casualty does not begin to breathe, open your mouth wide and take a deep breath, close the casualty's nose by pinching with your fingers, and, sealing your lips around his mouth, blow into his lungs until the chest rises.
- Remove your mouth and watch the casualty's chest fall.
- Continue this procedure at your natural breathing rate.
- If the mouth is damaged or you have difficulty making a seal around the casualty's mouth, close his mouth and inflate the lungs through his nostrils.
- Give artificial respiration until natural breathing is restored or until professional help arrives.

Heart stopped beating

- This sometimes happens following a severe electric shock. If the casualty's lips are blue, the pupils of his eyes widely dilated and the pulse in his neck cannot be felt, then he may have gone into cardiac arrest.
- Act quickly and lay the casualty on his back.
- Kneel down beside him and place the heel of one hand in the centre of his chest.
- Cover this hand with your other hand and interlace the fingers.
- Straighten your arms and press down on his chest sharply with the heel of your hands and then release the pressure.
- Continue to do this 15 times at the rate of one push per second.
- Check the casualty's pulse. If none is felt, give two breaths of artificial respiration and then a further 15 chest compressions.
- Continue this procedure until the heartbeat is restored and the artificial respiration until normal breathing returns. Pay close attention to the condition of the casualty while giving heart massage.
- When a pulse is restored the blueness around the mouth will quickly go away and you should stop the heart massage. Look carefully at the rate of breathing. When this is also normal, stop giving artificial respiration.
- Treat the casualty for shock; place him in the recovery position and obtain professional help.

Shock

Everyone suffers from shock following an accident. The severity of the shock depends upon the nature and extent of the injury. In cases of severe shock the casualty will become pale and his skin become clammy from sweating. He may feel faint, have blurred vision, feel sick and complain of thirst. Reassure the casualty that everything that needs to be done is being done. Loosen tight clothing and keep him warm and dry until help arrives.

Do not move him unnecessarily or give him anything to drink.

Items of a First-Aid Box

(i) Pair of scissors

(ii) Large size sterilized dressings

(iii) Medium size sterilized dressings

(iv) Small sized sterilized dressings

(v) Large size burn dressings

(vi) Packets of sterilized cotton wool

(vii) Rolled bandages 10 cm wide

(viii) Rolled bandages 5 cm wide

(ix) Bottle (4 oz) of salvolative having the dozs and made 1 of administration indicated on label

(xi) Safety pins

(xi) Eye drops

(xii) Adhesive plaster

(xiii) 4 bottle containing $KMnO_4$ crystals, etc.

(xiv) 4 bottle containing a 2% alcoholic solution

(xv) Betadine ointment (50mg)

(xvi) Saframycine ointment (50mg)

(xvii) Dettol

Accident reports

Every accident must be reported to an employer and the details of the accident and treatment given are suitably documented. A first aid Log book or accident book containing first aid treatment record sheets could be used to effectively document accidents which occur in the workplace and the treatment given. Failure to do so may influence the payment of compensation at a later date if an injury leads to permanent disability.

To comply with the Data Protection Regulations, from the all First Aid Treatment Log books or Accident Report books must contain perforated sheets which can be removed after completion and filed away for personal security.

2.2.1.4 Learning Activities

Learning Activity 1

While working in busy production line in textile industry, fire erupts from one of the faulty electrical equipment. The fire gets contained but one of the workers gets minor burns on his left leg. Perform the following to relieve him/her from pain.

1. Cool down the burn. After holding the burn under cool, running water, apply cool, wet compresses until the pain subsides.
2. Remove tight items, such as rings, from the burned area. Be gentle, but move quickly before swelling starts.
3. Avoid breaking blisters. Blisters with fluid protect the area from infection. If a blister breaks, clean the area and gently apply an antibiotic ointment.
4. Apply a moisturizing lotion, such as one with aloevera. After the burned area has been cooled, apply a lotion to provide relief and to keep the area from drying out.
5. Loosely bandage the burn. Use sterile gauze. Avoid fluffy cotton that could shed and get stuck to the healing area. Also avoid putting too much pressure on the burned skin.
6. Take an over-the-counter pain reliever if necessary.
   Consider acetaminophen (Tylenol), ibuprofen (Advil), or naproxen (Aleve).

Learning Activity 2

Objective: to demonstrate skills on how to use a fire extinguisher.

Exercise: Using a fire extinguisher to performs the following tasks.

Instructions: Lit a ***firewood*** fire on ***an open field*** to extinguish in this exercise.

Caution: Fire should be handled with a lot of care and is very dangerous

Procedure

1. Pull the pin (or other motion) to unlock the extinguisher.
2. Aim at the base (bottom) of the fire and stand 6-10 feet away.
3. Squeeze the lever to discharge the agent.

4. Sweep the spray from left to right until the flames are totally extinguished.

2.2.1.5 Self-assessment

1. Hazard may be defined as:
    A. anything that can cause harm
    B. the chance, large or small, of harm actually being done
    C. someone who has the necessary training and expertise to safely carry out an activity
    D. the rules and regulations of the working environment
2. A positive attitude to safety at work:
    A. is the duty of every employer
    B. is the duty of every employee
    C. increases accidents at work
    D. reduces accidents at work
3. The most common cause of accidents at work is:
    A. gloves, boots and hard hats
    B. sprains, strains and trap pains
    C. slips, trips and falls
    D. hook, line and sinker
4. What safety precautions that should be adhered to when giving first aid on a burn?

5. Complete the following table to justify the type of fire extinguisher used for the classes of fires indicated. Use **Yes** or **No**

Class of fire		Type of fire extinguisher			
		Water	Foam	Co_2	Dry powder
A	Ordinary fires: wood , paper ,cloth				
B	Flammable liquids: petrol ,paraffin				

C	Electrical equipment				

6. State the General Safety Precautions while Working in a Workshop
7. John is an electrical technician. Name Personal protective equipment that he may have worn:

2.2.1.6 Tools, Equipment, Supplies and Materials

Tools

- Set of screw drivers
- Pliers
- Phase testers
- Multimeter

Equipment

- PPE –hand gloves, dust coat, dust masks
- Multimeter
- Clamp meter
- Earth electrode resistance meter
- Phase sequence meter
- Computer/smart phone

Materials and supplies

- Stationery
- Cables
- Lubricants
- Service parts

2.2.1.7 References

- IEE regulations

- Organizational procedures manual
- Electrical Installation Maintenance K to 12 – Technology and Livelihood Education Learning Module Republic of the Philippines Department of Education
- Ray_C._Mullin,_Phil_Simmons Electrical_Wiring_Re(z-lib.org)
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- J. Craig Voelkert, A Brief Guide To Fire Chemistry And Extinguishment Theory For Fire Equipment Service Technicians, 2009 – Revised 2015, Amerex Corporation
- John F. Riley, Standard for Fire Extinguishers, Rating and Fire Testing of, UL 711 Fifth Edition, 1995, , Institute of Gas Technology

2.2.2 Learning Outcome 2: Use of workshop tools, Instruments and equipment

2.2.2.1 Introduction to the learning outcome

This learning outcome specifies the content of competencies required to properly handle and use workshop tools and equipment. It also specifies the content of competencies in taking care and maintenance of workshop tools, instruments and equipment. The learning outcome must be assessed against as per standard operating procedure.

2.2.2.2 Performance Standard

3.3.2.2.1 ***Workshop tools***, Instruments and equipment are identified as per required installation

3.3.2.2.2 Tools, Instruments and equipment are used as per the manufacture's manuals

3.3.2.2.3 Proper handling of workshop tools, Instruments and equipment as per standard operating procedure

3.3.2.2.4 Care and Maintenance of workshop tools, Instruments and equipment as per standard operating procedure

2.2.2.3 Information Sheet

Classification of workshop tools

A **tool** is a device that can be used to produce an item or accomplish a task, but that is not consumed in the process. It can be considered as extension of the human hand thus increasing speed, power, and accuracy and on the other hands equipment includes any machine powered by electricity.

Hand tools

Hand tools are tools manipulated by hands without using electrical energy such as: puller, hacksaw, pull-push rule, pliers, hammer, and others.

Machine/Power tools

Machine/Power tools are tools manipulated by our hands and with the use of electrical energy such as: electric drill, grinding wheels, vacuum cleaner and others.

Pneumatic tools

Pneumatic tools are tools or instruments activated by air pressure. Pneumatic tools are designed around three basic devices: the air cylinder, the vane motor, and the sprayer.

Hand tools

They include screwdrivers, hammers, pliers, wrenches and pullers.

1. Screwdrivers are used to drive, or turn screws. The common type has a single flat blade for driving screws with slotted heads. The other type has the cross slotted head.

1. Hammers are mostly used tools in the shop. They should be gripped at the end of the handle.

2. Pliers are specified types of adjustable wrenches. The two legs move on a pivot so that items of various sizes can be gripped.

3. Wrenches are used to turn screws, nuts and bolts with hexagonal heads. ―Hexagonal‖ means six-sided. A variety of wrenches are used in the shop.

4. Pullers are used to remove gears and hubs from shafts, bushings from blind holes, and cylinders' liners from the engine blocks.

Machine/Power Tools

Electric drill has an electric motor that drives a chuck. The chuck has jaws that can be opened and then closed to grip a drill kit.

Grinding tool can be either bench-mounted or installed on a pedestal. They may either have a grinding wheel, view wheel, or two grinding wheel

3. Vacuum cleaner is used for cleaning the floor and car interiors after service.

Pneumatic tools

Pneumatic Torque Wrench. This wrench uses compressed air to quickly and powerfully turn nuts, bolts, and other objects.

