Building Electrical Installation

Level-III

Based on November 2018, Version 5

Occupational standards

Module Title: - Inspecting and Commission Electrical Installation

LG Code: EIS BEI3 M12 LO (1-3) LG (42-44)

TTLM Code: EIS BEI3 TTLM 1220v1

December 2020

Table of Contents

LG #42	LO#1- Plan and prepare to commission electrical system

Instruction sheet

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

- understanding Work instructions
- Obtaining Materials and PPE to complete job requirements
- Tools, equipment and testing devices needed for commissioning procedures

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- understand Work instructions
- Obtain Materials to complete job requirements
- Obtain PPE to complete job requirements
- Use tools needed for commissioning procedures
- Use equipment needed for commissioning procedures
- Use testing devices needed for commissioning procedures

Learning Instructions:

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

Information Sheet 1- Understanding Work instructions

1.1 Work Instructions

Work Instructions are documents that clearly and precisely describe the correct way to perform certain tasks that may cause inconvenience or damage if not done in the established manner. That is, describe, dictate or stipulate the steps that must be followed to correctly perform any specific activity or work

What are standard work instructions?

Standardized Work Instructions (SWI) are instructions designed to ensure that your manufacturing processes are consistent, timely and repeatable. Often the standard work instructions are printed and posted near the operator's work station. The idea is that team leaders and managers should follow up if the operators uses and can use the instruction – which is something the hardest thing in the whole process.

It takes time and effort to produce the SWI. They should state the optimal steps to perform a process. Standard work instructions are a logical outcome from other process improvement initiatives. They are also helpful in later process improvement projects. Without the SWI, the operators and their supervisors must rely on collective memory to continue performing a process in an optimal fashion. SWI do not replace initial training, but they do reinforce what had been learned. The operator may be insulted from seeing the instructions every day of his (or her) working life. These instructions are truly to benefit the supervisor, who can quickly see discrepancies between the operator's actions and the posted instructions.

It is important to regularly review and update the SWI for each task. An organization using the kaizen approach of continuous improvement will create better ways of doing tasks. One aspect of implementing these improvements is by updating the SWI. In real

life, instructions get old the same moment that they were created so they need to be continuously improved.

What are standard operating procedures?

Standard Operating Procedures (SOP) are written, step-by-step instructions that describe how to perform a routine activity. An SOP is a procedure specific to an operation that describes the activities necessary to complete tasks in accordance with industry regulations, provincial laws or even just your own standards for running your business. Any document that is a “how to” falls into the category of procedures. Employees should complete them in the exact same way every time so that the business can remain consistent. Standard operating procedures help maintain safety and efficiency for departments such as production, operations, sales and customer service, employee training, legal, financial.

A standing operating procedure should never be difficult to read or vaguely worded. It should be brief, easy to understand and contain actions steps that are simple follow. A good standard operating procedure should clearly outline the steps and inform the employee of any safety concerns.

SOPs are integral parts of quality control and risk reduction. From aerospace manufacturing to pharmaceutical production and customer service practices, good SOPs are more than bureaucratic red tape. These written documents present standardized recipes for who, what, when, and where procedures should occur. And if SOPs are poorly written or implemented, consequences can be dire. The standing operating procedures should be the basis for training any new employees. They should also be updated every year to ensure they stay relevant to the current needs of the organization.

Self-check1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

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

_____ 1. Documents that clearly and precisely describe the correct way to perform certain tasks

A. Work Instructions C. Standard Operating Procedures

B. Commission D.None

_____ 2. Step-by-step instructions that describe how to perform a routine activity.

A. Work Instructions C. Standard Operating Procedures

B. Commission D.None

Score = _____

Rating: _____

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

Information Sheet 2- Planning Commissioning procedures

2.1 Planning Commissioning procedures

Commission: - the name of a service provided to validate the completeness and accuracy of a project or venture or business enterprise. An official charge or authority to do something, a sending or mission or to do or accomplish something, charge, payment, fee, cut, costs, expenses, hire, and order

Commissioning: - the process (a series of events to produce a result) of assuring that all systems and components of a major pieces of Equipment, a process, a building or similar are designed, installed and tested according to the operational requirements of the owner final client or costumer.

The commissioning of the electrical and mechanical systems within an electrical equipment/ system is a part of the 'handing-over' process of the new electrical installation/ electrical equipment installation by the electrician and main contractor to the client or customer in readiness for its occupation and intended use. To 'commission' means to give authority to someone to check that everything is in working order. If it is out of commission, it is not in working order.

Following the completion, inspection and testing of the new electrical installation/ equipment installation, the functional operation of all the electrical systems must be tested before they are handed over to the customer. It is during the commissioning period that any design or equipment failures become apparent, and this testing is one of the few quality controls possible on an electrical equipment/system services installation.

This is the role of the commissioning Person, who must assure himself that all the systems are in working order and that they work as they were designed to work. He must also instruct the client's representative, or the staff who will use the equipment, in the correct operation of the systems, as part of the handover arrangements.

