CHAPTER THREE: FIXING AND MAINTENANCE OF LIGHT FITTINGS, POWER OUTLETS AND BASIC APPLIANCES

Unit Code: ENG/LG/EI/CR/03/3/A

Related Unit of Competency in Occupational Standard: Perform fixing and maintenance of light fittings, power outlets, and basic appliances

Introduction to the unit of learning

This unit of learning provides insight into the maintenance requirements for over current protective devices and the potential impact on the arc flash incident energy when maintenance is not performed properly.

Electrical preventive maintenance and testing is one of the most important functions to be performed in order to maintain the reliability and integrity of electrical distribution systems, as well as for the protection of equipment and personnel. However, preventive maintenance of electrical systems and equipment, specifically with regard to over current protective devices is often overlooked, or is performed infrequently or inadequately. An unintentional time delay in the operation of a circuit breaker, due to a sticky operating mechanism, can cause the incident energy of an arc flash to rise, sometimes dramatically.

The National Electrical Code (NEC) states that over current protection for conductors and equipment are provided to open the circuit if the current reaches a value that will cause an excessive or dangerous temperature in conductors or conductor insulation. With regard to circuit breakers the only way to accomplish this is through proper maintenance and testing of these devices, per the manufacturer's instructions.

Summary of Learning Outcomes

1. Apply workplace safety
2. Select wiring devices
3. Install wiring devices, lighting fixtures and basic appliances
4. Perform basic repair and maintenance of installation and appliances.

3.0.Apply workplace safety

Introduction

Workplace safety is one of the most important considerations you should take before any installation project gets underway. Health and safety in installation are particularly important because the sites are prone to hazardous situations and can be dangerous at times.

Performance Standard

1. Meaning, importance and types of PPE
2. Safe and correct handling, use, maintenance and storage of different types of PPE
3. Occupational risks e.g., falling from heights, bites from insects, cuts

Information Sheet

Meaning of term PPE

Personal protective equipment (PPE) is protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection. The hazards addressed by protective equipment include physical, electrical, heat, chemicals, bio hazards, and airborne particulate matter.

Purpose of PPE

In the hierarchy of risk control, PPE is considered to rank lowest and represent the option of last resort. It is only appropriate where the hazard in question cannot be totally removed or controlled in such a way that harm is unlikely (for example by isolating the hazard or reducing the risk at source to an acceptable level).

Types of PPE

Various types of PPE are available for use in the workplace. The healthy and safety executive provides guidance and general information about types of PPE used in industry, but it doesn't cover specialized and less-used items.

Detailed information should be obtained from suppliers on these more specialized items. Potential users should be involved in the selection of equipment they will be expected to wear and if possible, more than one model should be made available to them.

The different types of PPE include:

i. Head and scalp protection;
ii. Respiratory protection;

iii. Eye protection;
iv. Hearing protection;
v. Hand and arm protection;
vi. Foot and leg protection
vii. Body protection;
viii. Height and access protection.

Head and scalp protection

There are five primary purposes of head protection, to protect:

i. The head in falls;
ii. Against falling objects, impact with fixed objects, or wielded weapons;
iii. The head by offering thermal insulation;
iv. Against entanglement and laceration to the head;
v. Against scalping/entanglement particularly on machinery where injuries are still numerous. Hair-nets and caps are also used for hygiene reasons.

All forms of head and scalp protection must be suitable, correctly fitted and have an easily adjustable headband, nape and chin strap where appropriate. The relevant standards are BS EN 397 and BS EN 14052.

Eye protection

PPE for the eyes is intended to provide protection against impact, cuts, splashes, mists and sprays. The relevant standards are BS 7028 (Guide to Selection of Eye Protection for Industrial and Other Uses) and BS EN 166 (Specification for Eye Protectors).

All PPE must be regularly cleaned, but this is especially important in the case of eye protection as dirty lenses lead to poor vision and may contribute to accidents.

Where lenses become scratched, pitted or cracked they should be replaced.

Users who need to wear corrective lenses (glasses) should have this requirement accommodated in the provision of the PPE to them e.g. as protective over glasses where appropriate, or in the form of prescription lenses if necessary. Where they may be required to wear eye protection on a regular and prolonged basis than any goggles, safety-glasses etc. should meet the user's prescription requirements.

Hearing protection

Assessments carried out under the 'Control of Noise at Work Regulations 2005' will determine whether personal ear protectors are required in the workplace or not, and the noise attenuation required. The relevant standard for the ear protectors is BS EN 352 Part 1.

In providing hearing protection, employers should select protectors which are suitable for the working environment and should consider how comfortable and hygienic they are. Like other PPE, hearing protection will need to be compatible with other PPE (eg hard hats, dust masks and eye protection) worn by workers.

Employers may also wish to provide a range of protectors to allow employees to choose ones which suit them.

Bearing mind that the theoretical attenuation is rarely achieved and it is therefore necessary to over-specify the protection. When selecting hearing protection, use the detailed noise assessment to determine the attenuation required at High, Medium and Low frequencies and match this against suitable products. Bear in mind that where ear plugs are used, training will be needed to ensure that they are used correctly. Where ear defenders are used it should be ensured that users do not use music headphones or buds simultaneously. For high noise environments, it may be appropriate to specify both plugs and defenders.

Hand and arm protection

Most work requires a degree of manual dexterity and consequently the hands are exposed to a wide range of hazards Risks include cuts, abrasions, heat, cold, chemical contamination, vibration, burns, infection, skin irritation and dermatitis.

Before selecting hand and arm protection, the hierarchy of control measures must be followed. Gloves and gauntlets provide the main form of hand protection against a range of industrial hazards, but other forms of PPE such as mitts, wrist cuffs or armlets may also be used.

In the case of manual handling where there may be a risk of piercing by abrasive, sharp or pointed objects, gloves should be provided where these hazards cannot otherwise be removed, isolated or reduced to an acceptable level. Such gloves are usually made from leather, chain mail, rubber, knitted Kevlar or stout canvas. However, gloves should not normally be worn where there is a risk of them being caught in machinery.

Where chemical exposure is a hazard, and the risk extends to contact with the arms, gauntlets should be specified rather than gloves.

BS EN 14328 is the standard for gloves and arm guards protecting against cuts by powered knives while BS EN 407 contains the specifications for gloves intended to protect against

thermal risk such as heat and/or fire. BS EN 374 Part 1 covers gloves for protection against chemicals and microorganisms. BS EN 511 covers gloves for protection against the cold. BS EN 388 covers the specification of gloves against mechanical hazards.

Foot and leg protection

A wide range of safety footwear is available providing protection against many hazards to the feet or legs including crushing, slipping, piercing, temperatures, electricity, chemicals, cutting, and chopping. The relevant standard for safety footwear is BS EN ISO 20345. BS EN ISO 17249:2004 is the standard for chainsaw footwear. Depending on the hazard various PPE options may be appropriate including safety boots and shoes with protective toe caps and penetration-resistant mid-sole; gaiters; leggings; and spats.

Body protection

The Regulations' definition of PPE excludes ordinary working clothes and uniforms which have no specific protection for the wearer. However, body protection may be required for extended periods of work outdoors to protect against the weather, and to ensure high visibility during work where there is mixed vehicle and pedestrian traffic (see BS EN 471 + A1 'High-visibility Warning Clothing for Professional Use').

PPE for the body may also be required where workers are exposed to extremes of temperature (whether outdoors or indoors), as well as chemical or metal splash, spray from pressure leaks or spray guns, impact or penetration, contaminated dust, excessive wear, entanglement of own clothing or the risk of drowning.

When choosing body protection, the following factors should be considered:

i. Thermal comfort, for example, due to sweating;
ii. Cost and practicality of cleaning;
iii. Emergency procedures, such as buoyancy or the need to be identified or spotted in hazardous situations;
iv. Level of hygiene control required;
v. Level of personal contamination;
vi. Personal preference;
vii. Restriction of movement;
viii. Storage;
ix. Temperature and humidity fluctuation;
x. Whether the worker is involved in a process that is wet or dry.

Respiratory protection

This covers equipment ranging from breathing apparatus and positive pressure powered respirators through to protective hoods, close-fitting full-face respirators, half mask respirators and disposable face masks. It is always essential to select the correct equipment both for the risk and the individual and to ensure there is adequate training in its use. It should be noted that the only form of respiratory protection which is suitable for work in a confined space is breathing apparatus, as other forms of respiratory protection do not provide a source of air or oxygen. Face fit testing requirements apply to all close-fitting respirators.

Height and access protection

This range of protective equipment is very wide and includes body harnesses, fall-arrest systems, rescue lifting and lowering harnesses, energy Absorbers and lanyards.

Such PPE is specialized and requires thorough training by competent persons, in user checks as well as correct use.

Equipment will require periodic inspection by a competent person and anchorage points will normally require periodic testing.

Skin care: 'Barrier' creams

Some occupations are prone to skin disease caused by contact with substances such as cutting oils; chemicals, depressants, glass-fiber and some horticultural agents (e.g. slug pellets). The main condition is dermatitis, in a variety of forms.

The use of barrier creams, although traditional in many occupations, should not be considered as personal protective equipment. It provides negligible protection and is unlikely to be effective in preventing contact dermatitis. The benefit of barrier creams is in preventing dirt from becoming so ingrained that it is difficult to remove.

A properly implemented skin-care hygiene programme, including barrier creams, emollient and skin-conditioning creams can help protect and replace the natural skin oil which is otherwise removed by degreasants and solvents. Before undertaking this, advice should be sought from independent skin-care specialists or a dermatologist.

Safe and Correct Handling, Use, Maintenance and Storage of Different Types of PPE

Safe and correct handling and use of PPE

PPE should fit properly, snug but not tight or loose, and it should not impede movement or communication. Select the right PPE for the task. Do not wear PPE that could potentially cause injury, such as loose-fitting gloves that could be caught in moving parts of equipment or

machinery. For loose fitting gloves, tape or fold a cuff on the gloves to prevent chemicals from running down the users' arm.

Do not wear PPE outside of laboratory or shop areas to prevent spreading contamination to other areas

Employees must be trained in how to don and doff PPE and the limitations of the PPE for the specific procedure. Workers need to handle PPE safely when removing it from the body to avoid contaminating themselves and surfaces nearby. Disposable gloves, sleeves, shoe covers and Tyvek clothing and potentially contaminated PPE such as aprons, lab coats and other items need to be removed so that any contamination is not exposed. Disposable items should be peeled off turning them inside out as they are removed. Reusable gloves, aprons and other potentially contaminated items should be rinsed off before removing them, and then peeled off or folded so that the contaminated surface is inside.

Inspection, maintenance and storage

The PPE must be inspected for defects every time it is put on. Look for symmetry; does each side look like a mirror image of the other or is one side distorted? Are there any broken, bent, frayed or torn pieces? Are the lenses scratched so they are hard to see through? Is the elastic still springy or is it stretched out? In addition to visual inspection as above, insulating gloves, sleeves and blankets for electrical workers must be electrically tested.

All must be tested prior to initial use, and then every 6 months thereafter for gloves, and every 12 months for sleeves and blankets. PPE should be clean. If dirty, clean it with soap and warm water. Do not use solvents or abrasives to clean it. Store it out of sunlight in an area where it will be protected and kept clean. Replace reusable PPE every 2-5 years, earlier if recommended by the manufacturer or if there is a major impact. Replace any defective parts with parts made by the same manufacturer for that equipment. Do not make makeshift repairs. If it cannot be repaired properly, replace it. Do not use paint or glue on PPE. Use decals or stickers to mark it.