Air chisel uses reciprocating motion to drive a cutting hammering tool. An air hammer drives a chisel to cut off a nut that has frozen to a stud. It can be used with a variety of tools-cutters and punches to do many jobs.

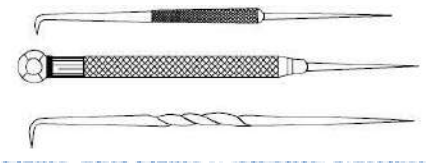
Air drill is lighter than a comparable electric drill. Repeatedly stalling or overloading does not damage or overheat the air drill.

Air racket uses the sockets and attachments from a standard socket set.

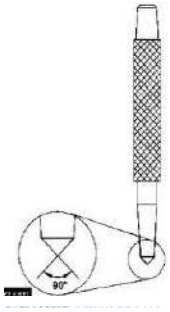
5. Pneumatic floor jack uses compressed air to flow into the jack cylinder and causes the ram to extend and raise the vehicle.

Marking tools

a) Marking out Tools are used to mark the given measurement on the surface of the work piece. a) Scriber



b) Dot punch



c) Center punch

d) Hermaphrodite caliper

Dividers

f) Try square

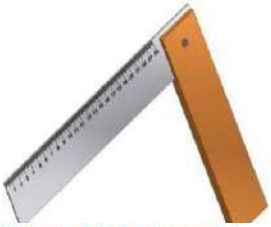


Figure SEQ Figure * ARABIC 7: Try square

g) Steel rule

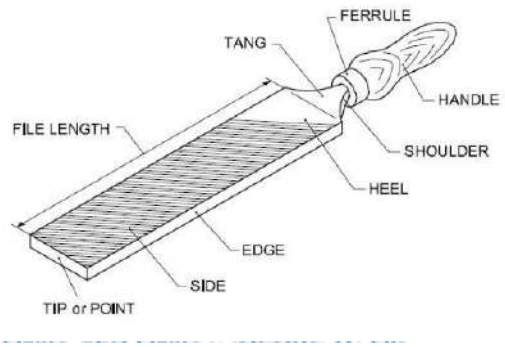
h) Scribing block

i) V-blocks

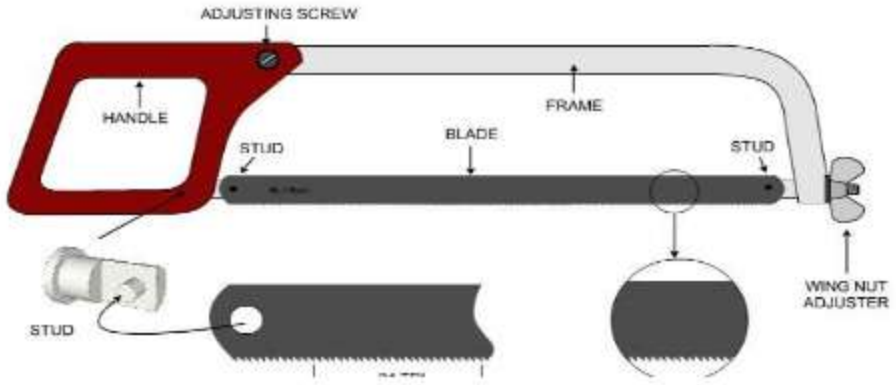
Cutting tools

- Files
- Hacksaw
- Chisel
- Scraper

a) File



b) Hacksaw



Chisel

Parts of a chisel

Ferrule: The ferrule is the brass or iron extension of the blade that attaches to the handle

Handle: A chisel handle can be made of hard timber materials such as beech, oak, hickory or ash.

Holding tools

- Vices
- Clamps
- Pliers

Striking tools

- Hammers
- Mallets

Tightening tools

Spanners

Uses of workshop tools, Instruments and equipment

Good quality, sharp tools are important to any craftsman, they enable learned skills to be used to the best advantage.

The basic tools required by anyone in the electro technical industry are those used for stripping and connecting conductors.

Basic electrical tools, equipment, and their uses include:

Pliers

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

Figure 13: Pliers

Diagonal Cutting Pliers

Figure 14: Diagonal Cutting Pliers

Diagonal cutting pliers, sometimes called side snips or dikes, are used to cut wires. They are specially designed with a cutting edge that goes down to the tip of the jaws, allowing you to get into tight areas to trim wires. Some types can also have a built-in voltage detector to sense live wires. You can also find combination tools that include wire-stripping slots built into the handles.

Drawing Wire/ Tape

Figure 15: Drawing Wire/ Tape

A Drawing Wire/ Tape is used to pull stranded or solid wire conductors through metal or PVC conduit. Cable lube is available to assist you in pulling the wires through the conduit. A fish tape can also be helpful when you are pulling cables through wall cavities.

This is a tool used when making wiring improvements, such as adding or extending circuits.

Voltmeter or Multimeter

Figure 16: Voltmeter or Multimeter

A voltmeter is used to read voltage levels and verify that circuits are “live” or off. Unlike a circuit tester, this tool gives you reading on how much voltage is being carried. More sophisticated forms of the tool are known as multimeters, and they can not only read voltage levels but also amperage, resistance, and DC voltage and amperage. They do, however, require practice to learn how to use them properly.

Wire Crimpers

Figure 17:Wire Crimpers

Wire crimpers are used to crimp lugs or connection terminals onto wires. This tool is not often used for routine circuit repairs, but it has many uses when working with appliances or electronics. Many types can also be used to strip wire insulation.

Screw Drivers

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

Figure 18: Screw drivers

Drilling Equipment

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

Figure 19: Driller

Sawing and Cutting

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

Figure 20: Hack saw

Soldering Equipment

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

Figure 21: Soldering equipment

Hammers

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

Figure 22: Hammers

Measuring Tools

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

Figure 23: Folding rule

Tape measure

Figure 24:Tape measure

A standard is used for all kinds of field measurements, such as setting heights for switches and outlets, centering lighting fixture boxes, and marking surfaces for cutouts.

Spirit level

A small level, such as a torpedo level, fits easily in a tool pouch and is used to make sure your work is level and plumb. A great installation starts with level boxes and straight switch and outlet covers.

A torpedo level should be part of every homeowner's standard toolkit; it will have plenty of uses beyond electrical work.

Figure 25:Tape measure

Flashlight

Electrical repair and improvement work involves a lot of dark places, from attics and basements, to wall and ceiling cavities, to the insides of electrical boxes. A tactical flashlight is needed as much for safety as it is for convenience. A couple of hand flashlights and a headlamp are good additions to an electrician's toolbox.

Figure 26: Utility Knife

Utility Knife

A utility knife, or *box cutter,* is handy for cutting sheathing from non-metallic (Romex) cable, to cut off electrical tape, and to open cardboard boxes.

Figure 27: Utility Knife

Voltage Testers

A voltage tester, as the name suggests, is used for testing the presence of voltage in a circuit. A voltage tester has a neon bulb with two wires attached to its bottom. This is used to test the flow of current in a wire. A good voltage tester is rated for up to 500 V. in the old days, Phase Tester also were used for this purpose.

Wire Strippers

Figure 29: Wire Strippers

Another essential electrical specialty tool for homeowners is a good pair of wire strippers. Wire strippers are used to cut and strip insulation from electrical wires. A wire stripper tool has a row of

gauged holes for stripping wires of different sizes, and it usually includes cutting jaws for trimming the wire ends.

Along with a voltage tester, this is perhaps the most important specialty electrical tool you can own. It makes sense to invest in a good set of wire strippers, as it will serve many functions.

Other tools and equipment include:

- Bending machine
- Stock and die

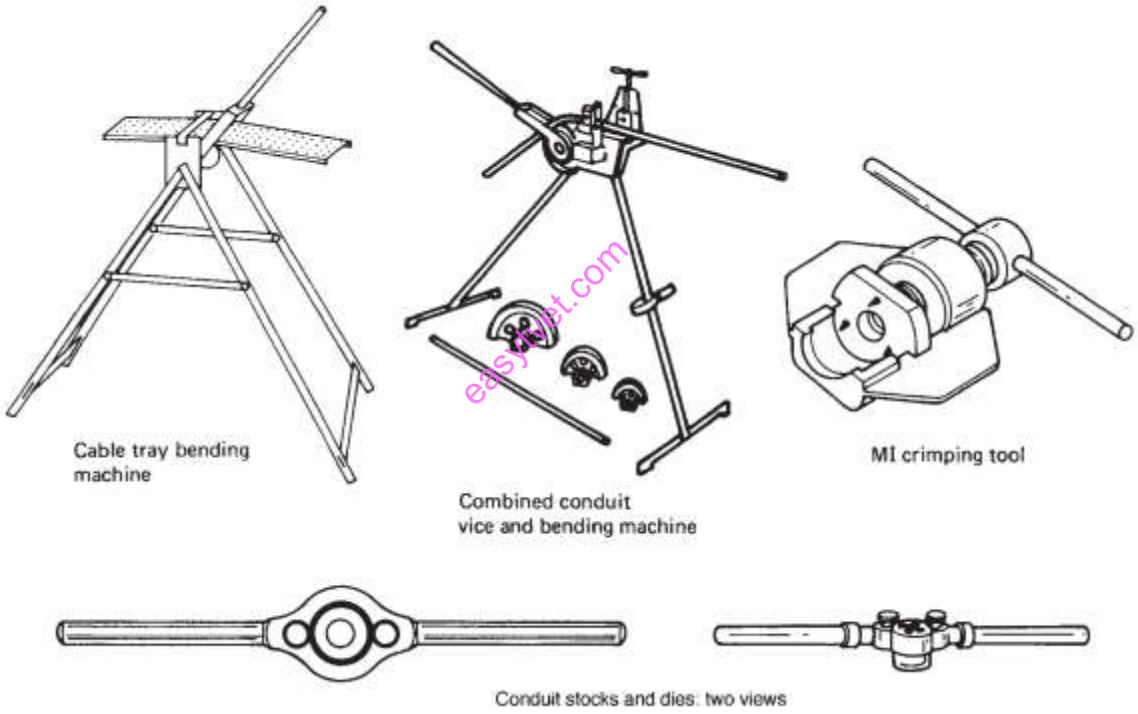


Figure 30: Some special tools required by an electrician engaged in industrial installations

Maintenance of electrical tools and equipment

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

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

2. **Check the Cords**. Look for tear/cut insulator on the power cords on your electric tools. This will ensure that your electric tool can get the power that it needs to function without an accident.