A commissioning plan is a document used to outline the scope and define the responsibilities of the commissioning process as well as the activities, schedules and documentation required. It is part of the commissioning management process, intended to ensure the client receives an efficient, fully functioning building by the planned occupancy date. An effective commissioning plan can help ensure handover to the client is smoother and less troubleshooting and fine tuning is required.

The best commissioning process is one that is planned from the project's very inception. Designing in the ability to commission systems properly from the outset can provide huge benefits, especially on cost and performance.

The commissioning plan should be started early, and populated with detail as it becomes available. This approach calls on project professionals to plan, reality-check as they go along, prepare fully for handover, and follow through after occupation to fine-tune and resolve issues as they emerge.

The Purpose of a Commissioning Plan

The general purpose of a commissioning plan is to give direction for the entire construction process. It basically acts as a road map for entire construction team. It lays out roles and responsibilities of individuals and teams, includes lines of communication and reporting, provides a resolution process for issues, and provides overall coordination. Included in a commissioning plan are:

1. **General Building Information.** This section of the commissioning plan lays out the basic information detailing the project, including the project name, address, building type, building description, owner agency, and scheduled completion date.
2. **The Commissioning Scope.** This section of the plan will document the official equipment checks for the building project. These systems will need to be commissioned in any general construction project: HVAC system, electrical system, and any other systems and equipment.
3. **Commissioning Team Information.** The plan will include documentation of every person and company involved in the construction process. Information includes: the owner, project manager, commissioning provider, mechanical engineer, electrical engineer, general contractor, etc.

4. **Project Schedule.** This section includes the entire project schedule, from initial design to the final commissioning report.
5. **Roles and Responsibilities.** This section of the plan will lay out each of the roles of the teams and their descriptions. This will include every role listed in the Team Information section, followed by a detailed description of each team's role and how that role in the construction project.
6. **General Management Plan and Protocols.** Every project needs specified protocols for handling various situations, because protocols ensure the project runs more smoothly. For example, this section of the commissioning plan will include the protocol for requesting information (RFI) or for requesting formal documentation during the construction process.

Commissioning procedure

Commissioning shall be executed by guidance of a detailed commissioning procedure describing:

- **Objective**; Details the operating parameters to be achieved.
- **Description**; Shall contain a brief description of the system/sub systems to be commissioned, including marked up P&ID or other relevant drawings as a basis for all functions to be tested.
- **Lists of temporary equipment and consumables**; Lists all consumables, temporary equipment tools and requirements for supplier's assistance.
- **Health/Environment/Safety**; A list of all toxic and polluting fluids and materials shall be made, describing their handling and disposal. A checklist of all required safety precautions including requirements for work permit shall be made. Prior to energization of electrical equipment a livening up notice shall be issued in order to inform all involved parties of forthcoming energizing.
- **Preservation**; Requirements for removal of existing preservatives/protection shall be made and subsequent new preservation of the system if the system shall be out of operation for a period
- **Scope**; the scope shall detail the work to be done step by step including the commissioning preparation, check records (ref. Annex "B").Irregularities and/or

faults shall be logged. Equipment supplier's start-up procedures shall be incorporated.

- **Planning**; detailed commissioning plans for system/sub system/commissioning package shall be worked out and shall include man-hours per discipline, including supplier assistance man-hours.
- **Hand over**; the handover shall contain a certificate and other documents agreed with operation

2.2 Insulation resistance

The insulation resistance (IR) test is the oldest and most widely used test for assessing the quality of insulation. Insulation Resistance Test is the second test required by the electrical safety testing standards. The Insulation Resistance Test consists in measuring the Insulation resistance of a device under test, while phase and neutral are short circuited together. The measured resistance has to be higher than the indicated limit from the international standards. A megohmmeter (also called insulation resistance tester, teraohmmeter) is used to measure the ohmic value of an insulator under a direct voltage of great stability.

Insulation cannot be perfect in the same way that something cannot be frictionless. This means that there will always be a little bit of current travelling through. This is known as “leakage current”. It’s acceptable with good insulation, but if the insulation deteriorates, leakage can start causing trouble. So what makes “good” insulation? Well, it needs a high resistance to current, and it needs to be able to sustain high resistance for a long time

Why Insulation Resistance Test is Done?

Insulation starts to age as soon as it’s made. As it ages, its insulating performance deteriorates. Any harsh installation environment, especially those with temperature extremes and/or chemical contamination, accelerates this process. This wear and tear can reduce the electrical resistivity of the insulating materials, thus increasing leakage currents that lead to incidents which may be serious in terms of both safety (people and property) and the costs of production stoppages. Thus it’s important to identify this

deterioration quickly so that corrective steps can be taken. In addition to the measurements carried out on new and reconditioned equipment during commissioning, regular insulation testing on installations and equipment helps to avoid such incidents through preventive maintenance. These tests detect ageing and premature deterioration of the insulating properties before they reach a level likely to cause the incidents described above.