Safety and environmental regulations

For environmental health exposures, the use of standard precautions refers to general contact control practices that prevent contamination of the skin, eyes, mucous membranes, and clothing. These precautions should be observed when contact with potentially hazardous materials, body fluids, fecal material, and other environmental contaminants is a possibility. The following standard precautions should be used during environmental investigations:

Avoid Contact

When possible, the EH practitioner should try to avoid contact with a potential contaminant. This may require observance from a distance, or referral of the situation to a trained response professional.

Wash Hands

i. Wash hands with soap and water and dry with disposable towels after any potential contamination may have occurred.
ii. Hand washing must also be done before putting on (donning) PPE and immediately after removing (doffing) PPE.
iii. Hand washing should be followed with the application of hand sanitizer, if possible.

Occupational risks e.g., falling from heights, bites from insects, cuts

Occupational risk deals with the probability of injury or illness occurring as a result of hazards within the workplace.

Falling from heights
The **hazards** and factors affecting the **risk** from working at **height** include vertical distance of a fall, fragile roofs, roof lights, voids, sloping roofs, deteriorating materials, unprotected edges, unstable or poorly maintained access equipment and adverse weather conditions.

Bites from insects
Insect bites are puncture wounds or lacerations made by **insects**. An **insect** may **bite** in self-defense or when looking to feed. **Insects** typically inject formic acid. This can lead to blisters, inflammation, redness, swelling, pain, itching, and irritation.

Cut injuries
A **cut** is a break or opening in the skin. It is also called a laceration. A **cut** may be deep, smooth, or jagged. It may be near the surface of the skin, or deeper. A deep **cut** can affect tendons, muscles, ligaments, nerves, blood vessels, or bone.

Types of hazards
A **hazard** is any source of potential damage, harm or adverse health effects on something or someone. Basically, a **hazard** is the potential for harm or an adverse effect (for example, to people as health effects, to organizations as property or equipment losses, or to the environment)

Electric shock

An electric shock happens when an electric current pass through your body. This can burn both internal and external tissue and cause organ damage.

A range of things can that cause an electric shock, including:

i. Lightning
ii. Electric machinery
iii. Electric weapons, such as tasers
iv. Household appliances
v. Electrical outlets
vi. Power lines

While shocks from household appliances are usually less severe, they can quickly become more serious if a child chews on an electric cord our puts their mouth on an outlet.

Aside from the source of the shock, several other factors affect how serious an electric shock is, including:

i. Voltage
ii. Length of time in contact with the source
iii. Overall health
iv. Electricity's path through your body
v. Type of current (an alternating current is often more harmful than a direct current because it causes muscle spasms that make it harder to drop the source of electricity)

If you or someone else has been shocked, you may not need emergency treatment, but you should still see a doctor as soon as possible. Internal damage from electric shocks is often hard to detect without a thorough medical exam.

Learning Activities

You are a lead technician in one of the big textile industries in Kenya. While working in the production line, the production manager announces that there is a fire outbreak in the line. While the workers are running out for, the production manager falls down and he gets burnt. Perform a first to him before he is taken to hospital for further medication

Self-Assessment

1. How are accident reports written?
2. OSHA encourages employers to investigate all instances where someone was hurt or incidents where the worker would be injured if circumstances had been slightly different. Choose Hazards controls and eliminating any future accidents.
3. What are common hazards at a construction site?

4. What are different types of workplace safety?
5. How can I improve my workplace safety?

Tools, Equipment, Supplies and Materials

i. Multimeter/AVO meter
ii. Wattmeter
iii. Insulation resistance tester
iv. Loop impedance tester
v. Earth resistance tester
vi. Clamp meter
vii. Power quality analyser
viii. Infrared camera
ix. Phase sequence meter
x. Frequency meter
xi. Synchroscope
xii. Tachometer
xiii. Tacho generator
xiv. Laser meter
xv. Lux meter

References

i. Chester Razer, OSHA Field Guide: Understand Workplace Safety & Save Money,2019,
ii. Trevor linsley, basic electrical installation work, fourth edition, Elsevier Ltd.

Answers to self-assessment test

1. When an accident occurs in the workplace it is important to do everything possible to get the treatment you need right away. Even if you don't believe the injury is too serious or life threatening, it is typically best to go to the doctor to get it checked out. Once you are certain that you are physically ok, you will need to write up an accident report. This report is submitted to the safety manager, HR, and potentially other groups.
2. It can be helpful for choosing hazards controls and eliminating any future accidents.

Create the Report ASAP: One of the most important things to do is write up the report as soon as possible after the incident occurs. This will help to ensure you remember the facts as clearly as possible. In addition, anyone else who was involved with the accident, and those who witnessed it, should also write their report right away.

Document Evidence: While this is certainly not a criminal investigation, it can be helpful to treat it like one. Documenting evidence like malfunctioning machinery, objects in the wrong place, and anything else that may have contributed to the accident is very important. Take pictures of anything related to the incident. Writing down the names of witnesses, the details of the surrounding environment, and other details will help make it easier to recreate the event if necessary.

Cooperate with Safety Professionals: Once you turn your accident report into your safety manager, they will almost certainly conduct a review on the incident. Some people are hesitant to work with them because they may fear that they are going to get in trouble. A good safety manager will want to work with everyone involved in the incident to discover the root cause so that actions can be taken to prevent further problems in the future.

3. Below are some of the most common dangers found in a construction site?

Confined spaces: Construction workers often find themselves working in confined spaces. Those working in spaces like manholes, tanks, and crawl spaces can face serious hazards including toxic and harmful substances, electrocutions, explosions, and asphyxiation.

Falls: Did you know falls are the leading cause of injury in the construction industry? Construction workers work from heights regularly and employers will need to provide training and proper fall protection in areas like walkways, hoist areas, holes, etc.

Struck-by hazard: A number of construction site accidents are the result of a struck-by hazard and there are four categories of struck-by hazards: falling objects, flying objects, swinging or slipping objects, and ground level objects. Every situation is unique, but there are specific safeguards you can put in place to address each hazard.

Hazardous energy: Dangerous equipment is often found on a construction site and will need maintenance or service at some point. Construction sites will need to practice a lockout/tag out program to ensure machinery is safely de-energize and re-energized when it is being worked on.

Chemicals: Like many other industrial workplaces, construction sites usually deal with a variety of toxic chemicals. Hazard communication is a standard notorious for being violated; the correct labeling of these chemicals and adherence to the GHS standard will not only keep workers safe but keep your organization in compliance.

4. OSHA has identified five different types of hazards that affect most workplaces. These are hazards that can be found in nearly every type of facility and should be addressed to keep workers from injury or health problems.

   Safety hazards: Safety hazards are the most common type of hazard and they are present in virtually every workplace at one time or another. These hazards are unsafe conditions in a facility that can cause injury, illness, or even death. Think of hazards like spills, working from heights, unguarded machinery, wiring issues, confined spaces, forklifts, and more.

   Biological hazards: Biological hazards affect those who work with animals, people, or infectious plant materials. People who are working at daycare centers, colleges, hospitals, nursing homes, etc. can be exposed to blood or other body fluids, fungi and mold, bacteria, viruses, and more.

   Physical hazards: Physical factors encompass environmental factors that can cause harm to workers even when they're not directly touched. Radiation, high sunlight exposure, working in extreme temperatures, and constant loud noises are all examples of physical hazards.

   Ergonomic hazards: These hazards can be the hardest to identify, but they can easily cause strain (and eventually injury) to the body. Workers can face ergonomic hazards if their workstations or chairs are improperly adjusted, if they're frequently lifting, if they're making repetitive and awkward movements and other situations where the body and muscles are overworked.

   Chemical hazards: Any chemicals in the workplace can put workers at risk. Some chemicals are far more dangerous than others, but even common chemicals can cause skin irritation, illness, or respiration problems.

5. Workplace safety should be a continuous effort for any company. You will most likely never achieve perfect safety, so there will always be areas for improvement. Here are some ways you can start improving the safety or your facility:

   Organize: Often times a messy or cluttered facility can lead to injury. A great first step in improving your safety strategy is to organize workbenches and cells. Arranging spaces in a

logical manner, organizing tools and materials, and cleaning will make it much easier for people to do their job without worrying about slipping or tripping.

Develop a committee: Workplace safety is seen as a priority when workers are brought together to form a safety committee. The safety committee is a permanent committee dedicated to identifying potential safety risks and implementing a solution. Senior management should support changes or improvements recommended by the committee.

Perform a JSA: In order to fully understand the state of your facility's safety it will be important to conduct a Job Safety Analysis. It proves use to identify safety hazards in specific jobs and use accepted best practices to make improvements; the more specific the better!

Go visual: Visual cues are one of the most effective ways to remind workers of safety practices and promote a culture of safety. The best visual communication strategies include a combination of equipment labels, wall signs, floor signs, floor markings, chemical labels, and more.

Take a Gemba walk: Sometimes managers and supervisors don't spend much time on the production line or the facility floor and can often overlook safety hazards. Taking a Gemba walk in the workplace and speaking with the frontline workers can show you if jobs are being performed safely, if there are any glaring issues, and how people feel about current safety procedures.

3.1.Select wiring devices

Introduction to the learning outcome

Selecting and applying wiring devices. Receptacles, switches, plates, and cord connector bodies are available in a wide range of sizes, ratings, and styles with specific features and characteristics to meet most design/application requirements. Grades of wiring devices Manufacturer's catalogs use a variety of terms to indicate the quality or grade of wiring devices offered. For example, the term "economy,"

Performance Standard

1. Interpretation of the drawings.
2. Identification of correct type and quantity of wiring devices and consumable items
3. Selection of tools and equipment
4. Identification and selection of correct PPE.

Information Sheet

Reading and interpreting drawings to determine job requirements.

Electrical drawings are a formal and precise way of communicating information about the layout, the dimensions, features and precision of Electrical installations. Drawing is the universal language of engineering. To understand how to “read and interpret” a drawing it is necessary to be familiar with the standard conventions, rules, and symbols used on the various types of electrical drawings.

The purpose of this is to prepare electrical personnel with the ability to read and understand the electrical diagrams, various standards and practices used for reading and Interpreting electrical drawings and schematics. Participants will be introduced to electrical symbols, one-line and three-line electrical schematics and their content, including basic layout and legends.

The learning outcome will help the attendees understand the symbols and the language used in electrical drawings in line with the international standards and practices, giving a detailed insight into the various types of electrical drawings used in the industry, their purpose and applications.
Symbols are a shorthand way of showing the locations, types, and sizes or ratings of **electrical** wiring and equipment, and the interrelationships between these items. It should be emphasized that **drawings** need to be supplemented with specifications in order to establish the details of the **electrical** systems.