3. **Use the right tool correctly**. Use tools correctly and for their intended purposes. Follow the safety directions and operating procedures recommended by the manufacturer. When working on a circuit, use approved tools with insulated handles.

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

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

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

Maintenance of power equipment

- Keep Power tools Clean.
- Dust and grime can bring your power tools to a grinding halt if left unchecked over time.
- Store Power tools correctly.
- Inspect for Wear or Damage.

- Lubricate Moving Parts.
- Keep Batteries in Shape.

Safety rules for hand tools

- Always use the correct tool for the job in hand and use it properly and sensibly
- Always keep tools clean and sharp
- Always keep tools in a toolbox and secure safety rules for power tools
- Always check that the casing is not damaged
- Always check that the cable is not damaged
- Always check that the plug top is not damaged
- Always check that no coloured conductors are showing anywhere on the flexible cord

Keep power tools clean

Dust and grime can bring your power tools to a grinding halt if left unchecked over time. Wipe them clean with a rag after every job has been completed and then store them. Deep clean periodically by using a damp cloth. Get into exhausts and intakes and other hard-to-clean areas with lightly oiled cotton swabs or other slender tools.

Store power tools correctly

Keep your power tools protected from dust, moisture and other adverse conditions by storing them properly after use. Keep them in their original cases if possible, or tuck them away in storage drawers or tool chests, preferably in a garage or basement with a moderately controlled climate. This not only protects them, it also keeps them organized so you can easily find the tool you need when you need it.

Inspect for wear or damage

Periodically inspect power tools for any signs of wear or damage. Pay special attention to power cords. If you see frayed insulation or exposed wires, have the cord repaired or replaced immediately by a professional, unless you have the expertise to do it yourself. Damaged power cords can potentially lead to injury from electric shock or can cause a fire. Also, check the cord's prongs to see if they are bent or loose. If any are, repair or replace.

Lubricate moving parts

Keep moving parts lubricated for premium performance. Not only does it keep the mechanics of a tool running smoothly, it also decreases the chance of rust developing. While common machine oil is a good choice, consult your owner's manual to see if the manufacturer recommends or requires a specific type of oil.

Keep batteries in shape

Cordless, battery-powered tools are convenient and portable and have become very popular for contractors and homeowners alike. To keep them running efficiently and effectively, it is essential for their batteries to be maintained.

Batteries remain working at peak level by fully charging and then fully discharging their power once every couple of weeks. Don't let batteries sit unused for extended periods of time. Try to use batteries once every two weeks.

Care for batteries by cleaning contacts with cotton swabs and alcohol. Store batteries you won't be using for a while in a dry, clean place away from excessive heat.

2.2.2.4 Learning activities

Learning Activity 1

Directions: Inside the tools box are hand, pneumatic, and power tools. Identify and write them in their corresponding column provided below.

	Air chisel Hammer Air racket Air drill Electric drill Vacuum cleaner

	Grinding wheels Wrenches Screwdrivers pullers	
Hand tools		Pneumatic tools
1.	1.	1.
2.	2.	2.
3.	3.	3.
4.	4.	4.

Instruction:

In a specific tool cabinet and a tool rack assigned to you, arrange and store tools and equipment accordingly.

Procedure:

1. Classify the tools and equipment according to their types.
2. Arrange the tools by their types in the shelves/racks.
3. Place equipment in designated places or location.

Assessment: The teacher will assess you based on the performance criteria listed below

PERFORMANCE CRITERIA	PERFORMANCE LEVEL		
	YES	NO	NA
1. Classified the tools and equipment according to their types.			

2. Arranged the tools by their types in the shelves/racks.				
3. Placed equipment in designated places or location.				
Overall Performance	Competent			
	Not yet competent			

Learning Activity 2

Let us determine how much you already know about usage of tools and instruments. Take this exercise

Exercise: Demonstrate skills on how to use stock and die correctly when making threads on steel conduit.

Procedure

i. Ensure the round section steel conduit is vertical in the vice (at 90 degrees).
ii. Place the die on the round section steel conduit, keeping it parallel with the vice.
iii. Add a little pressure and turn the stock in a clockwise direction.
iv. The first couple of 'turns' of the die are critical.
v. If the stock is not parallel to the vice, a drunken thread will result. Stop once the die begins to cut the first couple of threads and check that the stock is still parallel to the vice.
vi. Continue to rotate the stock in a clockwise direction.
vii. Once the thread has been started, for every clockwise rotation, rotate the stock in an anticlockwise direction, for half a turn.
viii. This clears away any steel chippings, from the die.
ix. Thread cutting can continue until the correct length is been achieved.
x. Remove the stock and die from the thread by rotating it in an anticlockwise direction, effectively unscrewing it from the steel.

xi. Untighten the centre adjusting screw and then tighten the two outer adjusting screws. Run the die down the thread a second time, as this will finish the thread accurately.

2.2.2.5 Self-Assessment

1. Pliers, cutters, a knife and a range of screwdrivers are the tools required in the electro technical industry for:

   A. Erecting conduit
   B. Assembling tray
   C. Stripping and connecting conductors
   D. Terminating an mi cable

2. Always wear PPE when in the shop, even when tools are not being used.

   A. True

   B. False

2. Grace is an electrical technician who manages an electrical workshop. outline the safety rules to be adhered to while using hand tools.

3. Tools are supposed to be maintained and taken care of. State how a technician can maintain and take care of power equipment.

4. Properly insulated electrical tools contribute to safety adherence in electrical works. Explain the essence of using properly insulated tools in electrical works.

2.2.2.6 Tools, Equipment, Supplies and Materials

Tools

Set of screw drivers

Pliers

Phase testers

Multimeters

Equipment

PPE –hand gloves, dust coat, dust masks

Clamp meter

Earth electrode resistance meter

Phase sequence meter

Materials and supplies

Stationery

Cables

Lubricants

Service parts

2.2.2.7 References

1. IEE regulations
2. Organizational Procedures Manual
3. Electrical Installation Maintenance K To 12 – Technology and Livelihood Education Learning Module Republic of The Philippines Department of Education
4. Ray C. Mullin, Phil Simmons Electrical Wiring Re(Z-Lib.Org)
5. Brian Scaddan Ieng; MII (Elec) Electrical Insta(Z-Lib.Org)
6. https://projects.truevalue.com/maintenance_and_repair/basic_maintenance/proper_tool_maintenance.aspx

2.2.3 Learning Outcome 3: Prepare workshop tools and instruments for an Electrical installation

2.2.3.1 Introduction to the learning outcome

This learning outcome specifies the content of competencies required to perform Issuing of required tools and instruments, check Functionality of tools and instruments and calibration of workshop instruments.

2.2.3.2 Performance Standard

1. List of required tools and instruments is prepared per the required installation
2. Issuing of required tools and instruments is performed as per standard operating procedure
3. Functionality of tools and instruments is checked in line with the standard operating procedure
4. Calibration of workshop instruments are performed as per the standard operating procedure

2.2.3.3 Information Sheet

Instruments for an Electrical practical

Wires Strippers

Professional electricians regularly strip the plastic coating on wires to expose the copper and make customized connections with other wiring or components. This essential electrical maintenance tool comes in a variety of models and types.

Fish Tape

Fish tape is one of many popular electrician tools. It's used to run wiring between gang boxes (or other electrical components) through conduit piping. Fish tape is housed in a retractable coil and can be fed through installed conduit piping. Once the end of the fish tape appears on the opposite side, wiring can be hooked to the tape and the tape can be retracted—pulling the wire along the conduit.

Fishing Rods

Fishing rods are essential electrician tools when installing wire through walls, below carpets, or above ceilings. Rods are typically fiberglass and include hooks on the end for easy manoeuvring.

Terminal Block

These modular, insulated devices assist electricians when grouping multiple wires together. They're used to connect wiring to a ground or connect electrical switches and outlets to mains.

Voltage Tester

To safely perform electrical work, electrical power must be cut off in key sections of the property (usually via the circuit breaker). A hand held voltage tester allows electricians to test outlets for power, so they know when they're safe to work on. Electricians also use this tool to confirm power has been restored.

Reaming Bit

An installing new conduit (or replacing old ones) means connecting different segments of piping together to create a wiring route between electrical components. A reaming bit attaches to an electric drill and widens the opening on one end of the piping, allowing it to connect to another segment of piping and complete a secure conduit.

Conduit Bender

When determining a wiring route, electricians often run wiring along the corner of the wall or in other mostly hidden areas. Conduit benders are electrician tools used to curve conduit piping to accommodate these routes and ensure the conduits remain non-intrusive and efficiently placed in the customer's home.

Splicing Connector

These plastic clips help electricians make quick connections with multiple pieces of wire. They can be used with multiple cables, including device wires, telephone cables, and electrical cables.