This test is often used as a customer acceptance test, with minimum insulation resistance per unit length often specified by the customer. The results obtained from IR Test are not intended to be useful in finding localized defects in the insulation as in a true HIPOT test, but rather give information on the quality of the bulk material used as the insulation. Wire and cable manufacturers use the insulation resistance test to track their insulation manufacturing processes, and spot developing problems before process variables drift outside of allowed limit.

Why is a Multimeter Not used for Measuring Insulation Resistance?

Although there is a degree of similarity between a multimeter and megger, the insulation resistance is measured using a Megger (or a similar device), because it's able to generate a high voltage that creates a moment of stress in the insulation. Insulation resistance is calculated usually in Mega- or Tera-ohms.

In conclusion, a multimeter measures the electrical resistance of a conductor (coil), while a Megger measures the insulation resistance of an isolated group (two coils relative to mass), something that a multimeter is unable to do.

How is Insulation Resistance Measured?

Insulation resistance measurement is done using an IR tester. This is a portable tool that is more or less an ohmmeter with a built in generator that's used to produce a high DC voltage. The voltage usually measures at least 500V, and causes a current to flow around the surface of the insulation. This gives a reading of the IR in ohms.

Insulation resistance measurement is based on Ohm's Law. (R=V/I). By injecting a known DC voltage lower than the voltage for dielectric is testing and then measuring the current flowing, it is very simple to determine the value of the resistance. In principle, the value of the insulation resistance is very high but not infinite, so by measuring the low current flowing, the megohmmeter indicates the insulation resistance value, providing a result in kW, MW, GW and also TW (on some models). This resistance characterizes the quality of the insulation between two conductors and gives a good indication of the risks of leakage currents flowing.

Well, if we get a high number of IR, you have some good insulation. However, this is not everything – a variety of factors can affect the IR, including temperature and humidity. We will have to do a number of tests over time to make sure the IR value stays more or less the same. Value of insulation resistance is often expressed in gigaohms [GΩ].

A Good Insulation is when megger reading increases first then remains constant. Bad Insulation is when megger reading increases first and then decreases.

Expected IR value gets on Temp. 20 to 30 decree centigrade.If this temperature reduces by 10 degree centigrade, IR values will increased by two times. If above temperature increased by 70 degree centigrade IR values decreases by 700 times.

Types of Insulation Resistance Tests

1. **Short-Time or Spot-Reading Test**

In this method, we simply connect the Megger instrument across the insulation to be tested and operate it for a short, specific time period we will simply pick a point on a curve of increasing resistance values; quite often the value would be less for 30 seconds, more for 60 seconds.

If the apparatus we are testing has very small capacitance, such as a short run of house wiring, the spot reading test is all that is necessary. For many years, maintenance professionals have used the one-megohm rule to establish the allowable lower limit for insulation resistance. The rule may be stated: Insulation resistance should be

approximately one megohm for each 1,000 volts of operating voltage, with a minimum value of one megohm.

2. Time-Resistance Method

This method is fairly independent of temperature and often can give us conclusive information without records of past tests. It is based on the absorption effect of good insulation compared to that of moist or contaminated insulation. Tests by this method are sometimes referred to as absorption tests.

This test is of value also because it is independent of equipment size. The increase in resistance for clean and dry insulation occurs in the same manner whether a motor is large or small. We can, therefore, compare several equipment and establish standards for new ones, regardless of their ratings.

Factors Affecting Values of Insulation Resistance

- Capacitance Charging Current: Current that starts out high and drops after the insulation has been charged to full voltage (much like water flow in a garden hose when you first turn on the spigot).
- Absorption Current: Also an initially high current which then drops (for reasons discussed under the section Time-Resistance Method).
- Conduction or Leakage Current: A small essentially steady current both through and over the insulation.

Insulation Resistance should be done to prevent hazards such as electric shock and short-circuits caused when the insulation in electrical devices, parts, and equipment used in industrial plants, buildings, and other settings degrades over long periods of use.

2.3 Earth resistance test

The resistance offered by the earth electrode to the flow of current into the ground is known as the earth resistance or resistance to earth. The earth resistance mainly implies the resistance between the electrode and the point of zero potential.

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.

Ideally a ground should be of zero ohms resistance. There is not one standard ground resistance threshold that is recognized by all agencies. However, the NFPA and IEEE have recommended a ground resistance value of 5.0 ohms or less

The resistance offered by the earth electrode to the flow of current into the ground is known as the earth resistance or resistance to earth. The earth resistance mainly implies the resistance between the electrode and the point of zero potential.

2.3.1 Four Important Methods of Ground Resistance Testing

The ability to properly measure ground resistance is essential in preventing costly downtime due to service interruptions caused by poor grounds. The procedures for earth resistance testing are referenced in IEEE Standard No. 81. Four of the most common methods of ground resistance testing used by test technicians are discussed below:

2.3.1.1 2-point (dead earth) method

In areas where driving ground rods may be impractical, the two-point method can be used. With this method, the resistance of two electrodes in a series is measured by connecting the P1 and C1 terminals to the ground electrode under test; P2 and C2 connect to a separate all-metallic grounding point (like a water pipe or building steel).