TYPICAL ELECTRICAL DRAWING SYMBOLS AND CONVENTIONS

ELECTRICAL SYMBOLS

CONTACTS, SWITCHES, CONTACTORS AND RELAYS

SYMBOL	DESCRIPTION
X1 N.O. X1 N.C.	Relay contact - Shown with relay in de-energized or in reset position. (Show relay coil designation near contact.)
T1 TDC T1 TDO	Timing Relay Contact - TDC indicates contact closes at end of timing period. TDO contact opens at end of timing period.
X1	Coil - Relay, contactors, circuit breaker, solenoid etc. (Show device designation, X1)
T1 TDPU (TDDO)	Coil - Timing Relay - TDPU indicates timing period starts when coil is energized. TDDO indicates timing period starts when coil is de-energized.
R1 O R	Latching Relay or Mechanically-Held Contactor O=operate; R=reset; TC=trip coil; CC=closing coil. (Coils may be separated on diagram)
	Pushbutton - Momentary or spring return. Single Circuit (make)
	Pushbutton - Momentary or spring return. Single Circuit (break)
	Pushbutton - Momentary or spring return. Two Circuit
	Pushbutton - Maintained, two circuit
	Pushbutton - Maintained, single circuit
H A	Selector Switch - Two position, maintained (designate position shown; i.e. A=Auto; H=Hand)
	Knife Switch, general. (If shown closed, terminals must be added.)
	Switch - General, single pole, single throw.
	Switch - One pole of multi-pole switch shown. Other poles shown elsewhere.
T C SR SR	Selector Switch - Three position, SR indicates spring return from position so labeled. ("TRIP-(NORMAL)-CLOSE" position shown)
	Limit Switch - Normally oper - Not applicable for Motor Operated Valves and Solenoid Valves.
	Limit Switch - Normally closed - Not applicable for Motor Operated Valves and Solenoid Valves.

Table 6: Installation drawing symbols

Identification of wiring devices

Wiring accessories are used for connecting appliances

Switch

A switch is used to make or break an electrical circuit.

It is used to switch ‘on’ or ‘off’ the supply of electricity to an appliance.

There are various switches such as:

- ❑ Surface switch
- ❑ Flush switch
- ❑ Ceiling switch
- ❑ Pull switch
- ❑ Push button switch
- ❑ Bed switch

Figure 92: Switches

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

i. One-way switch
ii. Two-way switch
iii. Intermediate switch

One-way switch: It is used to control single circuits and lamp
Two-way switch: It is used to divert the flow of current to either of two directions. The two-way switch can also be used to control one lamp from two different places as in the case of staircase wiring

Intermediate switch: It is used to control a lamp from more than two locations.

Flush switch:
It used for decorative purpose.

Bed switch: As the name indicates, it is used to switch 'on' the light from any place, other than switch board or from near the bed. This switch is connected through a flexible wire

one-way switche two-way switch *Intermediate switch*

Flush Switch *Bed switch*

Holders

A holder is of two types.

i. Pendant holder

ii. Batten holder

Fig 3.7: Pendant holder

Fig 3.8: Batten holder

Ceiling rose

It is used to provide a tapping to the pendant lamp–holder through the flexible wire or a connection to a fluorescent tube.

Ceiling rose

Socket outlet/plug

The socket outlet has an insulated base with the molded or socket base having three terminal sleeves.

socket outlet

Main switch

To control the electrical circuit a main switch is used. Through the main switch, the power in a building is controlled completely.

Main switch

PVC casing-capping wiring

PVC capping is done in order to cover the wires. It includes casing also. This casing-capping wiring is also known as open wiring, as it is done outside the wall. Materials required for PVC casing-capping wiring include:

i. Wire
ii. Casing enclosures made up of plastic
iii. Capping made up of plastic
iv. T. Joints VIR (Vulcanized Indian Rubber) or PVC (Polyvinyl chloride) insulated wire
v. Junction box
vi. Elbow
vii. Casing and capping joints

Wooden casing-capping wiring is old fashioned. Now PVC or VIR insulated wires are enclosed within the PVC casing enclosure and PVC capping is used to cover the casing.

PVC casing-capping accessories

PVC casing-capping bend

Advantages of casing-capping wiring

i. Easy to install
ii. Strong and durable wiring
iii. Customization can be done easily
iv. Safe from smoke, dust, rain and steam, etc.
v. No risk of shock due to casing and capping,

Disadvantages of PVC casing-capping wiring

i. Costly
ii. Not suitable for humid weather
iii. High risk of fire

Miniature Circuit Breaker (MCB)

A MCB is used in new constructions instead of the older types of fuses. Circuit breakers are small devices used to control and protect the electrical panel
and the other devices from overflowing of electrical power.

Figure 93: MCB Distribution Box

Uses of MCB

Home electrical panels

As with all breakers, the MCB is designed to protect the house from circuit overload. An MCB is much safer than the typical fuse, because it can be reset manually and can handle larger amounts of power. The breaker can manage the flow of energy, distributing the voltage even when many devices run off the same power circuit.

Lights

MCBs are used in the lighting system of the house, because they can deal with the amount of power needed to lightening a house, especially if specific types of lamps, such as fluorescent lights are used. MCBs overcome the need of additional power required when switching on the lights, especially when lights are used extensively in the entire house.

Industrial applications

There are many small-scale industrial buildings where MCBs are used instead of the old fuses. Miniature circuit breakers are largely used in restaurants, bakeries and commercial food stores.

Heaters

When heaters are used at home or in the office, the MCB can be beneficial. It is known in general that heaters can be problematic sometimes, especially with distribution of electrical power. The MCB prevents possible problems, cutting off electricity in the case of overload or fault. In this case, though, you need to choose a miniature circuit breaker of the proper capacity, enabling it to handle the load of power when needed.

Conduit Wiring

Electrical conduits are used to protect and provide the route of electrical wiring in an electrical system. Electrical conduits are made of metal, plastic, or fibre and can be rigid or flexible. Conduits must be installed by electricians as per standard regulations. For workshops and public buildings, conduit wiring is the best and most desirable system of wiring. It provides protection and safety against fire.

Figure 94: Conduiting Wiring

Figure 95: Conduit Wiring Components

Types of Conduits

i. Class A conduit: Thin layered steel sheet of low gauge
ii. Class B conduit: Thick steel sheet of high gauge

Some of the materials used in Conduit Wiring

i. GI (Galvanized Iron) wire
ii. Elbow
iii. Coupling
iv. VIR or PVC insulated cables
v. Lock nut
vi. Clip
vii. Junction Box

Advantages of conduit wiring

i. Safe
ii. Better appearance
iii. No risk of fire
iv. No risk of damage of cable insulation
v. Safe from humidity, smoke, steam, etc.
vi. No risk of shock

vii. Long lasting

Disadvantages of conduit wiring

i. Expensive
ii. Installation is not easy
iii. Not easily customizable for future use
iv. Hard to detect faults

Testing the functionality of the devices and appliances

Appliances with electrical problems can be a fire hazard or electrical shock risk. Even a refrigerator or dishwasher can be dangerous if not properly tested and maintained.

Electrical appliance testing falls into two broad categories:

Hot Tests: Tests made with power applied to the unit
Cold Tests: Tests made with the unit unplugged

Electrical Appliance Testing Equipment

What equipment is required for appliance electrical testing?

A non-contact millimeter

This is the most economical tool, as it fulfills the role of a non-contact voltage meter, continuity meter and more. Non-contact (clamp-style) millimeters use magnetic inductance to measure current flow, so they are safest to use on AC circuits and can measure much higher amperage values than lead-only-style millimeters.

A professional

The truth is, electrical appliance testing is dangerous. We recommend having a professional check it out. If there's a bigger electrical problem tied to your appliance issue, call a trusted electrician.

Appliance Electrical Testing Steps

During appliance electrical testing processes, professionals typically measure three different electrical parameters: continuity, voltage, and amperage.

Safety first: Do not touch any electrical components with your skin, do not touch the metal tips of the multicenter leads, and do not touch the multimeter's leads together.

Continuity

- Unplug the appliance first, and disconnect it from any water or gas lines.
- Turn your multimeter to the "ohms" function (Ω).
- Now test for electrical continuity of the switches, thermostats, and other contacts that are supposed to be closed.
- To do this, touch one end of the multimeter's lead to a terminal (the part's contact point) and the other end to the opposite contact point.
- Closed contacts should read 2 ohms or less if they have proper continuity. If the ohms read higher than 2, the electrical control you are testing should probably be replaced.
- Some parts (beyond those mentioned above) should have different resistance. Consult the manufacturer's manual to make sure you're looking for the right ohms reading.

Voltage

- These steps can be taken after voltage in the outlet is already safely confirmed.
- First, make sure the appliance is turned off and plugged in.
- To see if there's voltage running "downstream" of the outlet into the appliance, turn your multimeter to the AC volts setting (ṽ).
- With the appliance turned off, touch the multimeter's leads to the circuit. Read the voltage.
- The target voltage depends on the type of appliance you have and the components you're testing.
- When testing voltages to electric dryer heating elements and electric range or stove elements, look for 240 volts AC.
- When testing for control voltages to solenoids, timers, and other components on your 120-volt appliances, look for 120 volts AC.
- If the voltage reads lower than it should, you likely have one of these problems:
- A circuit issue—usually an open switch or thermostat or one with poor continuity
- A bad wire connection—look for burnt or discolored wires.

Amperage

- Testing for amperage, or current, is another way of testing for continuity. The main
- difference is that amperage tests are made with the appliance plugged in.
- Set the multimeter to the "amps" range (A), not the "milliamperes" range.
- Turn off the appliance, and connect the multimeter to the circuit to be tested.
- Turn the appliance back on, and get the multimeter reading.
- Consult your appliance manual to see if the amps detected match the operating load of your unit.

- ❖ If the amp reading is lower than it should be, there may be a failed component causing the resistance to be higher. If the amperage is much too high, a failed part may be causing a short and lowering the resistance.

Learning Activities

Adjust the electrical accessories like, switches, holders, sockets, etc. on the given board or round block. And then mark their positions by a pencil. Remove the covers of the accessories and loosen the screws of terminals. Make a powder of chalk and pour it in the holes of the terminal. Mark the point on them by the poker. Now make the holes on the round block or board by the drilling machine where the points have been marked. Insert the wires in the terminal, after removing the insulation. Then fix all the accessories on the board or round block by wooden screws after making holes on them by the poker. Then fix all covers on the accessories.

Tools and materials required

i. Hand drilling machine with a drift bit of 5 centimeter
ii. Poker
iii. Screwdriver
iv. Connector screwdriver 8 cms
v. Combination plier 15 cm
vi. Try square
vii. Firmer chisel 20 mm
viii. Electrician knife 10 cm

Material

i. Wooden round block/ PVC Round Block
ii. Wooden board/ Sun mica Board
iii. Single pole one-way switch 5 A, 250V
iv. PVC wire
v. Pencil
vi. Chalk

All the fittings (switch, holder) should be fitted well. No naked portion of the conductor should remain visible. The screws in the accessories fitted should be tight. The tools should be used carefully.

Self-Assessment

1. How do I know if my electrical wiring connection is good or bad?
2. What is the difference between neutral and earth lines?
3. How do you differentiate MCB from a fuse?