Flashlights

For an electrician, working in the dark is a potential hazard of the job. Keep essential electrician tools, like flashlights and other various work lights, handy and within reach.

Issuing and confirmation of tools and instruments before and after practical

You can specify tools on job plans and work orders to indicate which tools are needed to perform a task. In the Stocked Tools application, you can issue tools to those work orders to indicate that the tools are dispatched for use with the right job

Testing of practical tools and Instruments

While planning for a practical, one needs to be sure that the tools are in the right order. Some of the things to consider while testing tools are:

1. Making sure that they are working as expected.
2. They can give accurate, measurement.
3. Screw drivers are not blunt.
4. Stripping tools are available.

Functionality of tools

To check the functionality of tools and equipment, Equipment Inspections is necessary.

- Equipment inspections will be performed by both the operators and maintenance.
- Inspections can and will happen: daily, weekly, monthly, quarterly, semiannually, and annually.
- Developing and training operators in the proper techniques for machine inspection.
- The weekly/monthly/quarterly lubrication and preventive maintenance schedules are necessary to assure machine reliability, and safety.
- Master copy of each inspection will be located in the Maintenance Supervisor's Equipment Files.

Document Control

The Document control falls under three categories:

- retaining

- updating
- and deleting document
- Retaining documents means to collect all useful information of the specific items and store them in a logical manner.
- Information includes drawings, operator's manuals, maintenance /service manuals, and equipment inspection documents.

Calibration and service of equipment

Calibration, in its most basic form, is the measuring of an instrument against a standard. As instruments become more complicated, successfully identifying and applying best practices can reduce business expenses and improve organizational capabilities.

What is Calibration?

Calibration is the comparison of a measurement device (an unknown) against an equal or better standard. A standard in a measurement is considered the reference; it is the one in the comparison taken to be the more correct of the two.

Calibration finds out how far the unknown is from the standard. A “typical” commercial calibration uses the manufacturer’s calibration procedure and is performed with a reference standard at least four times more accurate than the instrument under test.

Purpose of a calibration

There are three main reasons for having instruments calibrated:

1. To ensure readings from an instrument are consistent with other measurements.

2. To determine the accuracy of the instrument readings.

3. To establish the reliability of the instrument i.e. that it can be trusted.

https://www.mgnewell.com/wp-content/uploads/2016/05/Purpose-of-Calibration.pdf

Classification of non-functional and functional tools

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

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

B. Classify your tools according to is function.

Method of identifying non-functional/faulty tools and equipment

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

2.2.3.4 Learning Activities

Learning Activity 1

Exercise

Objective: To be able to understand and perform how to make requisition of supplies, materials, and tools for a specific job/ Issuing of required tools and instruments

Task: Make a requisition of material you require to carry out the project in learning activity 2

Learning Activity 2: Project

Project plan in making an extension cord

Introduction

You might be wondering why there are several projects which are not completely done. Well, there are several reasons why this happens.

It might be out of budget or not properly planned. So, this Lesson will help you achieve the desired quality project.

A project plan is necessary before undertaking any project because it serves as your guide in accomplishing an activity.

It will give you an idea what needs to be done, how much to spend and what procedures to undertake. A well prepared project plan saves time and cost of materials.

Below is a sample project plan of an extension cord. This format can also be used in preparing a plan for other projects in the future.

Project Plan - (Making an extension cord)

Name of Student: _____ Year & level:_____

Name of Project: Extension Cord

Assembly Date Started: _____ Date Finished: _____

Objective:

a) Demonstrate how to make an extension cord.

b) Observe safety measures while doing the project.

c) Demonstrate tools selection for a specific practical.

Materials Needed

- Flat Cord
- Male Plug
- Eyelet wire connectors
- Convenience Outlet

Tools and Equipment Needed:		Quantity	Remarks
1.	Standard/Flat Screw Driver		
2.	Philips Screw Driver		
3.	Long Nose Pliers		
4.	Side Cutting Pliers		
5.	Electrician's knife/ Pocket knife		
6.	Continuity Tester or Multi-tester		

Procedure:

1. Prepare the plan.
2. Gather all necessary materials, tools and equipment needed.
3. Insert cord into the male plug, split the cord wires about 8 centimeters long.
4. Remove insulation of both wires 1 centimeter long with a pocket knife as if sharpening a pencil. Be careful not to cut any strand.
5. Scrape bare wire with the back of the knife until shiny. Twist the wire stands.
6. Tie the underwriter's knot.
7. Make a loop on terminal wires and connect the wires to the screw of the male plug. The loop should go with the thread clockwise direction.
8. Split the cord wires at the other end about 4 centimeters long, then follow procedure no. 4.
9. Connect the wires to the connectors.
10. Open the convenience outlet then remove the screw.
11. Insert the wire connectors to the screws, tighten it and return the cover.
12. Check the continuity and test the extension cord.

2.2.3.5 Self-Assessment

1. An instrument used to measure the amount of electrical current in a circuit.

   A. Voltmeter
   B. Ammeter
   C. Micrometer
   D. Ohmmeter

2. A pocket sized tool used to test the line wire or circuit if there is current in it.

   A. Phase Tester
   B. Wire gauge
   C. Ruler
   D. Pull-push rule

3. A measuring tool used to measure the length of an object in centimeter and inches.

A. Test light
B. Wire gauge
C. Ruler
D. Pull-push rule

4. It is used to measure the diameter of wires/conductors. It can measure small and big sizes of wires and cables.

A. Voltmeter
B. Ammeter
C. Micrometer
D. Ohmmeter

5. It is used to measure the voltage, resistance and current of a circuit. It connected in parallel or series with the circuit depending on what to measure.

A. Avometer or multimeter
B. Micrometer
C. Ohmmeter
D. Ammeter

2.2.3.6 Tools, Equipment, Supplies and Materials

Tools

- Standard/Flat Screw Driver
- Philips Screw Driver
- Long Nose Pliers
- Side Cutting Pliers
- Electrician's knife/ Pocket knife
- Continuity Tester or Multi-tester
- Set of screw drivers
- Pliers
- Phase testers

Equipment

- PPE –hand gloves, dust coat, dust masks
- Multimeters
- Clamp meter
- Earth electrode resistance meter
- Phase sequence meter

Materials and supplies

- Borrower's Slip/ Form
- Stationery
- Cables
- Lubricants
- Service parts

2.2.3.7 References

- IEE regulations
- Organizational procedures manual
- Electrical Installation Maintenance K to 12 – Technology and Livelihood Education Learning Module

  Republic of the Philippines DEPARTMENT OF EDUCATION
- Ray C. Mullin, Phil Simmons] Electrical Wiring Re(z-lib.org)
- [Brian Scaddan IEng; MIIE_(elec)] Electrical insta(z-lib.org)

2.2.4 Learning outcome 4: Store electrical tools and materials

2.2.4.1 Introduction to the learning outcome

This learning outcome specifies the content of competencies required in the management of tools. That is storage of tools, cleaning of tools and waste management in workshops.

2.2.4.2 Performance Standard

1. Tools are checked against the issuing list as standard operating procedures
2. Tools are stored as per the standard operating procedure
3. Tools are cleaned as per the workshop standard operating procedure
4. Waste materials are disposed as per the EHS

2.2.4.3 Information Sheet

Essential Electrician Tools

Wire Strippers

Professional electricians regularly strip the plastic coating on wires to expose the copper and make customized connections with other wiring or components. This essential electrical maintenance tool comes in a variety of models and types.

Fish Tape

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Splicing Connector

These plastic clips help electricians make quick connections with multiple pieces of wire. They can be used with multiple cables, including device wires, telephone cables, and electrical cables.

Flashlights

For an electrician, working in the dark is a potential hazard of the job. Keep essential electrician tools, like flashlights and other various work lights, handy and within reach.

Electrical measuring equipment

Electrical instruments are classified according to the electrical quantity or the measured characteristics. It is also classified according to the type of test function, according to the current that can be measured by them.

Ammeter

An ammeter is an instrument which is used to measure the electric current in amperes in a branch of an electric circuit. In order to measure the current it must flow through the ammeter, so the ammeter must be placed in series with the measured branch and it must have very low resistance so that the alteration of the current can be avoided which is measured. Instruments which is used to measure smaller currents are micro-ammeter. The ammeter is connected in series to the device which is to be measured because objects in series have the same current.

Types of ammeter

Moving iron ammeter

In a moving iron, ammeter can measure the AC and DC; it has an iron piece instead of the spring and pointer system of the galvanometer. The iron will act by the magnetic field created in the coil.

Zero centre ammeters

Zero centre ammeters are used where the voltage needs to be monitored in two directions and they are used along with a battery. In this the charging of battery deflects the needle in one direction and discharging of the battery deflects the battery in the other.

Galvanometer

Galvanometer was the first type of ammeter, it is used to detect and measure electric current. It is an analogue electromechanical transducer which makes a rotary deflection in response to the electric current flowing through the coil. A galvanometer can read direct current flow, the

magnetic field created as current flows through a coil acts on a spring, which will move the needle indicator.

Shunt

A shunt can be used in ammeters to measure large currents, shunt acts as a resistor the known quantity of resistance is used to obtain an accurate reading. Digital ammeters use analog to digital converter to measure the current across the shunt.

Clamp meter

Clamp meters are used to measure the current flowing through a conductor; AC clamp meters have a current transformer in it. With the help of the current transformer the reading will be taken. There are two types of clamp meters AC clamp meter which is used to measure the AC and the DC clamp meter which is used to measure the DC.