The dead earth method is the simplest way to obtain a ground resistance reading but is not as accurate as the three-point method and should only be used as a last resort, it is most effective for quickly testing the connections and conductors between connection points

Note: The earth electrode under test must be far enough away from the secondary grounding point to be outside its sphere of influence to obtain an accurate reading The

two-point method is most effective for quickly testing the connections and conductors between connection points.

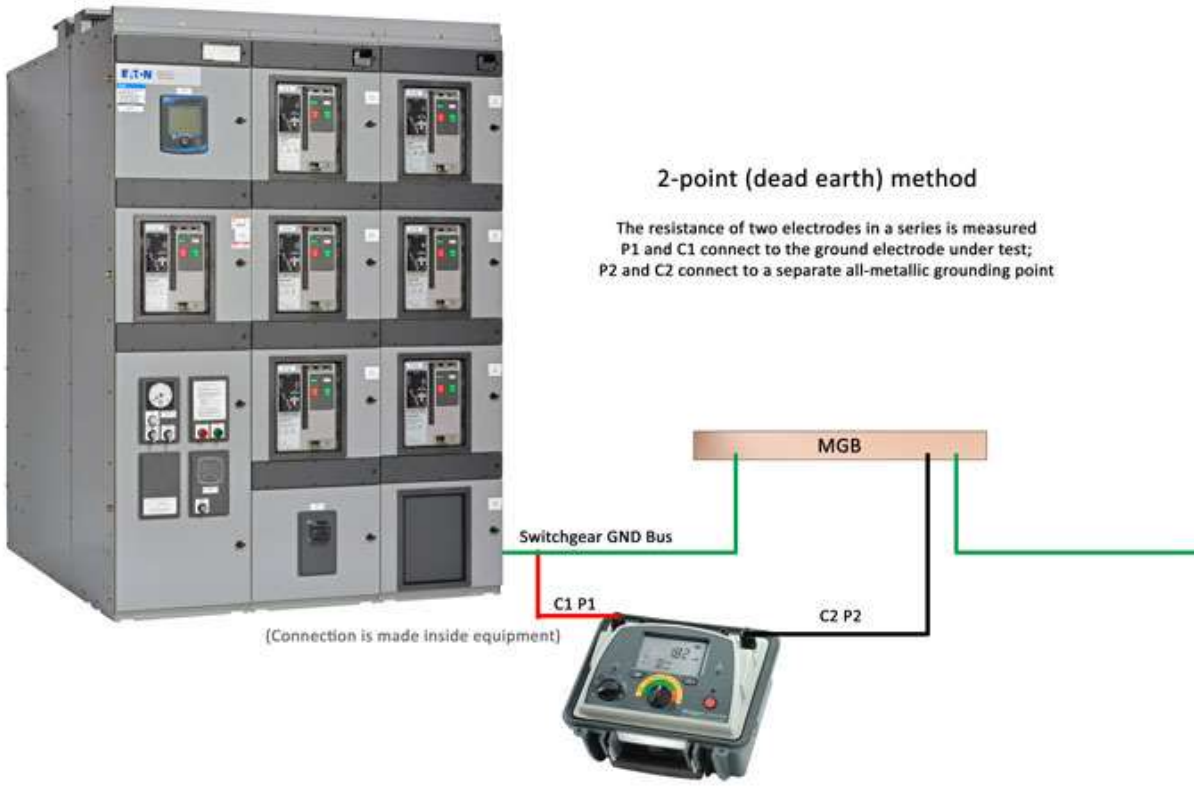

Fig.1 two-point method earth resistance

2.3.1.2 3-point (Fall-of-potential) method

The three-point method is the most thorough and reliable test method; used for measuring resistance to earth of an installed grounding electrode.

The standard used as a reference for fall-of-potential testing is IEEE Standard 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

With a four terminal tester, **P1 and C1** terminals on the instrument are jumpered and connected to the earth electrode under test while the **C2** reference rod is driven into the earth straight out as far from the electrode under test as possible. Potential

reference **P2** is then driven into the earth, at a set number of points, roughly on a straight line between C1 and C2. Resistance readings are logged for each P2 point.