4. How do you wire one lamp controlled by two switches?
5. What is an isolator?

Tools, Equipment, Supplies and Materials

i. Multimeter/AVO meter
ii. Wattmeter
iii. Insulation resistance tester
iv. Loop impedance tester
v. Earth resistance tester
vi. Clamp meter
vii. Power quality analyser
viii. Infrared camera
ix. Phase sequence meter
x. Frequency meter
xi. Synchroscope
xii. Tachometer
xiii. Tacho generator
xiv. Laser meter
xv. Lux meter

References

i. Black & Decker, the Complete Guide to Wiring, 7th edition, Cool springs press.
ii. https://ncert.nic.in/vocational/pdf/kvcj103.pdf

Answers to self-assessment test

i) Some electrical connections are good others not so much! Product manufacturers might give you a choice of connection points which include switches and outlets. You may be able to ascertain which will be the wisest choice by researching and using common sense. Whatever you do, beware of loose connections that can cause devices to heat up and result in an electrical fire. Create a safe and secure connection that will last a long time.

ii) Neutral – Return line or return path of current, connected to the start point of the transformer usually connected to ground.
Earth – Connected to earth or soil through an earth rod that offers a low resistance current path for electric discharges. It carries current during a fault condition and not a current-carrying path under normal condition.

iii) Both devices have the same function they are used to protect the electrical system from over current and overload, but they are different in both construction and operation.

MCB's are more preferable because it offers better sensitivity, accuracy, precision, etc. The main advantages are MCBs can be operated safely as just like a switch. Whereas a fuse needs to very carefully plugin to and out from live conductors and the fuse wires need to be replaced after every burnout.

iv) By wiring, the load using multiway switching or staircase wiring one lamp can be controlled from two switches placed at different locations like the top and bottom of a staircase, indoor and outdoor of the home, etc.

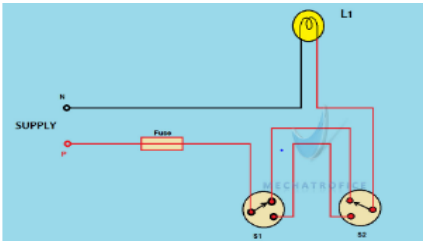


Figure 96: One Lamp Controlled by two switches

v) An isolator is a mechanical switching device used for isolating a circuit or equipment from the power source.

3.2.Install wiring devices, lighting fixtures and basic appliances

Introduction to the learning outcome

Electrical wiring needs expertise attention to every building project. It directly related to the safety of human beings and utilities equipment people handle.

Performance Standard

1. Power points identification
2. Installation of light fixtures
3. Identification and selection of tools, equipment and materials
4. Termination and fitting of wiring devices, lighting fixtures and basic appliances
5. Earthing of the wiring devices, lighting fixtures and basic appliances
6. Labeling of final circuits on the distribution board
7. Maintenance and storage of tools and equipment

Information Sheet

Use of safety harness and PPE

The best way to keep people safe from electrical hazards in the workplace is by implementing policies and procedures that reduce or eliminate various risks. Unfortunately, it is impossible to take steps that can be 100% effective, and if there is even one incident it can be deadly. With this in mind, it is important that anyone working with or around dangerous electrical equipment use personal protection equipment to keep them safe in the event of an accident. The following are among the most frequently used types of PPE, and how they can keep your workplace safer.

Insulated Gloves – Insulated gloves will prevent electricity from traveling into your hands should there be an exposed wire, short circuit, or other issue.

Insulated Matting – Insulated matting will put a protective layer between the employee and the floor. This is helpful when working at switchboards, transformers, and other high-voltage areas. It can help prevent electricity from traveling up from the floor into the person's body, as well as eliminating a path for electricity to travel through the body and out to the floor.

Insulated Ladders – Insulated ladders won't transmit electricity into the person who is using it. If a normal metal ladder accidentally touches a live electrical wire, it can be devastating. With the insulated ladder, this isn't an electrical concern.

Rescue Rods – In the event that someone is being electrocuted, people will be tempted to rush in to save them. Unfortunately, this will only lead to them becoming electrocuted as well. Having a rescue rod present will allow those in the areas to pull the victim to safety, or push the source of the electricity away.

Voltage Detectors – Even after a power source has been removed, there can still be electricity in a system because of capacitors. A voltage detector will show the level of electricity in a given system at the current time, so employees won't mistakenly begin working on a system until all power has been eliminated.

Identification of power points

A power circuit is defined as any circuit used to carry electricity that operates a load. This may seem like a simplistic definition but it is important to distinguish power circuits from control circuits since they serve different purposes.

All power connection points need to be well marked for easy access.

Types of lighting fixtures

A **light fixture**, **light fitting**, or **luminaire** is an electrical device that contains an electrical lamp that provides illumination all light fixtures has a fixture body and one or more

lamps. The lamps may be in sockets for easy replacement—or, in the case of some LED fixtures, hard-wired in place.

Fixtures may also have a switch to control the light, either attached to the lamp body or attached to the power cable. Permanent light fixtures, such as dining room chandeliers, may have no switch on the fixture itself, but rely on a wall switch.

Fixtures require an electrical connection to a power source, typically AC mains power, but some run on battery power for camping or emergency lights. Permanent lighting fixtures are directly wired. Movable lamps have a plug and cord that plugs into a wall socket.

Different types of lighting fixtures

Track

This type of modern lighting is mounted or suspended from the ceiling. Track lighting is essentially a linear housing that has multiple heads, which can be positioned anywhere along the track. The direction of the heads can be adjusted to provide lighting to specific areas in the room. Many homeowners prefer track lighting for accent lighting and task lighting.

Figure 97: Track Lighting

Recessed and Under-Cabinet

Recessed lighting fixtures are installed above the ceiling so that the opening can be flush with the ceiling. Recessed lighting requires six inches or more of clearance above the ceiling. Insulation of the lighting fixture is essential, as it ensures that condensation does not drip into the fixture. Recessed lighting projects a narrow band of light in one direction, making it ideal for accent, ambient, and task lighting. Under cabinet lighting is a type of recessed lighting that is mounted under kitchen cabinets. It is very popular for task lighting in the kitchen.

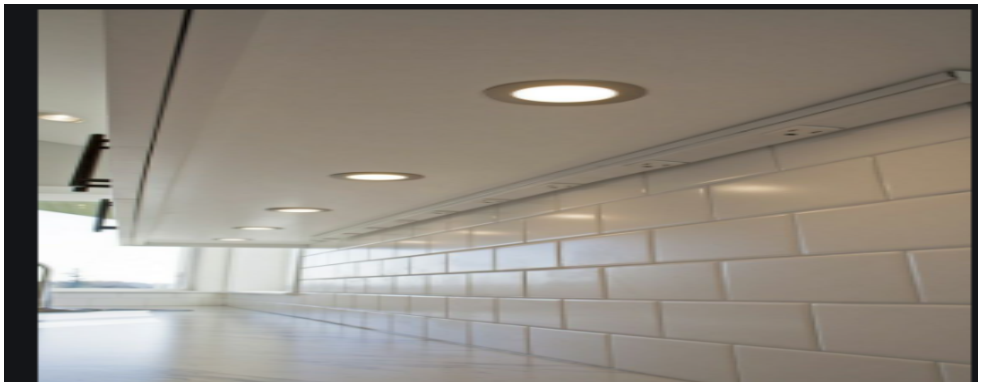


Figure 98:Recessed and Under-Cabinet Lighting

Pendants

Pendant light is suspended from the ceiling and broadcasts light downward, usually over a kitchen island, countertop, or table. A pendant enhances the decor of a room and can make for very attractive task and ambient lighting.

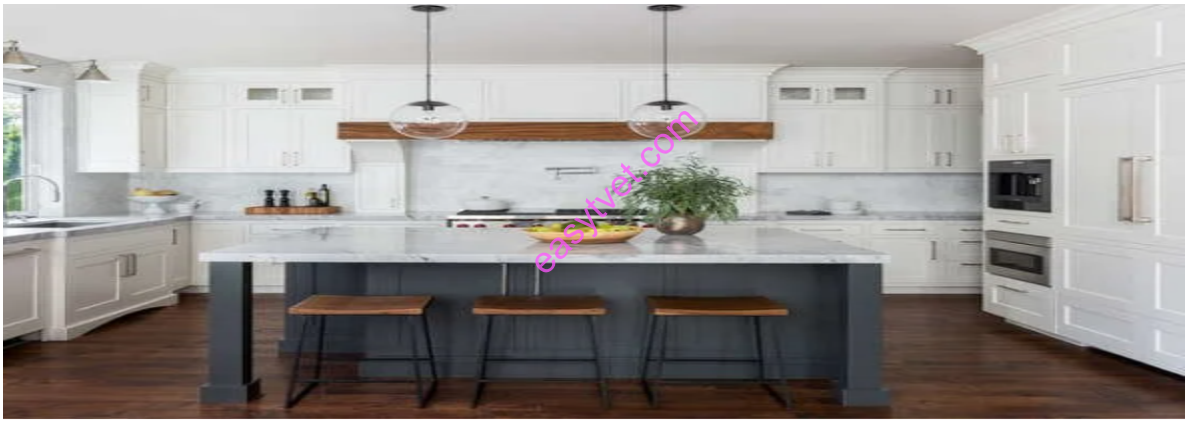


Figure 99: Pendants lighting

Chandeliers

Chandeliers are suspended from the ceiling. They direct their light upward, oftentimes over a table or an entryway. Chandeliers elevate the style of any room and provide attractive ambient lighting.

Figure 100: Chandaria Lighting

Wall Sconces

Sconces are typically surface-mounted to the wall. They direct light downwards or upwards. Many homeowners buy covers or shades for their wall sconces to add design appeal to a room. Wall scones are especially great for task lighting and ambient lighting.

Figure 101: Wall Sconces lighting

Identification of lighting fixtures

Antique lighting fixtures are a valuable and inspirational decorative accent in a real estate investment. The historical significance and unique styling associated with antique lighting fixtures make them a luxurious element in a home design. If you have antique lighting fixtures and want to identify them by age, period and genre, there are several ways to evaluate and assess their historical relevance. It's important to research carefully to ensure that a piece is authentic rather than a modern reproduction.

Examine the Fixture for Markings

Study the light fixture for manufacturer impressions, initials and hallmarks. Examine the metal framework supporting the fixture, the base of the light and the arms connecting to the globes. Most markings are company names or signatures that were incorporated into the original casting. According to Vintage Lights, many of the numbers on antique lighting fixtures represent casting marks that showed the installer how to connect the pieces. As a result, some antique fixtures have multiple numbers, primarily used for internal use by the manufacturer. These numbers weren't usually recorded as serial numbers and aren't necessarily useful for identifying the fixture; however, they do help distinguish originals from reproductions.

Study the Design Elements

Research antique lighting styles and visit antique stores to compare and discuss historical influences associated with your lighting fixture. For example, early antique Fenton light fixtures exemplified Gone with the Wind designs and incorporated rounded vertical globes and brass hardware into their construction. Antique Tiffany lamps used colorful stained glass to add color and artistic design to salons and living rooms. Test to see if the glass in a Tiffany lamp is lead-based, likely signifying that it's an antique fixture.

Date the House or Location

Verify the age of your property, or the original location of the light fixture, to authenticate and identify it. If the light fixture was an original that came with your real estate investment, research the history of the house and its previous owners. If a previous owner was a world traveler, there is a strong possibility that the piece could be from a foreign country. Establish the age of your home to get a reliable guesstimate on the age of the fixture. If your home was built post-1950s, the light fixture is probably not antique and is likely a reproduction. Most homeowners took valuable antique possessions with them when they relocated.