Voltmeter

The voltmeter can be considered as a kind of galvanometer, which can be used to measure the voltage potential of an electrical circuit or the potential difference between two points. A voltmeter can also be considered as an ammeter they also measure the current, voltage is only measured when the current is transmitted in a circuit through resistance. Voltmeters are capable to measure the current, voltage and resistance. Voltmeters are also termed as high resistance ammeters they can also measure DC and AC. A voltmeter can measure the change in voltage by two points in an electrical circuit and they are connected in parallel with the portion of the circuit on which the measurement is made. Voltmeters must have high resistance so that it won't have any effect on the current or voltage associated with the circuit.

Types of voltmeter

Digital voltmeter

Digital voltmeters can measure the AC and DC voltages and it displays the result in converted digital form with decimal point and polarity. It can provide accurate details about the current draw and current continuity and this will help the users to troubleshoot erratic loads.

What are the advantages of digital voltmeter?

- Outputs are accurate without any error
- Readings are taken quickly
- Versatile and accurate
- Less power consumption
- Portable instrument

Electrostatic voltmeter

These voltmeters are instruments that can accurately measure the voltage without any charge transfer. Whereas conventional voltmeter needs charge transfer to the voltmeter and it will lead to loading and adjustment of the source voltage. The main advantage of an electrostatic voltmeter is that it can do the surface potential measurement on any type of material without any physical contact.

Ohmmeter

An ohmmeter is an instrument that is used to measure the resistance and they can measure the value of resistance accurately. According to their measurement and construction, these instruments are classified into the series type and shunt type ohmmeter. It can be used to check the continuity of the electrical circuits and components. Series type ohmmeters are used to measure the high resistance values while the shunt type is used to measure low resistance values.

Potentiometer

Potentiometer is instruments that can be used to measure the unknown voltage. The known voltage will be supplied from a standard cell or any other known voltage reference source. Potentiometer measurement has high accuracy because the measurement is done by the comparison method and the obtained result is not by the deflection of the pointer. Potentiometer can be used to compare the E.M.F of the two cells, it can be used to determine the E.M.F of a cell, it can be used to determine the internal resistance of a cell and to calibrate the voltmeter and ammeter.

Wattmeter

Watt-meters are used to measure power; these instruments are similar in design and construction of an ammeter. It can be used to measure the average electric power in watts. Wattmeter has two coils

they are current and pressure coil. Wattmeter can be used to measure the gain in amplifiers, bandwidth in filters.

Multi-meter

Multi-meters can be used to make various electrical measurements; they can be used to measure AC and DC voltage, AC and DC current, and resistance. It is known as multi-meter because it can do the functions of various meters such as voltmeter, ammeter, and ohm-meter. Multi-meters can also be used to check the continuity. Multi-meters are of two types they are analog and digital multi-meter analog multi-meter has an analog scale and they are less accurate, while the digital multi-meter and the reading are in digital and they are more accurate.

Issuing and confirmation of tools and instruments before and after practical

You can specify tools on job plans and work orders to indicate which tools are needed to perform a task. In the Stocked Tools application, you can issue tools to those work orders to indicate that the tools are dispatched for use with the right job

Testing of practical tools and Instruments

While planning for a practical, one needs to be sure that the tools are in the right order. Some of the things to consider while testing tools are:

1. making sure that they are working as expected
2. they can give accurate ,measurement
3. Screw drivers are not blunt
4. Stripping tools are.

Why Maintain Inventory of Tools and Equipment

The most significant point to think at the start of your career is to acquire branded tools.

They must be made out of high-quality steel and manufactured for precision. Special consideration is given to balance so that the tool/equipment will be properly maintained and prevent loses.

Since the technician must work with his tools daily, regular inventory of tools/equipment is very significant.

The initial cost of a minimum number of tools is high but there is accompanying warranty guarantees satisfaction and many years of service.

It is better, in the long run, to start with a few cautiously selected tools that will take care of your most common needs and then slowly build-up to a complete set.

It is sometimes hard to identify and memorize the huge number of tools and equipment in the workshop, maintaining the inventory record is of great value.

For better equipment inventory management:

- Know what you have.
- Track how it is used.
- Right asset, right place, right time.
- Don't spend more – spend smarter.
- Fix things before they break.
- Find underlying issues.
- Buy the best.
- Use the right **equipment** inventory system.

Maintaining and Storing Tools & Equipment

An important aspect of any business is the maintenance and storage of tools and equipment.

The investment in tools and equipment is a significant part of the overhead expenses in any operation.

Proper selection and maintenance of equipment are important factors in managing business. Selecting the proper tool for the job and using the tool properly will increase efficiency and reduce maintenance problems.

Purchase tools, which are well-made and suited to the intended use. Commercial usage may entail more heavy duty demands on equipment.

Hand tools:

1. Clean dirt and debris from tools after each use.

2. Oil metal parts to prevent rust.

3. Lightly sand rough wooden handles and apply linseed oil.

4. Repair loose handles.

5. Sharpen blades of cutting tools.

6. Store tools in a clean dry storage area.

7. Protect surfaces of cutting tools in storage.

Power tools:

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

2. Change the oil.

3. Clean the air filter.

4. Lubricate moving parts.

5. Sharpen dull blades or replace worn blades according to the owner's manual.

6. Replace spark plugs.

7. Drain oil and gasoline before long-term storage.

8. Check electric cords and connections on electric-powered tools.

9. Store tools in a clean dry storage area.

Equipment:

1. Store equipment in a clean dry storage area.

2. Rinse and clean spray equipment after each use.

3. Clean spreaders and check wheel-driven gears.

4. Clean carts and wheelbarrows after use.

Figure 31: Sample Proper Arrangement and storage of tools and equipment

A lubricant is a substance introduced to lessen friction between moving surfaces. It may also transport external particles. The property of reducing friction is known as lubricity.

Types and Kinds of Cleaning Solvents

Solvent is a component of a solution that dissolves solute and is usually present in large proportion or amount. It can be classified as polar and nonpolar.

Polar solvents are solvents which dissolve/are soluble in water; while nonpolar solvents are solvents which do not dissolve/are insoluble in water. Solvents are usually used for cleaning in workshops.

They are water, gasoline, kerosene, thinner and detergent soap. The table below shows the kinds of cleaning solvent based on their solubility in water.

Cleaning Solvents	Solubility in Water	Polar	Nonpolar
a. water	soluble	x	
b. gasoline	insoluble		x
c. kerosene	insoluble		x
d. thinner	insoluble		x
e. detergent soap	soluble	x	

Table 2: Shows the kinds of cleaning solvent based on their solubility in water

Uses of Cleaning Solvents

Cleaning Solvents	Uses
Gasoline	Wash greasy tools/ equipment.
Kerosene	Remove dust, grease oil, paint, etc.
Thinner	Remove spilled paint on the floor, walls and tools.
Water	Wash dust in the floor, walls, etc.
Detergent Soap and water	Wash/clean benches, tables, cabinets, etc.

Waste Disposal

Waste is any substance which is discarded after primary use, or is worthless, defective and of no use. A by-product by contrast is a joint product of relatively minor economic value.

Waste management (or **waste disposal**) includes the activities and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process.

Waste disposal methods

Recycling

Recycling refers to both the direct **reuse** of used products (e.g. used clothing and functioning parts removed from used vehicles) and **material recycling**, that is the recovery of raw materials from waste (e.g. production of new glass from fragments, the melting of scrap iron and the production of recycled building materials from construction waste). **Down cycling** refers to the transformation of waste to materials of lower quality than the initially used material.

Incineration

Combustible waste from households and waste wood that is not suitable for recycling undergo thermal treatment in waste incineration plants or waste wood furnaces. The heat released in the process **is used to generate electricity and heat buildings**. Waste with a high calorific value and low level of pollutant contamination can be used in industrial plants, e.g. cement plants, as an alternative to fossil fuels. Waste that is contaminated with organic pollutants undergoes separate thermal treatment (e.g. in hazardous waste incineration plants). Incinerators must have a flue gas treatment system. The requirements for flue gas treatment and the incineration system are based on the nature of the waste.

Chemical-physical and biological treatment

The objective of both chemical-physical and biological treatment is to enable **the removal of pollutants from waste** or its **safe land filling**. Waste water and polluted excavated material are

typical of the types of waste that are managed in this way. Following chemical-physical treatment, the pollutants can be disposed of in concentrated form in facilities suitable for this purpose.

Landfills

Residues from waste incineration or waste that is not suitable for material recycling or thermal treatment are deposited in landfills that are compliant with the legal requirements. If the waste does not fulfil the requirements for land filling, it must be pre-treated

Collection and logistics

The waste management sector involves many different specialised actors. Their tasks include the collection of waste at source (industry, commerce and households) in suitable transport containers, its intermediate storage and handover to waste disposal operations. The treatment of waste is often based on a cascade of specialised plants. In all cases, **smooth logistics** are a precondition for the efficient management of waste. In the case of hazardous waste, in accordance with the Ordinance on Movements of Waste, the handover must be **documented**.

Correct Disposal of Waste Material

The Controlled Waste Regulations 1998 tell us that we have “a Duty of Care” to handle, recover and dispose of waste responsibly

The Environmental Protection (Duty of Care) Regulations 1991 tell us that any business has a duty to ensure that any waste produced is handled safely and in accordance with the law.

Your company is responsible for the waste that it produces even after handling it over to another party such as a Skip Hire company.

If such a third party mishandles your waste or disposes of it irresponsibly then it is the responsibility of the company you work for, not the Skip Hire company.

The duty of care under the new Regulations has no ‘time limit’ and extends until the waste has either been finally and properly disposed of or fully recovered.