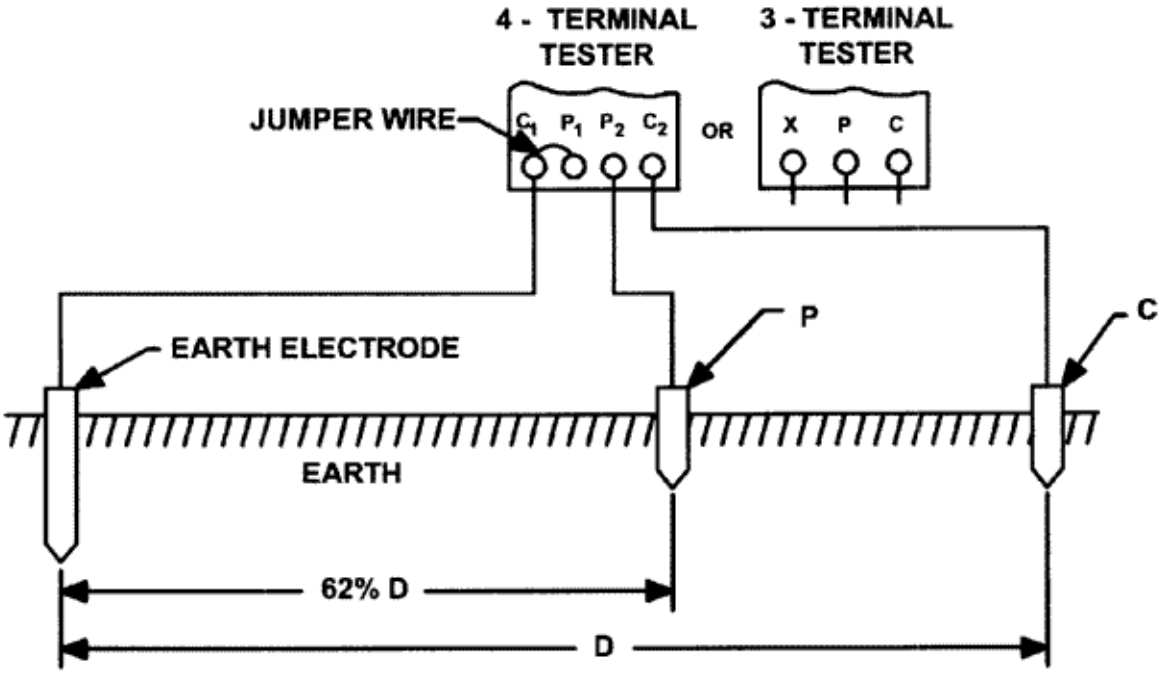

Fig.2 three-point method earth resistance

Fall-of-potential test method

Measurements are plotted on a curve of resistance vs. distance. Correct earth resistance is read from the curve for the distance that is roughly **62% of the total distance** between C1 and C2. There are three basic types of the fall-of-potential method:

- **Full fall-of-potential:** A number of tests are made a different spaces of P and a full resistance curve is plotted.
- **Simplified fall-of-potential:** Three measurements are made at defined distances of P and mathematical calculations are used to determine the resistance.

- **61.8 Rule:** A single measurement is made with P at distance 61.8% (62%) of the distance between C1 and C2.

Note: Fall-of-potential testing, and its modifications, is the only ground testing method that conforms to IEEE 81

2.3.1.3 4-point method

This method is the most commonly used for measuring **soil resistivity**, which is important for designing electrical grounding systems. In this method, four small-sized electrodes are driven into the earth at the same depth and equal distance apart - in a straight line - and a measurement is taken.

The amount of moisture and salt content of soil radically affects its resistivity. Soil resistivity measurements will also be affected by existing nearby grounded electrodes. Buried conductive objects in contact with the soil can invalidate readings if they are close enough to alter the test current flow pattern. This is particularly true for large or long objects. This is the most commonly used technique for soil resistivity measurement.

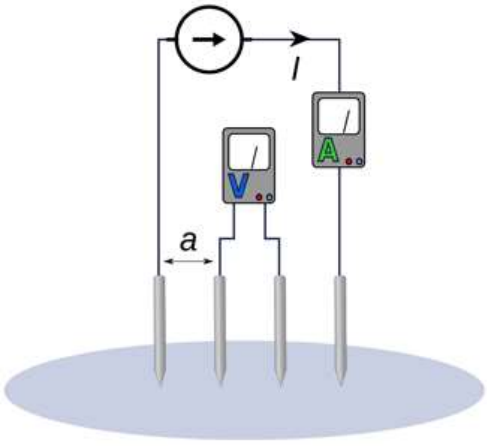

Fig.3 Four-point method earth resistance

2.3.1.4 Clamp-on method

The clamp on method is unique in that it offers the ability to measure resistance without disconnecting the ground system. It is quick, easy, and also includes the bond to ground and overall grounding connection resistances in its measurement.

Measurements are made by "clamping" the tester around the grounding electrode under test, similar to how you would measure current with a multi-meter current clamp.

The tester applies a known voltage without a direct electrical connection via a transmit coil and measures the current via a receive coil. The test is carried out at a high frequency to enable the transformers to be as small and practical as possible.

For the clamp-on method to be effective, there must be a complete grounding circuit in place. The tester measures the complete resistance path (loop) that the signal is taking. All elements of the loop are measured in series. It is important for the operator to understand the limitations of the test method so that he/she does not misuse the instrument and get erroneous or misleading readings. The clamp on method is unique in that it offers the ability to measure resistance without disconnecting the ground system Some limitations of the clamp-on method include:

1. Effective only in situations with multiple grounds in parallel.
2. Cannot be used on isolated grounds, not applicable for installation checks or commissioning new sites
3. Cannot be used if an alternate lower resistance return exists not involving the soil, such as with cellular towers or substations.
4. Results must be accepted on "faith.