Compare Fixture to Other Specimens

Examine antique light fixtures in books, on the Internet and in local museums. Compare your light fixture to others of the same variety. For example, if your fixture has Victorian appeal, compare it to other fixtures from the late 1800s and early 1900s. Take photographs of your light fixture and show it to museum owners and antique dealers to get their professional analysis and

viewpoint. Identification of antique light fixtures isn't an exact science, so comparisons with other similar specimens are often the key to identification.

Identification of tools and equipment

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.

Pliers

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.

Screw drivers

Drilling Equipment

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

Driller

Sawing and Cutting

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

Hark saw

Soldering Equipment

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

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

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.

Measuring tools

Assembling of tools and equipment

Here's how to put together a comprehensive tool box full of hand and power tools that will allow you to tackle almost any home repair.

https://www.youtube.com/watch?v=4T3UvYN-bbw&feature=emb_logo

Termination and fitting of wiring devices, lighting fixtures and basic appliances

For centuries, copper wire has been used as an electrical conductor. But wire requires termination. Simple screw clamps were originally used to terminate wire. Although screw clamps are still used today, there are now numerous means to terminate wires.

Soldering

Soldering offers flexibility, durability and corrosion-resistance. Connections can be made and removed easily, which simplifies prototyping and fieldwork.

Insulation Displacement Connections

Insulation displacement connectors (IDC) are probably the fastest way to terminate wires. IDCs were first used in the telecom industry on small, stranded wire. The process can quickly and efficiently terminate the hundreds of wires in large patch panels.

Crimping
Crimping is the most commonly used method of wire termination, and is most efficient for high-volume wire termination. The terminations are fast, clean and mechanically strong.

Ultrasonic Welding
Ultrasonic welding is used in various bonding applications, such as joining such dissimilar metals as copper, aluminum, nickel and brass.

Earthing of the wiring devices, lighting fixtures and basic appliance
The process of transferring the immediate discharge of the electrical energy directly to the earth by the help of the low resistance wire is known as the electrical earthing. The electrical earthing is done by connecting the non-current carrying part of the equipment or neutral of supply system to the ground.

Mostly, the galvanized iron is used for the earthing. The earthing provides the simple path to the leakage current. The short-circuit current of the equipment passes to the earth which has zero potential. Thus, protects the system and equipment from damage.

Types of Electrical Earthing
The electrical equipment mainly consists of two non-current carrying parts. These parts are neutral of the system or frame of the electrical equipment. From the earthing of these two non-currents carrying parts of the electrical system earthing can be classified into two types.

i. Neutral Earthing
ii. Equipment earthing.

Neutral Earthing
In neutral earthing, the neutral of the system is directly connected to earth by the help of the GI wire. The neutral earthing is also called the system earthing. Such type of earthing is mostly provided to the system which has star winding. For example, the neutral earthing is provided in the generator, transformer, motor etc.

Equipment Earthing
Such type of earthing is provided to the electrical equipment. The non-current carrying part of the equipment like their metallic frame is connected to the earth by the help of the conducting wire. If any fault occurs in the apparatus, the short-circuit current to pass the earth by the help of wire. Thus, protect the system from damage.

Importance of Earthing

The earthing is essential because of the following reasons:

i. The earthing protects the personnel from the short-circuit current.
ii. The earthing provides the easiest path to the flow of short-circuit current even after the failure of the insulation.
iii. The earthing protects the apparatus and personnel from the high voltage surges and lightning discharge.

Earthing can be done by electrically connecting the respective parts in the installation to some system of electrical conductors or electrodes placed near the soil or below the ground level. The earthing mat or electrode under the ground level have flat iron riser through which all the non-current-carrying metallic parts of the equipment are connected.

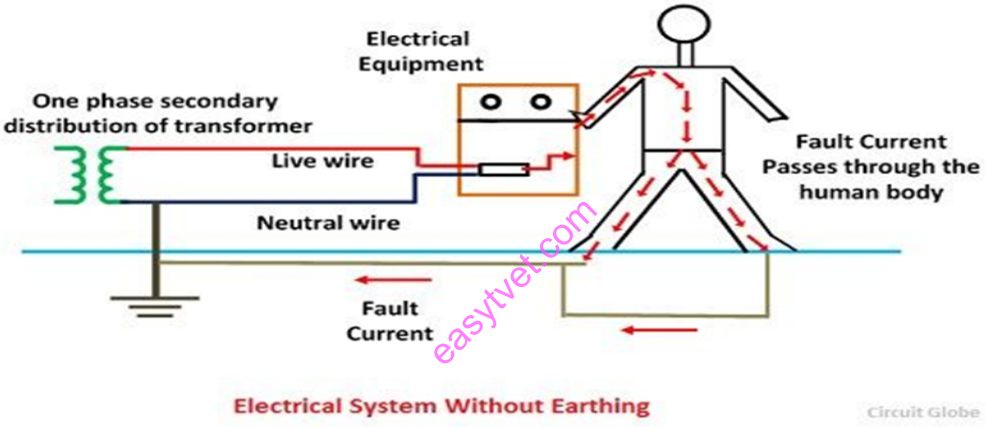


Figure 102: Electrical System Without Earthing

When the fault occurs the fault current from the equipment flows through the earthing system to the earth and thereby protects the equipment from the fault current. At the time of the fault, the earth mat conductors rise to the voltage which is equal to the resistance of the earth mat multiplied by a ground fault.

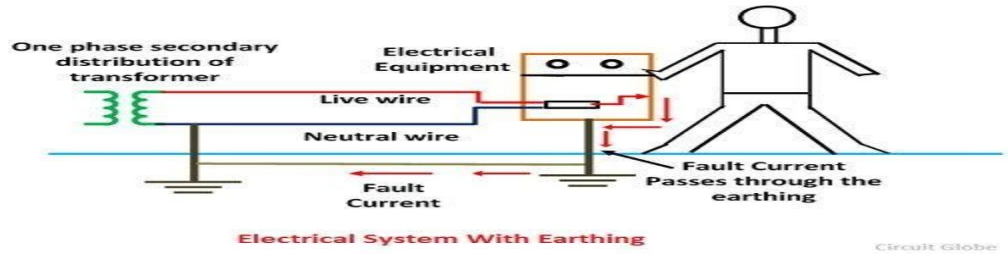


Figure 103: Electrical system with Earthing

The contacting assembly is called earthing. The metallic conductors connecting the parts of the installation with the earthing are called electrical connection. The earthing and the earthing connection together called the earthing system.

Types of Earthing Systems,
TNC, TNS, TNCS, TT, IT.
TN-S (T- EARTH, N –NEUTRAL, S-SEPARATE)
TN-C-S (T-EARTH, N –NEUTRAL, C-COMBINED, S-SEPARATE)
TN-C (T-EARTH, N –NEUTRAL, C-COMBINED,)
IT (ISOLATED EARTH)

Component parts of earthing system are to include the following:

i. Earth electrode (rods, tapes etc.)
ii. Main earthing terminals or bars.
iii. Earthing conductors.
iv. Protective conductors.
v. Equipotential bonding conductors.
vi. Electrically independent earth electrodes for special systems (clean earth)

Methods of Earthing.
There are several methods of earthing like wire or strip earthing, rod earthing, pipe earthing, plate earthing or earthing through water mains. Most commonly used methods of earthing are pipe earthing and plate earthing. These methods are explained below in details.

Earthing Mat
Earthing mat is made by joining the number of rods through copper conductors. It reduced the overall grounding resistance. Such type of system helps in limiting the ground potential. Earthing mat is mostly used in a placed where the large fault current is to be experienced. While designing an earth mat, the following step is taken into consideration.

In a fault condition, the voltage between the ground and the ground surface should not be dangerous to a person who may touch the noncurrent-carrying conducting surface of the electrical system.

The uninterrupted fault current that may flow into the earthing mat should be large enough to operate the protective relay. The resistance of the ground is low to allow the fault current to flow through it. The resistance of the mat should not be of such a magnitude as to permit the flow of fatal current in the live body.

The design of grounding mat should be such that the step voltage should be less than the permissible value which would depend on the resistivity of the soil and fault required for isolating the faulty plant from the live system.

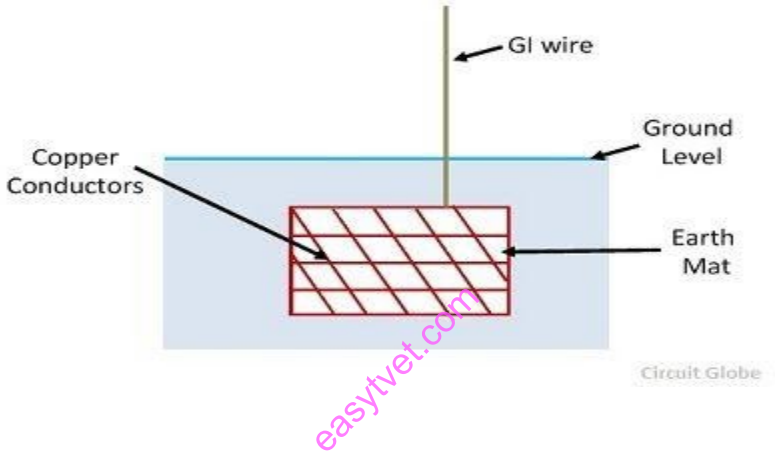
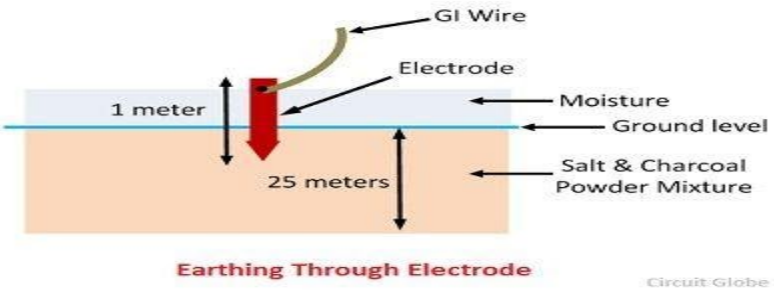


Figure 104: Earth Mat

Earthing Electrode

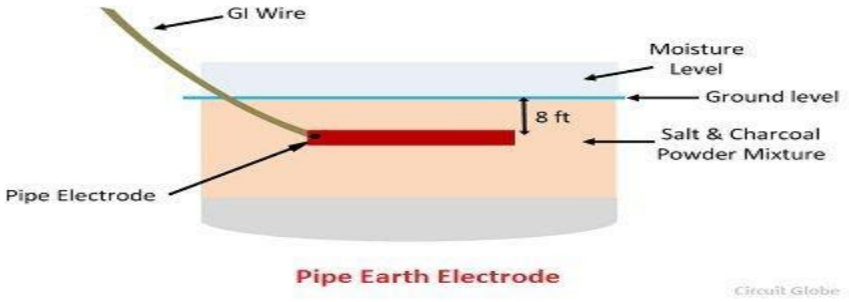
In this type of earthing any wire, rod, pipe, plate or a bundle of conductors, inserted in the ground horizontally or vertically. In distributing systems, the earth electrode may consist of a rod, about 1 meter in length and driven vertically into the ground. In generating substations, grounding mat is used rather than individual rods.