If a material has hazardous properties, it may need to be dealt with as ‘Special Waste’. Containers may be classified as ‘Special Waste’ if they contain residues of hazardous or dangerous substances.

If the residue is ‘Special’ then the whole container is Special Waste. Do not burn scrap cable on site, re-cycle it through a scrap metal merchant.

Electro technical companies produce very little waste material and even smaller amounts of ‘Special Waste’. Most electrical contractors deal with waste by buying in the expertise and building in these costs to the total cost of a contract.

However, this method still requires individuals to sort any waste responsibly by placing it in the appropriate skip or container.

To comply with the Waste Regulations:

- Make sure waste is transferred only to ‘authorized’ companies as per the law.
- Make sure that the waste being taken is accompanied by the proper paperwork called ‘waste transfer notes’
- Label waste skips and waste containers so that it is clear to everyone what type of waste is going into which skip or container
- Minimise the waste that you produce and do not leave it behind when a job is completed for someone else to clear away. As the producer of any waste, you are responsible for it. Remember there is no time limit on the Duty of Care for waste materials

Waste management

Waste management is the collection, transport, processing or disposal, managing and monitoring of waste materials.

The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment or aesthetics.

Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources.

The management of wastes treats all materials as a single class, whether solid, liquid, gaseous or radioactive substances, and tried to reduce the harmful environmental impacts of each through different methods.

Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers.

Management for non-hazardous waste residential and institutional waste in metropolitan areas is usually the responsibility of local government authorities, while management for non-hazardous commercial and industrial waste is usually the responsibility of the generator.

2.2.4.4 Learning Activities

Learning Activity 1

Procedure in Arranging and Storing Tools and Equipment

Instruction:

In a specific tool cabinet and a tool rack assigned to you, arrange and store tools and equipment accordingly.

PERFORMANCE CRITERIA	PERFORMANCE LEVEL		
	YES	NO	NA

1. Were the tools/equipment placed in their respective location and accessible for use when needed?				
2. Were the tools arranged according to their types?				
3. Were the tools and equipment ready before performing the task?				
4. Were the equipment placed in their proper location and arranged according to their types?				
Overall Performance *(Competent if all the tasks are completed correctly)*	Competent			
	Not yet competent			

Procedure:

1. Classify the tools and equipment according to their types.

2. Arrange the tools by their types in the shelves/racks.

3. Place equipment in designated places or location.

Assessment: The teacher will assess you based on the performance criteria listed below.

Learning Activity 2: Procedure in Cleaning Tools and Work Area

Instructions: Bring cleaning solvents, rags and brooms, washing pan, electric fan and safety apparel. Clean tools and work area.

Procedure:

A. Tools

1. Wear protective clothing and goggles.

2. Gather the tools to be cleaned in the designated area for cleaning.

3. Classify the tools to be cleaned according to how dirty they are.

4. Measure and pour enough amount of cleaning solvent to the washing pan.

5. Submerge the tools in the washing pan.

6. Use paint brush to remove the dirt from the tools.

7. Get the tools from the washing pan and wipe them with rags until dry.

8. Clean and keep all materials used for cleaning.

B. Work Area

1. Wear protective clothing and goggles.

2. If there is dirt on the floor such as paint, used oil, grease, rust, etc., remove it first using the appropriate cleaning solvent.

3. Use the broom in cleaning the remaining dirt in the work area and an electric fan to facilitate the drying of the floor.

Assessment:

The teacher will assess the students based on the performance criteria listed below.

PERFORMANCE CRITERIA		PERFORMANCE LEVEL		
		YES	NO	NA
1. Were protective clothing and goggles worn at all times?				
2. Were tools and equipment free of dust, grease, oil and other substances?				
3. Was the work area dry, free of dust, grease and other substances?				
4. Were excess cleaning substances cleaned and kept in proper places?				
Overall Performance *(Competent if all the tasks are completed correctly)*	Competent			
	Not yet competent			

2.2.4.5 Self-Assessment

1. Pliers, cutters, a knife and a range of screwdrivers are the tools required in the electro technical industry for:
   A. Erecting conduit
   B. Assembling tray
   C. Stripping and connecting conductors
   D. Terminating an mi cable

2. An example of 'Special Waste' is:

A. sheets of asbestos

B. old fibre-glass roof insulation

C. old fluorescent tubes

D. part coils of PVC insulated cables

3. Special Waste must be disposed of:

A. in the general site skips

B. in the general site skip by someone designated to have a 'duty of care'

C. at the 'Household Waste' re-cycling centre

D. by an 'authorised company' using a system of waste transfer notes'

4. Put a (✓) after each word if the solvent is polar and (X) if it is nonpolar**.**

1. water ( )
2. kerosene ( )
3. detergent soap ( )
4. gasoline ( )
5. thinner ( )

5. The table below show cleaning solvents for tools and equipment. Complete the table .

Cleaning solvents	Uses
Gasoline	
Kerosene	
Thinner	
Water	
Detergent Soap and Water	

2.2.4.6 Tools, Equipment, Supplies and Materials

Tools

- Set of screw drivers
- Pliers
- Phase testers
- Multimeter

Equipment

- PPE –hand gloves, dust coat, dust masks
- Multimeter
- Clamp meter
- Earth electrode resistance meter

Phase sequence meter

Materials and supplies

- Stationery
- Cables
- Lubricants
- Service parts

2.2.4.7 References

- IEE regulations
- Organizational procedures manual

- Electrical Installation Maintenance K to 12 – Technology and Livelihood Education Learning Module
  Republic of the Philippines DEPARTMENT OF EDUCATION
- Ray_C._Mullin,_Phil_Simmons]_Electrical_Wiring_Re(z-lib.org
- [Brian_Scaddan_IEng;_MIIE_(elec)]_Electrical_insta(z-lib.org)

2.2.5 Learning Outcome 5: troubleshoot and repair/replace workshop tools and equipment

2.2.5.1 Introduction to the learning outcome

This learning outcome specifies the content of competencies required to identify, diagnose, repair/ replace faulty tools and finally and testing the functionality of the tools after repair.
The level of troubleshooting most often performed on tools and equipment hardware is exchanging *Field Replaceable Units* (*FRU*s). The cost of using a technician to diagnose the problem further, and repair it, can quickly exceed the cost of the new replacement unit.

2.2.5.2 Performance Standard

1. Faulty tools are identified as per their expected functionality
2. Faulty equipment are diagnosed in line with the fault diagnosis procedures
3. Repair/Replace faulty components as per standard operating procedure
4. Repaired/Replaced tool and equipment are tested as per the expected functionality

2.2.5.3 Information Sheet

Meaning of troubleshooting

Troubleshooting is the first step in the heavy **equipment repair** process in making a repair action and returning the **equipment** into service.

Electrical Troubleshooting can be hazardous. Ensure you take the proper precautions. Electricity has long been recognized as a serious workplace hazard, exposing employees to electric shock, electrocution, burns, fires and explosions.

Meaning of troubleshooting

Troubleshooting is a form of problem solving, often applied to repair failed products or processes on a machine or a system. It is a logical, systematic search for the source of a problem in order to solve it, and make the product or process operational again. Troubleshooting is needed to identify the symptoms. Determining the most likely cause is a process of elimination eliminating potential causes of a problem. Finally, troubleshooting requires confirmation that the solution restores the product or process to its working state.

In general, troubleshooting is the identification or diagnosis of "trouble" in the management flow of a system caused by a failure of some kind. The problem is initially described as symptoms of malfunction, and troubleshooting is the process of determining and remedying the causes of these symptoms.

Common faults in Electrical equipment

Fault-finding for electronic/electrical equipment is a skill that is neither an art nor a science, but an engineering discipline in its own right. Effective fault-finding requires:

- A good general knowledge of electricity and electronics.
- Specialized knowledge of the faulty equipment.
- Suitable test equipment.
- Experience in using such test equipment.
- The ability to formulate a procedure for isolating a fault.
- The availability of service sheets and other guides.

Common Problems

An electrical fault is the deviation of voltages and currents from nominal values or states. Under normal operating conditions, power system equipment or lines carry normal voltages and currents which results in safer operation of the system.

But when a fault occurs, it causes excessively high currents to flow which causes damage to equipment and devices. Fault detection and analysis are necessary to select or design suitable switchgear equipment, electromechanical relays, circuit breakers, and other protection devices.

Symmetrical faults

These are very severe faults and occur infrequently in the power systems. These are also called balanced faults and are of two types namely line to line to ground (L-L-L-G) and line to line (L-L-L).

2. Unsymmetrical faults

These are very common and less severe than symmetrical faults. There are mainly three types namely line to ground (L-G), line to line (L-L), and double line to ground (LL-G) faults.

Fault diagnosis procedure

Here are six key points to consider

Collect the Evidence

All the evidence collected must be relevant to the problem in hand. If one is in doubt as to whether anything is relevant, then include it. Reject it afterwards at the first opportunity if it clearly is not relevant. The quantity of information collected is unimportant, what matters are that all information collected is relevant. Observe the system running, if you consider it safe to do so. Use all your senses: smell (burning), hearing (vibration), touch (temperature), sight (for unusual conditions). Refer to any relevant documentation.

Analyse the Evidence

Consider all the evidence collected and, if possible, reject any which after further careful consideration is not relevant. Study the hard core of relevant evidence and – through the process of careful, logical thinking –diagnose the likely fault or at least the area or region of the fault.

Locate the Fault

In a sense this is a continuation of the process of ‘analyses. The areas or regions are systematically reduced in size until a specific part can be identified as being faulty. For example, if a door bell

does not ring when it should; it is only by means of a systematic approach that one determines that the bell itself is faulty.