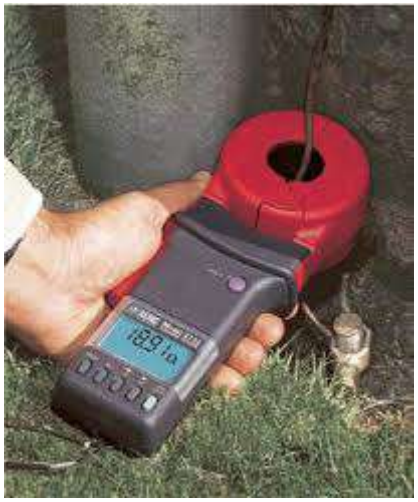

Fig.4 Clamp on method earth resistance

2.4 Phase sequence

In a three-phase system, the order in which the voltages attain their maximum positive value is called Phase Sequence. There are three voltages or EMFs in the three-phase system with the same magnitude, but the frequency is displaced by an angle of 120 deg electrically.

Taking an example, if the phases of any coil are named as R, Y, B then the Positive phase sequence will be RYB, YBR, BRY also called clockwise sequence and similarly the Negative phase sequence will be RBY, BYR, YRB respectively and known as an anti-clockwise sequence.

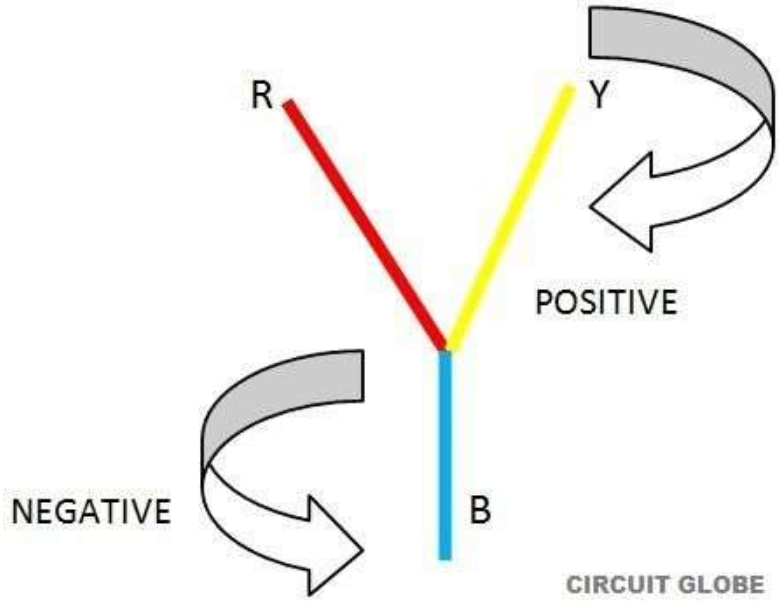

Fig.5 Phase Sequence for three Phase system

It is essential because of the following reasons:

1. The parallel operation of the three-phase transformer or alternator is only possible when its phase sequence is known.
2. The rotational direction of the three-phase induction motor depends upon its sequence of phase on three-phase supply. And thus to reverse its direction the phase sequence of the supply given to the motor has to be changed.

Self-Check–2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I: - chose and write the letter of the correct answer on the space provided or on the separate answer sheet (6pts**)**

_____1. A document used to outline the scope and define the responsibilities of the commissioning process

A. phase sequence
C. commissioning plan
B. insulation resistance
D. None

_____2. Order in which the voltages attain their maximum positive value

A. insulation resistance
C. Multimeter
B. phase sequence
D. commissioning plan

_____3. In the three-phase system with the same magnitude, how much is the displaced frequency angle

A. 90
C. 120
B. 180
D. 30

Score = _____

Rating: _____

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

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

Information Sheet 3- Obtaining Materials and PPE to complete job requirements

3.1 Materials necessary for commissioning work

3.1.1 commissioning aids

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

3.1.2 Blueprints and drawings

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

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

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

3.2 Personal Protective Equipment

PPE is defined as all equipment designed to be worn, or held, to protect against a risk to health and safety. This includes most types of protective clothing, and equipment such as eye, foot and head protection, safety Harnesses, life jackets and high visibility clothing. Under the Health and Safety at Work Act, employers must provide free of charge any personal protective equipment and employees must make full and proper use of it. Safety signs such as those shown at Fig. 6 are useful reminders of the type of PPE to be used in a particular area. The vulnerable parts of the body which may need protection are the head, eyes, ears, lungs, torso, hands and feet and, additionally, protection from falls may need to be considered. Objects falling from a height present the major hazard against which head protection is provided. Other hazards include striking the head against projections and hair becoming entangled in machinery. Typical methods of protection include helmets, light duty scalp protectors called ‘bump caps’ and hairnets. The eyes are very vulnerable to liquid splashes, flying particles and light emissions such as ultraviolet light, electric arcs and lasers. Types of eye protectors include safety spectacles, safety goggles and face shields. Screen based workstations are being used increasingly in industrial and commercial locations by all types of personnel. Working with VDUs (visual display units) can cause eye strain and fatigue. Noise is accepted as a problem in most industries and surprisingly there has been very little control legislation.