Earthing electrode

Pipe Earthing

This is the most common and best system of earthing as compared to other systems suitable for the same earth and moisture conditions. In this method the galvanized steel and perforated pipe of approved length and diameter in place upright in a permanently wet soil, as shown below. The size of the pipe depends upon the current to be carried and type of soil.



Pipe earth electrode

Normally, the size of the pipe uses for earthing is of diameter 40 mm and 2.5 meters in length for ordinary soil or of greater length in case of dry and rocky soil. The depth at which the pipe must be buried depends on the moistures of the ground.

The pipe is placed at 3.75 meters. The bottom of the pipe is surrounded by small pieces of coke or charcoal at a distance of about 15 cm. Alternate layers of coke and salt are used to increase the effective area of the earth and to decrease the earth resistance respectively.

Another pipe of 19 mm diameter and minimum length 1.25 meters is connected at the top of GI pipe through reducing socket.

During summer the moisture in the soil decreases, which causes an increase in earth resistance? So, a cement concrete work is done to keep the water arrangement accessible, and in summer to have an effective earth, 3 or 4 buckets of water are put through the funnel connected to 19 mm diameter pipe, which is further connected to GI pipe.

The earth wire either GI or a strip of GI wire of sufficient cross section to carry faulty current safely is carried in a GI pipe of diameter 12 mm at a depth of about 60cm from the ground.

Plate Earthing

In Plate Earthing an earthing plate either of copper of dimension 60cm×60cm×3m of galvanized iron of dimensions 60 cm× 60 cm×6 mm is buried into the ground with its face vertical at a depth of not less than 3 meters from ground level.

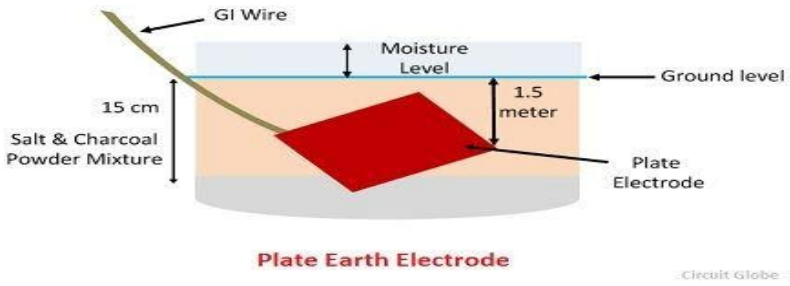
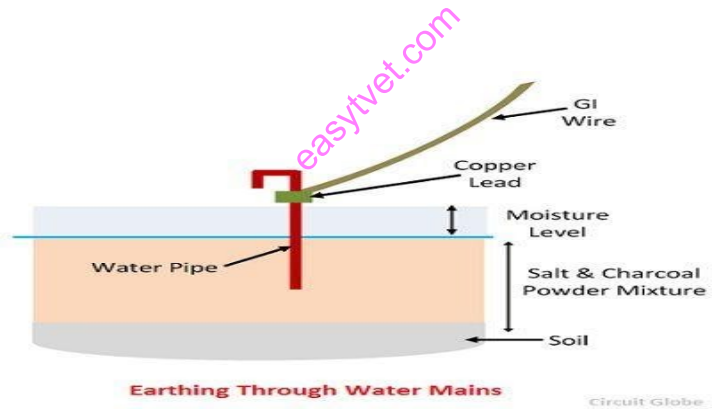


Plate earth electrode

The earth plate is inserted into auxiliary layers of coke and salt for a minimum thickness of 15 cm. The earth wire (GI or copper wire) is tightly bolted to an earth plate with the help of nut or bolt. The copper plate and copper wire are usually not employed for grounding purposes because of their higher cost.

Earthing Through Water Mains

In this type of earthing the GI or copper wire are connected to the water mains with the help of the steel binding wire which is fixed on copper lead as shown below.



Earthing through water mains

The water pipe is made up of metal, and it is placed below the surface of the ground, i.e. directly connected to earth. The fault current flow through the GI or copper wire is directly get earthed through the water pipe.

Over-current protection is protection against excessive currents or current beyond the acceptable current rating of equipment. It generally operates instantly. Short circuit is a type of over-current. Magnetic circuit breakers, fuses and over-current relays are commonly used to provide over-current protection.

Test for an earthing system

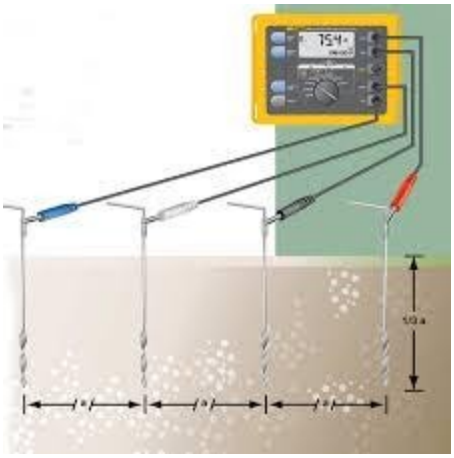


Figure 105: Earth Test System

The fall-of-potential test method is used to measure the ability of an earth ground system or an individual electrode to dissipate energy from a site. ... Then, two earth stakes are placed in the soil in a direct line – away from the earth electrode, for the 3-pole fall of potential test. The earth ground tester works on the principle that in parallel/multi-grounded systems, the net resistance of all ground paths will be extremely low. A good connection is defined as having a resistance of less than 0.1 ohms (or 100 milliohms). The Earth Continuity test is sometime referred to as the Earth Bond test or the Earth Resistance test.

Labeling of final circuits on the distribution board
Branch circuit panel board directories

A. Provide neatly typed schedule under plastic jacket or protective cover for protection from damage or dirt.

i. Number each single pole space: Odd-numbered circuits on left side or top, even on right side or bottom.
ii. Securely mount on inside face of panel board door.
iii. When there is no cover, provide individual nameplates for each over-current and other device.
iv. Define briefly, but accurately, nature of connected load (i.e., Lighting Office, Receptacles, Mechanical/Electrical Room, etc.) as approved.
v. Provide room locations for all loads and indicate panel name on the schedule.
vi. Multipole circuits: Use first pole space number as circuit number.

B. Confirm room numbers with UC Construction Management before noting on schedules.

i. Spare circuit breakers and space positions shall be noted in pencil.

ii. Panel schedules and as-built circuit numbers shall agree.

Wire and cable labeling

Control wiring

All control-wire terminations are to be identified by tubular sleeve heat shrink-type markers to agree with wire marking identification on manufacturer's equipment drawings.

Power conductor wire, cable, and buses

Buses, feeders, branch circuit conductors, and medium-voltage cables shall be properly phased and identified throughout. Individual conductors shall be color coded as noted below.

Conductor	**102/208V and Medium Voltage**	**277/480V**
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green
Isolated Ground	Green/Yellow	Green/Yellow

Table 7: Colour codes

Buses and connections shall be identified left to right, top to bottom, or front to rear; shall read A-B-C; and shall be color-coded per the table above.

Feeders for all new construction shall have color-coded phase identification at all junction boxes and wherever feasible, and shall have solid color-coded insulation for phase designation. Where the proper color wire insulation cannot be obtained, black insulation shall be used and the conductors shall be coded with plastic vinyl tape, 3M #190-A, ¾ inch or equal.

Identify color-coded conductors with appropriately colored plastic vinyl tape (3M #190-A) in the panel when branch circuits are reconnected for balancing panel load.

"Low voltage" cable and special systems

See individual functional specification sections.

Color scheme for labels

See attached standard drawings for examples

System	Label Color	Lettering Color	Identification
2.4 kV and 4.16 kV emergency	Red	White	
13.8 kV normal	Yellow	Black	
2.4 kV normal	Orange	White	
Normal power and control	White	Black	
Emergency power and control:			
Emergency – life safety	Red	White	"EM - LS"
Emergency – critical	Red	White	"EM - CR"
Emergency – legally required standby	Red	White	"EM - LRS"
Emergency – optional standby	Red	White	"EM – OS"
Fire alarm	Red	White	"FA"
Halon	Dk. Blue	White	"FP"
Security	Green	Black	"SEC"

Intercom, public address, **nurse call**	Orange	Black	"IC", "PA", or "NC" (as app.)
Clock	Lt. Blue	Black	(Symbol for Clock)
TV	Yellow	Black	"TV"
Communication data	Black	White	"C/D"

Table 8: Colour scheme for labels

Conducting final checks for work manship, conformity with instructions and job requirements

At the completion of the electrical installation works, the entire installation shall be subject to the test before final placing in service under the full responsibility of the contractor. Unless otherwise specifically called for all tests shall be carried out in conformity with IEE regulations. Contractor shall coordinate with the Client and the Supervising Engineer to get electricity from the local supply authority before starting of testing and commissioning.

Following tests shall be carried out: Wiring continuity test, Insulation resistance test, Earth continuity test, Earth resistivity test, Performance test, and any other tests as instructed by the Supervising Engineer.

Electrical wiring continuity testing

All wiring system shall be tested for continuity of circuits, short circuits and earthing after wiring is completed and before energizing.

Electrical insulation resistance testing

The insulation resistance shall be measured across earth and the whole system of conductors, or any section thereof, with all fuses in place and all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together.

A direct current pressure of not less than twice the working pressure provided that it does not exceed 660 V for medium voltage circuits. Where the supply is divided from AC three phase systems, the neutral pole of which is connected to earth, either direct or through added

resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

The insulation resistance measured as above shall not be less than 50 mega ohms divided by the number of points on the circuit provided that the whole installation shall not be required to have an insulation resistance greater than one mega ohm.

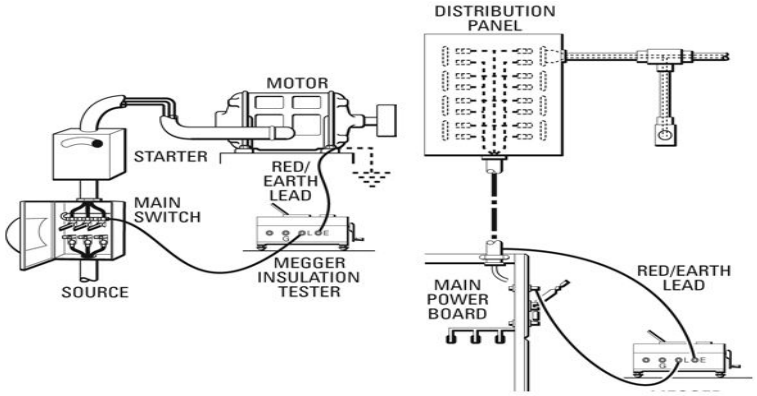


Figure 106:Insulation Megger testing of machine to panel board

The insulation resistance shall also be measured between all conductors connected to one phase conductor of the supply and all the conductors connected to the middle wire to the neutral or to the other phase conductors to the supply. Such a test shall be carried out after removing all metallic connections between the two poles of the installation and in these circumstances the insulation shall not be less than that specified above.

The insulation resistance between the case or frame work of housing and power appliances, and all live parts of each appliance shall not be less than that specified in the relevant British standard specification or where there is no such specification shall not be less than a mega ohm.

Electrical earth continuity path testing

The earth continuity conductor metallic envelops of cables, shall be tested for electric continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

Electrical testing of non-linked single pole switches

In a two wire installation a test shall be made to verify that all non-linked single pole switches have been fitted in the same conductor throughout, and such conductor shall be labeled or

marked for connection, throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or non-earthed conductor a test shall be made three or four wire installation a test shall be made to verify that every non linked single pole switch is fitted in a conductor to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Supervising engineer as well as the local authorities.