Determination and Removal of the Cause

If the cause of a fault is not removed, the fault will recur even though the fault has been rectified. For instance, a flat bicycle tyre might be the result of a puncture (the fault) in the inner tube. If the puncture is repaired (i.e. the fault is removed) this will not be of much use if the cause of the puncture in the first place is not determined and appropriate action taken. The cause of the puncture may be a nail which has penetrated the outer cover. This must be removed

Rectification of the Fault

This may be a simple task, as in the case referred to above, or it may be a much bigger one. Whatever is the case, it is a specific task based on earlier findings.

Check the System

It is important to ensure that the machine, equipment or system is functioning normally after the cause of the fault and the fault itself has been dealt with. In the case of the puncture, it is easy to confirm that the cause of the fault – and the fault itself – has indeed been dealt with satisfactorily, assuming that the tyre remains inflated. With more sophisticated equipment or systems it may necessary to 'fine-tune' the system in order to return it to optimum working conditions.

Repair/Replace of components in Electrical equipment

Any electronic instrument or piece of equipment can be considered as a system. A system can be defined as "anything formed of component parts connected together to make a regular and complete whole".

An instrument or piece of equipment can have subsystems made in blocks to perform specific functions. These subsystems are made up of electronic circuits, which are forms of electronic/electrical or electromechanical component parts. The failure of a component in equipment may lead to the failure of the system. Failure is said to be the inability of a system to

perform its required function. The need for continuous performance of equipment requires that it is given regular maintenance. It is, therefore imperative that the meaning of maintenance is well understood.

Maintenance

This is all the activities carried out on an equipment in terms of proper installation, good servicing, routine checks, repairs and replacement of faulty parts in order for such equipment to operate at it maximum output throughout its useful life. An equipment or instrument is considered to have failed when under any of these conditions:

a) when it becomes completely inoperative

b) when it is still in operation but unable to perform the required function any longer

c) When it becomes unsafe for its continued use.

Maintenance of tools and equipment in electrical workshop

Preventive Maintenance

This is the practice or arrangement whereby a piece of equipment or instrument are regularly checked, oiled, greased or cleaned according to manufacturer's specification for effective performance. This maintenance method is normally carried out at a specified time of a year and in that case the entire working system is shut down. Fund is normally provided to ensure that spare parts and some other materials meant for such maintenance are provided. The essence of this form of maintenance is to ensure that the equipment does not break down and thus performs to specification.

Corrective Maintenance

This method is applied to equipment that has failed and thus broken down due to either improper operations or a defective part. It is concerned with the detection, location and repairs of faults as they occur. This requires a good understanding of system fault location methods in addition to an understanding of overall system and circuit operation.

Types of Maintenance

There are five different types of maintenance and these are as follows:

3. Fixed Time Maintenance

This is servicing of equipment periodically at regular intervals. The particular maintenance requirements will probably vary with the level of service. For example the requirements for 12 monthly services will be different for those for 3 monthly.

2. **Condition Based Maintenance**

This type of maintenance requires the use of human senses to know when it is needed. In the cause of operating an equipment one may see signs of smoking, electrical sparks, feel for excessive heated, smells for signs of burning and some others. The condition at which the equipment is will necessitate that it should be opened up immediately for maintenance. This act will assist in preventing further damage. Some more complex systems have sensing devices built in to them, and alarm systems to detect variation from the norm.

3. **Opportunity Based Maintenance**

This is carried out when an equipment is opened up for repairs and this opportunity is used to do any other maintenance tasks which are due in the near future, such as routine servicing and the replacement of any parts which are at the end of their useful life. Also, the opportunity can be used

to replace a broken part which had occurred before opening the equipment but had no effect in its operation.

4. **Design Out Maintenance**

This maintenance type is used on equipment which has a part that is failing regularly due to an apparent design weakness. It may be possible to upgrade the weak part and effectively change the design for the better. If a particular part is not available one may be able to change the design to allow a more common part to be used. In spectrophotometry, for example, it may be possible to modify a simple car headlamp bulb to enable it to function as a tungsten source.

5**. Operate To Failure Maintenance**

These are cases whereby equipment is not given general routine care but it is allowed to fail before any other maintenance is attempted. This is widely used on electronic equipment which normally is not just taken to a mechanic for servicing while still functional. They are only opened up when they have broken down. This means that equipment is operated to failure before it is opened up for maintenance.

Troubleshooting Hazards

Troubleshooting can introduce many new safety concerns especially when inspecting equipment that is energized. Testing often requires the troubleshooter to temporarily connect test instruments to “live” terminals, which may involve opening enclosures or cabinets that normally are locked or bolted closed to protect workers.

This introduces two main hazards:

1. Shock Hazard. If you were to contact live equipment with your body or a tool you are holding the current flowing through your body could cause severe injury, burns, and even death.

2. Flash Hazard. If you are in the vicinity of equipment that fails and causes an electric arc, the flash, heat and shrapnel caused by the arc can also be life threatening.

Fault Condition Reporting

While repairs are under way it is sometimes necessary to hand over the work or the equipment to someone else. If this is to work efficiently you must be able to pass on all relevant information. This is also important to ensure the safety of all personnel while the system is not in its usual operating condition.

The steps involved are:

1. Document all changes to normal operational line-up either in the log or, if the system is in use, on forms supplied for this purpose. You should also make notes in your personal journal.

2. Set out work schedules in accordance with safe practices and nominated company procedures.

This may require you to document all notifications given to relevant persons together with Authority to Carry Out Running Repairs, Work Permits, Clearance Certificates, Tags(Danger and Out of Service, etc.) Locks and Sentinels in operation or other applicable special precautions.

3. Highlight any special precautions or fallback procedures relating to operation of running equipment.

4. Prepare a concise report on the current status of the repair being undertaken including personnel involved, equipment or tooling obtained, equipment or tooling ordered or required, parts availability, strip-down status of the machine and estimated completion time.

5. Pass on findings in regard to component condition or potential weaknesses found during dismantling and other information necessary for the person taking over to make informed decisions.

6. Where practical, carry out a tour of inspection with the new person of the affected plant, pointing out areas of concern and activities under way.

7. Ensure they have understood you and have a clear picture of the situation and its implications.

Calibration and service of equipment

Calibration, in its most basic form, is the measuring of an instrument against a standard. As instruments become more complicated, successfully identifying and applying best practices can reduce business expenses and improve organizational capabilities.

What is Calibration?

Calibration is the comparison of a measurement device (an unknown) against an equal or better standard. A standard in a measurement is considered the reference; it is the one in the comparison taken to be the more correct of the two.

Calibration finds out how far the unknown is from the standard. A "typical" commercial calibration uses the manufacturer's calibration procedure and is performed with a reference standard at least four times more accurate than the instrument under test.

Purpose of a calibration

There are three main reasons for having instruments calibrated:

1. To ensure readings from an instrument are consistent with other measurements.

2. To determine the accuracy of the instrument readings.

3. To establish the reliability of the instrument i.e. that it can be trusted.

Calibration, zeroing and care of instruments

Precise calibration of instruments is usually well outside the province of the electrician, and would normally be carried out by the manufacturer or a local service representative.

A check, however, can be made by the user to determine whether calibration is necessary by comparing readings with an instrument known to be accurate, or by measurement of known values of voltage, resistance, etc.

It may be the case that readings are incorrect simply because the instrument is not zeroed before use, or because the internal battery needs replacing.

Most modern instruments have battery condition indication, and of course this should never be ignored. Always adjust any selection switches to the off position after testing.

Too many instrument fuses are blown when, for example, a multimeter is inadvertently left on the ohms range and then used to check for mains voltage. The following set procedure may seem rather basic but should ensure trouble-free testing:

1. Check test leads for obvious defects.
2. Zero the instrument.
3. Select the correct range for the values anticipated. If in doubt, choose the highest range and gradually drop down.
4. Make a record of the test results, if necessary.
5. When a zero reading is expected and occurs (or, in the case of insulation resistance, an infinite reading), make a quick check on the test leads just to ensure that they are not open-circuited.
6. Return switches/selectors to the off position.
7. Replace instrument and leads in carrying case.

Safe use of electrical equipment

When one is using electrical equipment such as drills, saws, sanders, etc. on site or in a workshop, great care must be taken to ensure that the tools are in good condition and that the cables supplying them are not damaged in any way and are adequate for the job they have to do.

Any connections of cables must be carried out by a competent person using approved tools and equipment. For work on building sites, tools using a voltage lower than usual (110 V instead of 230 V) are recommended.

All current-using and current-carrying apparatus used on sites must be inspected and checked at regular intervals. A 3-month period is recommended, but the user should always check before use that all electrical apparatus is in good condition.

Ensure that all cables exposed to mechanical damage are well protected.

https://www.mgnewell.com/wp-content/uploads/2016/05/Purpose-of-Calibration.pdf

Classification of non-functional and functional tools

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

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

B. Classify your tools according to is function.

Method of identifying non-functional/faulty tools and equipment

7. Visual inspection. It refers to the visual observation of an expert on the appearance of the tools and equipment.
8. Functionality. Vibration or extra noise from the operation means problems on parts and accessories started to develop.
9. Performance. When there is something wrong with the performance of either hand tools or equipment they need an immediate repair or maintenance.
10. Power supply (for electrically operated only). Failure to meet the required power supply, malfunction will occurs in the part of hand tools or equipment.

11. Person's involved. It refers to the technical person who has the knowledge and skills about the technology.

2.2.5.4 Learning activities

Learning Activity1

Let us determine how much you already know about checking conditions of tools and equipment. Take this test.