Fig. 6 Safety signs showing type of PPE to be worn.

Self-Check–3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.
Instruction I: - chose and write the letter of the correct answer on the space provided (4pts)

_____1. _____exact copies of Electrical or other types of drawings and employ a language of their own?

A. PPE
B. Blueprints
C. bump caps
D. None

_____2. Which one of the following is an eye protector?

A. safety goggles
B. face shields
C. safety spectacles
D. All

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

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

Score = _____

Rating: _____

Information Sheet 4- Tools, equipment and testing devices needed for commissioning procedures

4.1 Electrical Tools and Equipment

Electrical Tools

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

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

4.2 Electrical Testing equipment

Testing devices

1. **Multi-meters:-**It works like an ammeter; ohmmeter and voltmeter for it can measure current, voltage as well as resistance. A multi-meter or a multi-tester, also known as a VOM (Volt-Ohm meter or Volt-Ohm-mill ammeter), is an electronic measuring instrument that combines several measurement functions in one unit.
2. **Insulation resistance tester (meager):-**Megger is basically a DC generator operated manually and ammeter calibrated as kilo-ohm and mega ohm is generally used to measure the insulation. Megger has become the generic description for a high voltage, low current insulation tester.
3. **Clamp meters:-** Meters which measure high voltages or current may use non-contact attachment mechanism to trade accuracy for safety. Clamp meters provide a coil that clamps around a conductor in order to measure the current flowing through it.
4. **Wattmeter:-**The wattmeter is an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit.
5. **Test light:-**A test light, test lamp, or mains tester is a very simple piece of electronic test equipment used to determine the presence or absence of an electric voltage in a piece of equipment under test.
6. **Tachometer:-**Tachometer showing engine RPM (revolutions per minute), and a red-line from 6000 and 7000 RPM. A tachometer is an instrument that measures the rotation speed of a shaft or disk, as in a motor or other machine. The device usually displays the revolutions per minute (RPM) on a calibrated analog dial, but digital displays are increasingly common.

Self-Check–4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I: chose and write the letter of the correct answer on the space provided (6pts)

_____1. _____ device specifically designed to insert and tighten, or to loosen and remove?

A. Cutting tools
B. Wattmeter
C. Screw driver
D. Multi-meters

_____2. Multi-meters are used to____?

A. To measure current
B. To measure voltage
C. To measure resistance
D. All

_____3. What is an instrument for measuring the electric power?

A. wattmeter
B. Tachometer
C. Megger
D. None

Score = _____

Rating: _____

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

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

LG #43	LO #2- Commission electrical system

Instruction sheet

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

- Following Safety policies and procedures.
- Performing commissioning activities
- Attending unplanned events
- Undertaking ongoing checks of quality of work
- Responding unplanned events or conditions.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Follow Safety policies and procedures.
- Perform commissioning activities
- Attend unplanned events
- Undertake ongoing checks of quality of work
- Respond unplanned events or conditions.

Learning Instructions:

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

Information Sheet 1- Following Safety policies and procedures.

1.1 Electrical safety procedures

Electricity has become an essential part of our everyday life. It is used to power research equipment, office equipment, heating and cooling equipment, etc. Electricity can be dangerous, causing shocks, fires, explosions, or burns. Accidents involving electricity may cause minor injury or may result in serious disabling injuries or death. Electricity must be recognized and respected as a serious workplace hazard.

Most injuries involving electricity could have been prevented if unsafe equipment had been taken out of service or if unsafe work areas and work practices did not exist. To minimize the risk of injury from electrical sources, it is necessary to assure that electrical "sources" are properly insulated and grounded, that circuit-protecting devices are utilized, and that safe work practices are followed.

Safe working practices:

1. Electrical cords must be inspected for frays, cracks, exposed wires, and to ensure that the insulating jacket is intact. Check the plug and cord for defects, and replace or repair prior to further use.
2. Electrical cords must not come in contact with heat sources such as pipes or radiators, hazardous substances, or sharp objects and must not be run through water.
3. Equipment must not be placed where the electrical connection could be hit, tripped over, or walked on.
4. Extension cords shall not be used as a permanent source of wiring.
5. Electrical utility rooms containing circuit breakers shall not be blocked with equipment, clutter, etc. Equipment/articles should not be placed within three feet of a circuit breaker.
6. Employees should know the location of circuit breakers in their work area.