Electrical earth resistivity testing

Earth resistivity test shall be carried out in accordance with British Standard Code of Practice of Earthing. All tests shall be carried out in the presence of the Supervising Engineer.

Electrical performance testing

The complete electrical installation and equipment shall be subject to the final performance test as intended for each and every equipment shall be tested as per the manufacturer's instructions.

Maintenance of tools

When it comes to home improvement tools, regular maintenance tools are mandatory. Only a high-quality tool ensures excellent results and longevity.

As a passionate craftsman, you should know the essential tips about the maintenance of tools and equipment. Machine *maintenance tools* suffer a lot of wear and tear due to regular use.

If you don't do proper maintenance, it may result in machine breakdown and damage. With the proper handling and maintenance, you may reduce any risks. That is why you should do a regular check-up of your machine tools.

Basic Tips about Maintenance Tools and Equipment

Clean the Tools Regularly.

Whenever you use any tools for your projects, make sure to clean them immediately. The next day, you'll notice there is a layer of dirt that may lead to rust.

That's why you should clean the tools after use. You don't need to use chemicals every time, sometimes wiping is good enough.

Lubricate the Tools.

Machine tools include moving parts that require lubrication to work smoothly. Check the details daily, whether they are properly lubricated.

Please read the instruction in case of power tools as it requires an adequate level of oil

Sharpen the Essential Parts.

Some equipment is used for cutting and slicing, such as blade, drill bits, and lathe tools. You'll need to check whether it is sharp or not.

If these tools are not sharp enough, it may result in serious injuries.

Check the Function of the Tools.
You should check the functions of the tools for any damage or fault. Scrutinize each part.
If any faulty functioning is found, then immediately repair them.
Check Machines Tools, Alignments.
Most of the time, the machine works with fault due to improper alignment. Improper alignment also affects the tools in a negative way.
So, you should check the arrangement every time you intend to use the tool.
To ensure proper alignment, you may want to perform a few test tasks. If it is working well, that means the machine is all set.

Store with Care.
Proper storing also enhances the lifetime of any machine tools. Moisture and air is the reason for rust over the metal surface of the devices.
You will need to keep the tools in a place that is dry and clean.
If the tools are extensive, keep it in a tight closing garage or dry basement or insulated rooms.
Conversely, store the small tools in an air-tight box. Make sure to cover the device and inspect them regularly.

Care for Electrical Cords and Batteries.
The cable wires in some tools are prone to damage. Power tools like circular saw or drill may cut the wires accidentally. That's why you should keep them protected. You may want to use purpose-built ramps or industrial-strength casing. If the tool is battery operated, inspect the battery from time to time. Don't let sit it for long. Also, recharge it if needed.

Require Decent care of Parts and Accessories.
It truly is crucial to carry out regular maintenance checks. On each one of your accessories and components. A vitally significant part of perfect maintenance.
It is always to need to take specific most care of your tools accessories.
And parts have been managed and kept sensibly. You really don't desire to be more careless using almost any component of one's system application.
Good awareness plays a significant role. Use each one you sense to find prospective issues.
A strange noise, an odd scent or unordinary vibration may indicate a problem.
All items which may be easily cared for if discovered early.
Keeping a checklist and logging all of the upkeep completed will maximize the procedure.

Storage of tools
The proper care and storage of tools and equipment are not only the concern of the management but of the workers who use the equipment.

Importance of proper storage of tools and equipment

i. It is an important factor for safety and health as well as good business.
ii. Improves appearance of general-shop and construction areas.
iii. Reduces overall tool cost through maintenance.
iv. This also ensures that tools are in good repair at hand.
v. Teaches workers principles of (tool) accountability.

Points to consider in storing tools and equipment:

i. Have a designated place for each kind of tools.
ii. Label the storage cabinet or place correctly for immediate finding.
iii. Store them near the point of use.
iv. Wash and dry properly before storing.
v. Store knives properly when not in use with sharp edge down.
vi. Put frequently used items in conveniently accessible locations.
vii. Gather and secure electrical cords to prevent entanglement or snagging.
viii. Cutting boards should be stored vertically to avoid moisture collection.
ix. Metal equipment can be stacked on one another after drying such as storage dishes and
bowls.
x. Make sure the areas where you are storing the equipment are clean, dry and not overcrowded.

Good housekeeping

Effective housekeeping can help control or eliminate workplace hazards. Poor housekeeping practices frequently contribute to incidents. If the sight of paper, debris, clutter and spills is accepted as normal, then other more serious hazards may be taken for granted.

Housekeeping is not just cleanliness. It includes keeping work areas neat and orderly, maintaining halls and floors free of slip and trip hazards, and removing of waste materials (e.g., paper, cardboard) and other fire hazards from work areas. It also requires paying attention to important details such as the layout of the whole workplace, aisle marking, the adequacy of storage facilities, and maintenance. Good housekeeping is also a basic part of incident and fire prevention.

Effective housekeeping is an on-going operation: it is not a one-time or hit-and-miss clean-up done occasionally. Periodic "panic" clean-ups are costly and ineffective in reducing incidents.

Purpose of workplace housekeeping

Poor housekeeping can be a cause of incidents, such as:

- Tripping over loose objects on floors, stairs and platforms

- Being hit by falling objects
- Slipping on greasy, wet or dirty surfaces
- Striking against projecting, poorly stacked items or misplaced material
- Cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping

To avoid these hazards, a workplace must "maintain" order throughout a workday. Although this effort requires a great deal of management and planning, the benefits are many.

Benefits of good housekeeping practices
Effective housekeeping results in:

- Reduced handling to ease the flow of materials
- Fewer tripping and slipping incidents in clutter-free and spill-free work areas
- Decreased fire hazards
- Lower worker exposures to hazardous products (e.g. Dusts, vapours)
- Better control of tools and materials, including inventory and supplies
- More efficient equipment clean-up and maintenance
- Better hygienic conditions leading to improved health
- More effective use of space
- Reduced property damage by improving preventive maintenance
- Less janitorial work
- Improved morale
- Improved productivity (tools and materials will be easy to find)

Good housekeeping program
A good housekeeping program plans and manages the orderly storage and movement of materials from point of entry to exit. It includes a material flow plan to ensure minimal handling. The plan also makes sure that work areas are not used as storage areas by having workers move materials to and from work areas as needed. Part of the plan could include investing in extra bins and more frequent disposal.

The costs of this investment could be offset by the elimination of repeated handling of the same material and more effective use of the workers' time. Often, ineffective or insufficient storage planning results in materials being handled many times and being stored in hazardous ways. Knowing the workplace layout and the movement of materials throughout it will help when planning work procedures.

Worker training is an essential part of any good housekeeping program. Workers need to know how to work safely with the products they use. They also need to know how to protect other

workers such as by posting signs (e.g., "Wet - Slippery Floor") and reporting any unusual conditions.

Housekeeping order is "maintained" not "achieved." Cleaning and organization must be done regularly, not just at the end of the shift. Integrating housekeeping into jobs can help ensure this is done. A good housekeeping program identifies and assigns responsibilities for the following:

- Clean up during the shift
- Day-to-day cleanup
- Waste disposal
- Removal of unused materials
- Inspection to ensure cleanup is complete

Do not forget out-of-the-way places such as shelves, basements, sheds, and boiler rooms that would otherwise be overlooked.

The final step to any housekeeping program is inspection. It is the only way to check for deficiencies in the program so that changes can be made. Examples of checklists include inspecting offices and manufacturing facilities.

Documentation and reporting

Documentation is about documents, which communicate information. Those documents provide information for and about a certain object, process or topic. Documentation can be published in digital (CD, DVD, disc, memory stick, download, as a web site,) or in analogue (book, paper, poster, photo.) form. Furthermore, digital documentation can be presented in an interactive manner, which increases ease of use. Examples for interactive features are, among others, cross references, search, tip-of-the-day features, contextual information, wizards or knowledge-based help systems.

Another important characteristic of documentation is the level of detail. There may exist several documents describing the same aspect, but are intended for a different audience (with varying domain knowledge) and thus serve a different purpose. Software system underlies continuous changes throughout their whole life cycle. As a consequence, also the amount of information grows continually. For international software systems, the documentation has to be available in multiple languages. All these aspects contribute to the problems of documentation: Keeping up with changes during the development, propagating changes in requirements documents, design documents to the development and keeping documents on the desired level of quality

Learning Activities

KENM is a fashion industry in Taita Taveta County. An electrical shock occurs in one of its production lines. As the industry lead installation technician lead your team in carrying out the following tests to identify the root cause of the problem

- ❖ Continuity test
- ❖ Insulation resistance tester
- ❖ Earth loop impedance
- ❖ Polarity test

Self-Assessment

1. What Happens if a Fluorescent Bulb Breaks?
2. Do I Need an Electrician to Install Under Cabinet Lights?
3. How is continuity test performed?
4. How is measurement of earth resistance carried out using earth tester?
5. Show how does a Ring circuit work?

Tools, Equipment, Supplies and Materials

- ❖ Multimeter/AVO meter
- ❖ Wattmeter
- ❖ Insulation resistance tester
- ❖ Loop impedance tester
- ❖ Earth resistance tester
- ❖ Clamp meter
- ❖ Power quality analyser
- ❖ Infrared camera
- ❖ Phase sequence meter
- ❖ Frequency meter
- ❖ Synchroscope
- ❖ Tachometer
- ❖ Tacho generator
- ❖ Laser meter
- ❖ Lux meter

References

i. https://homeguides.sfgate.com/identify-antique-lighting-fixtures-20282.html
ii. https://www.wrightlighting.com/blog/2014/10/different-types-of-lighting-fixtures/
iii. https://www.pickamachine.com/maintenance-tools-and-equipment/
iv. https://www.assemblymag.com/articles/83099-wire-termination-uses-and-methods

v. https://www.facebook.com/permalink.php?id=478424296051998&story_fbid=479078152653279
vi. https://www.ccohs.ca/oshanswers/hsprograms/house.html
vii. Mario Gastegger and Simon Zünd, Maintenance of technical and user documentation, 2015

Answers to self-assessment test

1. Older fluorescent bulbs have mercury gas contained within them. If the bulb breaks, leave the area and wait for the gas to dissipate. The newer CFL fluorescent bulbs have very little mercury gas and are not harmful. Your local home improvement center will likely have a free collection box for you to drop off old or used bulbs.
2. Under cabinet lights can be installed by the homeowner if you follow the instructions and take all of the appropriate precautions during the installation process. If you are not comfortable working with electricity, then absolutely hire a professional.
3. A continuity test is performed by placing a small voltage (wired in series with an LED or noise-producing component such as a piezoelectric speaker) across the chosen path. If electron flow is inhibited by broken conductors, damaged components, or excessive resistance, the circuit is "open".
4. Earth resistivity is usually measured using the Wenner method, which involves the use of four temporary earth spikes. The spikes do not need to be moved as part of the testing procedure however – their location and spacing is determined by the depth at which it is required to determine the earth resistivity.
5. The power sockets in a house are connected by means of a ring circuit. In a ring circuit the live, neutral and earth wires form a loop of cable going from the consumer unit to all of the sockets in turn and then back to the consumer unit. The live wire carries current to the house/appliance at a high voltage.