Instruction: Read each statement and identify what is being described. Choose your answer inside the circle and write them in the space provided before each number.

Hand tools

Pneumatic floor jack screwdrivers

Wrenches

Personal Protective Equipment(PPE)

Pullers

Vacuum cleaner

Air drill

Pneumatic torque wrench

Machine /power tools

_____1. Uses compressed air to flow into the jack cylinder and causes the ram to extend and raise the vehicle.

_____2. These are tools manipulated by our hands without using electrical energy.

_____3. Are used to drive, or turn screws. The common type has a single flat blade for driving screws with slotted heads. The other type has the cross slotted head.

_____4. A tool used to turn screws, nuts and bolts with hexagonal heads. ―Hexagonal‖ means six-sided. A variety of wrenches are used in the shop.

_____5. A tool used to remove gears and hubs from shafts, bushings from blind holes, and cylinders' liners from the engine blocks.

_____6. This is used for cleaning the floor and car interiors after service.

_____7. This is lighter than a comparable electric drill. Repeatedly stalling or overloading does not damage or overheat the air drill.

_____8. A gadget that protects workers from injury or illness caused by having contact with the dangers/hazards in the workplace, Used by linemen to remove insulation of wire and cables in low and high voltage transmission lines.

_____9. This wrench uses compressed air to quickly and powerfully turn nuts, bolts, and other objects.

_____10. These are tools manipulated by our hands and with the use of electrical energy

Learning Activity 2

Let us determine how much you already know about selecting measuring tools and instruments. Take this test.

Instruction: Match the electrical measuring tools and instruments in Column A to their descriptions in Column B. Write the letter of your answer in the space provided before each number.

Column A	Column B
_____1. 	A. Voltmeter
_____2. 	B. Volt-ohmmeter
_____3. 	C. Micrometer
_____4. 	D. Clamp Ammeter
_____5. 	E. Wire gauge

2.2.5.5 Self-Assessment

1. What is troubleshooting?

2. Explain the following two hazards that can arise in faulty equipment
   i. **Shock Hazard**.
   ii. **Flash Hazard**.
3. List the three main reasons for having instruments calibrated:

4. Explain the following Methods of identifying non-functional/faulty tools and equipment

2.2.5.6 Tools, Equipment, Supplies and Materials

Tools

Phase tester

Screw drivers

Equipment

- PPE
- Oscilloscope
- Multimeter

Supplies and Materials

Insulation tape

2.2.5.7 References

1. IEE regulations
2. Organizational procedures manual
3. Electrical Installation Maintenance K to 12 – Technology and Livelihood Education Learning Module Republic of the Philippines DEPARTMENT OF EDUCATION
4. Ray C. Mullin, Phil_Simmons Electrical Wiring Re(z-lib.org)
5. Brian Scaddan IEng; MII (elec) Electrical insta(z-lib.org)
6. https://www.mgnewell.com/wp-content/uploads/2016/05/Purpose-of-Calibration.pdf

2.2.5.6 Responses on Self-Assessment

2.2.5.6.1 Responses on Self-Assessment: Learning outcome 1

1. A
2. D
3. C
4. **Remove heat from the burn to relieve the pain by placing the injured part under clean cold water. Do not remove burnt clothing sticking to the skin.**

   Do not apply lotions or ointments.

   Do not break blisters or attempt to remove loose skin. Cover the injured area with a clean dry dressing.
5.

Class of fire		Type of fire extinguisher			
		Water	Foam	Co_2	Dry powder
A	Ordinary fires: wood , paper ,cloth	**Yes**	**Yes**	**No**	**No**
B	Flammable liquids: petrol ,paraffin	**No**	**Yes**	**Yes**	**Yes**
C	Electrical equipment	**No**	**No**	**Yes**	**Yes**

6. One should not leave the machine ON even after the power is OFF and until it has stopped running completely. Someone else may not notice that the machine is still in motion and be injured.

- Operator should not talk to other industrial persons when he is operating a machine.
- One should not oil, clean, adjust or repair any machine while it is running. Stop the machine and lock the power switch in the OFF position.
- One should not operate any machine unless authorized to do so by the authorize person in the shop.

- Always check that work and cutting tools on any machine are clamped securely before starting.
- The floor should be kept clean and clear of metal chips or curls and waste pieces. Put them in the container provided for such things. Scraps and chips or curls may cut through a shoe and injure the foot.
- Defective guards must be replaced or repaired immediately.
- One should not operate any machinery when the supervisor or instructor is not in the shop.
- All set screws should be of flush or recessed type. Projecting set screws are very dangerous because they catch on sleeves or clothing.
- One should not try to stop the machine with hands or body.
- Only trained operator should operate machine or switches as far as possible.
- Always take help for handling long or heavy pieces of material.
- Always follow safe lifting practices
- No one should run in the shop at work time.
- Always keep your body and clothes away from moving machine parts. Get first aid immediately for any injury.
- Never talk to anyone while operating the machine, nor allow anyone to come near you or the machine.
- Stop the machine before making measurements or adjustments.
- Operator should concentrate on the work and must not talk unnecessarily while operating the machines.
- Never wear necktie, loose sweater, wristwatch, bangles, rings, and loose fitting clothing while working in workshop.
- Always wear overcoat or apron.
- Stop machines before attempting to clean it.
- Make sure that all guards are in their place before starting to operate a machine.
- Do not attempt to operate a machine until you have received operating instructions.
- Be thoroughly familiar with the 'stop' button and any emergency stop buttons provided on the machines.

- Remove burrs, chips and other unwanted materials as soon as possible. They can cause serious cuts.
- Do not leave loose rags on machines.
- Wash your hands thoroughly after working to remove oils, abrasive particles, cutting fluid, etc.
- Report all injuries to the foreman, howsoever small. Cuts and burns should be treated immediately.
- Keep the work area clean.
- Keep your mind on the job, be alert, and be ready for any emergency.
- Always work in proper lighting.
- On should not lean against the machines.

7. Personal protective equipment:

· Safety goggles

· Safety shoes

· Safety helmet

· Safety gloves

· Safety shoes

· Safety belt

Learning Activity 1

Hand tools	Powers	Pneumatic tools
Screw drivers	Grinding wheels	Air racket

Wrenches	Vacuum cleaner	Air drill
Pullers	Electric drill	Air chisel
Hammers		

2.2.5.6.2 Responses on Self-Assessment: Learning outcome 2

1. C

2. A

3. Always use the correct tool for the job in hand and use it properly and sensibly
   - Always keep tools clean and sharp
   - Always keep tools in a toolbox and secure safety rules for power tools
   - Always check that the casing is not damaged
   - Always check that the cable is not damaged
   - Always check that the plug top is not damaged
   - Always check that no coloured conductors are showing anywhere on the flexible cord

4. **Keep Power tools Clean.**

   Dust and grime can bring your power tools to a grinding halt if left unchecked over time.

   Store Power tools correctly.

   Inspect for Wear or Damage.

   Lubricate Moving Parts.

   Keep Batteries in Shape.

4. **Better electrical hand tools, such as wire cutters and linesman pliers, have insulated handles to help guard against shock**

2.2.5.6.3 Responses on Self-Assessment: Learning Outcome 3

1. B
2. A
3. D
4. C
5. A

2.2.5.6.4 Responses on Self-assessment: learning outcome 4

1. C
2. A
3. D
4. Put a (✓) after each word if the solvent is polar and (X) if it is nonpolar.

    1. water (✓)
    2. kerosene (X)
    3. detergent soap (✓)
    4. gasoline (X)
    5. thinner (X)

5. The table below show cleaning solvents for tools and equipment. Complete the table .

Cleaning solvents	Uses
Gasoline	**Wash greasy tools/equipment**
Kerosene	**Remove dust, grease oil paint, etc**
Thinner	**Remove spilled paint on floor, walls and tools**
Water	**Wash dust in the floor, walls, etc**
Detergent Soap and Water	**Wash/ clean benches, tables, cabinets,etc**

Learning activity 1: learning outcome 5

1. Pneumatic floor jack
2. Hand tools
3. Screw drivers
4. Wrench
5. Puller

6. Vacuum cleaner
7. Air drill
8. Personal Protective Equipment (PPE)
9. Pneumatic Torque Wrench
10. Machine/Power tools

Learning activity 2: Learning outcome 5

Answer

1. C
2. E
3. A
4. B
5. D

2.2.5.6.5 Responses on Self-assessment: Learning outcome 5

1. **Troubleshooting is the first step in the heavy equipment repair process in making a repair action and returning the equipment into service.**

2.

i. **Shock Hazard**. If you were to contact live equipment with your body or a tool you are holding the current flowing through your body could cause severe injury, burns, and even death.

ii. **Flash Hazard**. If you are in the vicinity of equipment that fails and causes an electric arc, the flash, heat and shrapnel caused by the arc can also be life threatening.

3.

i. To ensure readings from an instrument are consistent with other measurements.

ii. **To determine the accuracy of the instrument readings.**

iii. **To establish the reliability of the instrument i.e. that it can be trusted.**

4.

i. **Visual inspection.** It refers to the visual observation of an expert on the appearance of the tools and equipment.

ii. **Functionality.** Vibration or extra noise from the operation means problems on parts and accessories started to develop.

iii. **Performance.** When there is something wrong with the performance of either hand tools or equipment they need an immediate repair or maintenance.

iv. **Power supply** (for electrically operated only). Failure to meet the required power supply, malfunction will occurs in the part of hand tools or equipment.

v. **Person's involved**. It refers to the technical person who has the knowledge and skills about the technology.