3.3.Perform basic repair and maintenance of installation and appliances

Introduction to the learning outcome

An appliance installation and repair program gives students the skills necessary to service, repair and install any commercial or consumer electric, gas or microwave appliance.

Performance Standard

1. Repair and maintenance
2. Identification, selection and application of maintenance tools and equipment.
3. Perform repair on the appliance in line with the manufacture’s manual.
4. Maintain the installation and appliances in line with the set standards

5. Manufacture's manual use in fault identification and appliances repair process
6. Standards in appliances and installation maintenance and repair process

Information Sheet

Meaning of repair and maintenance

Maintenance and Repair means activities relating to the maintenance and repair of electrical installations in accordance with and to the standard from time to time prescribed by by-law policy.

The maintenance and repairing of the electrical appliances are crucial for avoiding any disturbance or obstacle during work routine and also to prevent oneself and assets from any catastrophe.

Maintenance does not mean to wait for the time when the equipment or appliance goes out of functioning and display fault in its performance. The electronic equipment at home or at workplace demands maintenance by systematic and proper use and so it is a task to be performed on a regular basis. Improper use of appliances can disturb the functioning of the appliances.

Purpose and reasons of repair and maintenance

Electrical components are some of the most intricate and complex systems in existence. Proper training is required to repair, troubleshoot and maintain systems and equipment that supplies electricity to industrial and commercial buildings. While electrical maintenance can be done by the owner or manager of the building, it's better if it's handled by someone who has completed electrical maintenance training and is suitably qualified to do the job.

Electrical issues are known to kill, injure, and cause property destruction if not maintained properly. The necessity for periodic inspection is noted in various regulations that deal with safety at work and home. One of the best things to do is to hire an expert to conduct a visual inspection periodically for all electrical installations at your home or office.

Reasons to conduct periodic electrical maintenance:

i. Test the reliability and proper functioning of installed electrical equipment.
ii. Protective measures for safety.
iii. Taking care of defects that may be dangerous.
iv. Protection against damage to property by fire.
v. It may be a requirement for securing compensation from the insurance company in case of property damage due to fire.

Fault identification

In an electric power system, a fault or fault current is any abnormal electric current. For example, a short circuit is a fault in which current bypasses the normal load. An open-circuit

fault occurs if a circuit is interrupted by some failure. In three-phase systems, a fault may involve one or more phases and ground, or may occur only between phases. In a "ground fault" or "earth fault", current flows into the earth.

Finding Electrical Faults

At times, **finding electrical faults** is hard**.** Electrical faults cause some faults or defects and therefore necessitate electrical troubleshooting. When tracing and rectifying the faults, you have to keep in mind that there are the electrical problems can arise due to one of the following three causes.

Open circuit

An open circuit occurs when a connection breaks. To test such a problem, you will have to use the continuity test.

Short circuit

Any closed connection is known as a short circuit. Such a connection causes flow of excess current in the circuit and damages the electrical components. A short circuit problem mostly arises due to damaged/weak insulation that you can detect with the insulation test. To troubleshoot a short circuit, check channel resistance, the potential difference between at least two points and the flow of current. Check the input voltage and check the total voltage at various test points on the PCB. Ensure that every protection device is operating in properly.

Typically, an electrical circuit features two main components: control circuit and the power circuit. Therefore, you will have to start by ensuring that:

- The input voltage exists
- The protection devices are functioning properly
- Channel resistance is normal
- Every component is not physically damaged due to excess heat

For the control circuit, ensure that:

- The input voltage to the control circuit is right,
- The switches, relays and timers are healthy,
- The cable has continuity,
- The contact switches are functioning logically and
- The timing of your switching circuit is right

The continuity tests

You can check the continuity of your circuit in two ways: the dead continuity and the power on continuity. The dead continuity testing requires you to switch off the power to reduce the risk of a shock. When conducting an insulation test, you will have to switch off the power too.

To check for the circuit continuity when the power is off, you will millimeter the multi-meter knob on beep sound. The beep will confirm that the electrical path is complete. If the path is broken, you should not expect a beep.

IEE regulations on fault identification, maintenance and repair process

The study of a proposed electrical installation requires an adequate understanding of all governing rules and regulations.

Low-voltage installations are governed by a number of regulatory and advisory texts, which may be classified as follows:

- Statutory regulations (decrees, factory acts, etc.)
- Codes of practice, regulations issued by professional institutions, job specifications
- National and international standards for installations
- National and international standards for products

Meaning of fault identification

Electrical powers system is growing in size and complexity in all sectors such as generation, transmission, distribution and load systems. Types of faults like short circuit condition in power system network results in severe economic losses and reduces the reliability of the electrical system.

Electrical fault is an abnormal condition, caused by equipment failures such as transformers and rotating machines, human errors and environmental conditions. Theses faults cause interruption to electric flows, equipment damages and even cause death of humans, birds and animals.

Manufacture's manual use in fault identification and appliances repair process

Your equipment owner's manual may not sound like interesting reading material, but taking some time to review this information can potentially save you time and money. These manuals, which are commonly stored in glove compartments and are often available on manufacturers' websites, contain important information and instructions regarding your equipment's maintenance and service needs. Following these maintenance and service guidelines will help to ensure the longevity and reliability of your equipment

Here are the top 5 reasons you should read your owner's manual:

- Maintenance Schedule

- ❖ Maintaining your equipment is important. Educate yourself on what services your equipment needs and when they are recommended. If your electrician recommends that your equipment be serviced, ask why the service is needed and if it is recommended by the manufacturer. If you are still unsure why a service is required or how it will benefit your equipment or machine, don't feel pressured to agree to the service until you can do some research. Additionally, be sure to keep good records of all services done on your equipment. Many manuals include helpful logs to record your service history and repair information.

Fluid Requirements

In addition to knowing how often to service your equipment, it's also a good idea to know what types of other services your equipment requires and when they should it be done.

Setup Helpful Reminders

It can be difficult to remember when your equipment's parts needs to be changed.

Warranty Information

Before agreeing to any repairs on your equipment or machine, consult your owner's manual for any parts or repairs that may be covered under your equipment's or machine's warranty. Also, pay close attention to any products that are not recommended by the manufacturer and any services that may void your warranty if performed.

Standards in appliances and installation maintenance and repair process

This information sheet contains specific advice about some of the ways of avoiding injury during the servicing and repair of domestic appliances such as washing machines, dryers, refrigerators/freezers, cooking equipment etc., normally operating from a 230-volt supply.

How can injuries happen during testing?

The most significant danger to people carrying out electrical testing work is that they might suffer an electric shock. Any simultaneous contact of a part of the body with a conductor that is live at a dangerous voltage, e.g., one that is connected to the mains supply while another part of the body is connected to an earth, will result in an electric shock. There is also a risk of burn injuries resulting from arcing when conductors are accidentally short-circuited.
An electric shock can lead to serious injury, sometimes fatal. Injuries can also occur when a person reacts to an electric shock, for example by falling or touching another hazard. Factors which are likely to increase the risk of receiving an electric shock include the following:

a) The majority of domestic appliances have large areas of earthed metal that may be easily touched. Touching exposed live conductors connected to the mains supply at the same time as touching the earthed metalwork will result in an electric shock;

b) Some appliances could also be using water in their operation, such as washing machines or dishwashers. This may lead to an increased risk of shock because water can conduct electricity and reduces the resistance of the skin;

c) When working on microwave ovens there may be a risk of severe electric shock from the internally generated high voltage (approximately 4kV);

d) Work may be carried out in the customer's home, so people other than those doing the work (including children) may also be at risk;

e) Additional risks may be present at the customer's premises if their electrical installation is not electrically sound, e.g., earthing, insulation resistance, polarity.

Learning Activities

During the course working in the production factory, the lighting in the office of the production manager goes off while lights remain in the other rooms. Carry out the following steps to locate the fault.

- Collect the Evidence
- Analyze the Evidence
- Locate the Fault
- Determination and Removal of the Cause
- Rectification of the Fault
- Check the System

Self-Assessment

1. What are the components of lighting systems?
2. What are the goals of lighting maintenance?
3. What are common preventative maintenance schedules and checklists for lighting?
4. Mention what are the challenges that maintenance and repair work usually face?
5. What is the potential risk that repair and maintenance work usually face?

Tools, Equipment, Supplies and Materials

- Multimeter/AVO meter
- Wattmeter
- Insulation resistance tester
- Loop impedance tester
- Earth resistance tester
- Clamp meter
- Power quality analyser

- ❖ Infrared camera
- ❖ Phase sequence meter
- ❖ Frequency meter
- ❖ Synchroscope
- ❖ Tachometer
- ❖ Tacho generator
- ❖ Laser meter
- ❖ Lux meter

References

i. **https://www.onewayelectrical.co.uk/electrical-maintenance-necessary/**
ii. https://www.tcd.ie/eleceng/safetystatement/Electrical/eis35.pdf

Answers to self-assessment test

1. Among the items you'll need to factor into your PM scheduling are the following:
   - ❖ Lamps or bulbs, including fluorescent, incandescent, and LEDs
   - ❖ Ballasts, which control power and brightness
   - ❖ Housing, used to protect and shield the lamp
   - ❖ Lighting control, such as switches, dimmers, occupancy sensors, and timers

   Each of these will need cleaning, check-ups, or replacement every so often in order to keep working optimally.

2. Typically, most lighting systems are designed to provide more lighting than is actually necessary. The reason for this is because lamps lose brightness over time.

   - ❖ A solid preventive maintenance plan can slow light loss, meaning there's less necessity to overdesign the system. That translates into savings on initial installation as well as lower energy costs over time. Given how about 20% of money spent on electricity in the U.S. goes toward lighting, those savings can be significant.

   In addition to reducing the costs of lighting overdesign, preventive lighting maintenance also aims to improve the following:

   - ❖ Energy efficiency overall
   - ❖ Addressing design issues
   - ❖ Safety and security
   - ❖ Aesthetic appeal

3. A common checklist used for lighting preventive maintenance is the one the U.S. Department of Energy outlines (provided below). That said, the items on your checklist will depend on the following:

   - ❖ What components are you responsible for?
   - ❖ Are there specific goals you are trying to achieve?
   - ❖ What are your capabilities in terms of tools, equipment, procedures?

4. The challenges are:
   - ❖ Unusual working condition like bad weather or low temperature
   - ❖ May have to work in an unusual shift
   - ❖ May have to work in a messy area
   - ❖ May sometimes be physically distressing and exhausting
   - ❖ May have to work in dangerous places like working at height or working with electrical appliances and wires

5. The potential risk that repairs and maintenance worker faces are

- ❖ Faulty electrical: Risk of electrocuted always remains with repair and maintenance workers, if not equipped with electric-proof tools and attires. They are prone to burns, shocks, etc.

- ❖ Lifting equipment: Workers usually have to deal with heavy metal objects and lifting equipment is not inspected or maintained then they are at risk of a fatal accident

- ❖ Maintenance of working and walking surfaces: Slippery working surfaces, sharp tools and nails scattered on working surface, slip and trip, uneven and potholed are some potential hazards that may cause an accident

- ❖ Dust: Its potential risk for the workers specially working in woodworking or iron industries.