7. Circuit breaker switches must be identified as to the equipment controlled.
8. Multi-plug adaptors (inclusive of extension cords, cube adaptors, and strip plugs) must meet the following requirements:
    - Nationally recognized testing laboratory approval.
    - Insertion into a properly grounded outlet and not used in tandem or in conjunction with other adaptors.
    - Current breaker overload safety device and not exceed a maximum rating of 15 amps.
    - Protection from physical damage, not affixed to structures or extended through walls, ceilings, floors, under doors or floor coverings or be subject to any damage/impact.
    - No alterations in any manner.
9. De-energize electrical equipment before inspecting or making repairs. Prior to inspecting or repairing equipment, turn off the current at the switch box and lockout/tagout the system. Accidental or unexpected sudden starting of electrical equipment can cause severe injury or death.
10. Check the receptacle for missing or damaged parts. Do not plug equipment into defective receptacles.
11. When plugging in or unplugging power equipment, the power switch must always be in the OFF position.
12. Plugs must not be removed from outlets by yanking the cord.
13. Care must be taken when electrical equipment is used in areas where oxygen, flammable gases, or anesthetics are present. Sparks from electrical equipment can cause a fire or explosion.
14. Insulated tools are recommended when working near energized equipment.
15. When working with equipment that may pose an electrical hazard, wear the proper personal protective equipment, e.g., rubber, insulating gloves; hoods; sleeves; helmets; shoes; etc.
16. Prior to beginning a task that may involve an electrical hazard, be sure you are familiar with all safety procedures.

17. Supervisors are responsible for assuring that equipment such as radios, coffee pots, etc., meet the guidelines for proper grounding and other electrical safety standards.
18. In the event that a fellow employee receives an electric shock, turn off the current. Do not touch the victim until he or she can be separated from the current source. Use a nonconductive item such as a wooden broomstick

Self-Check–1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I: - write true if the statement is correct or write false if the statement is incorrect and write the answer on the space provided (6pts)

_____1. Plugs must be removed from outlets by yanking the cord.

_____2. Extension cords shall not be used as a permanent source of wiring.

_____ 3. Most injuries involving electricity could have been prevented if unsafe equipment had been taken.

Note: **Satisfactory rating - Greater than or equal to 4 points** **Unsatisfactory - below 2 points**

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

Answer Sheet

Score = _____

Rating: _____

Information Sheet 2- Performing commissioning activities

2.2 Performing commissioning activities

Commissioning is the process of testing a facility, plant or specific piece of equipment when it is almost finished being built to make sure it functions properly. Therefore, commissioning engineers need to have a thorough knowledge of manufacturing in order to test whether a piece of machinery or production plant functions correctly and according to the specifications of the customer.

Commissioning is the systematic process by which a piece of equipment, system, or facility is tested to verify that it functions in accordance with the design intent and owner's operational requirements.

The objective of the commissioning process in a new building project is to ensure all building systems perform optimally, according to their design intent and the building owner's requirements. Laying out a project's plan is the necessary step to help make for a seamless construction process

Some of the advantages include:

- Electrical systems that meet the operational needs of the owner
- Reduced downtime due to power outages caused by utility loss and/or failures within the electrical system
- Coordinated electrical systems that balance protection with reliability and meet the recent code requirements and standards for critical facilities
- Confidence that the electrical systems will operate correctly when required
- Knowledge of and experience with the operation of the electrical equipment.

The Commissioning Process

1. **The initial scope meeting**. All members of the design, construction, and operations teams will come together to agree upon the scope of work required, tasks, schedules, and responsibilities for the implementation of the commissioning plan.
2. **Finalize the plan**. The agent will finalize the commissioning plan draft using the information gathered from the scope meeting. The timeline is also fine-tuned in this step as the construction progresses.
3. **Design intent documentation.** All design requirements for the building system must be documented to establish a baseline of performance expectations. These expectations will then need to align with the actual performance of the systems once they're actually installed.
4. **Submittals.** The commissioning agent will be provided with the equipment and system submittals by the general contractor. The submittal data includes the installation and startup procedures, performance data, temperature control drawings, and more.
5. **Site observation.** The official commissioning agent needs to make regular site visits to witness equipment and system installations to ensure everything is running according to the plan.
6. **Pre-functional checklists and procedures.** Initial inspection checklists are developed and filled out for all mechanical equipment being commissioned. This is to ensure the systems are complete and operating.
7. **Execution of testing procedures.** At this step, the commissioning agent will schedule functional tests through the general contractor and subcontractors. When it's time to run performance tests, the commissioning agent will need to witness and record these test outcomes.
8. **Short-term diagnostic monitoring.** For a two-to-three week period, the commissioner will monitor diagnostic tests to ensure all systems are performing under natural occupancy.

9. **Operations manuals and training.** Operation and maintenance manuals are prepared by the contractors and are then used to train the owner personnel and occupants if necessary.

10. **Warranty period.** The building's mechanical systems may experience variations in performance during different seasons. Therefore, they may be required additional testing during peak heating and cooling seasons. If any issues arise, the general contractor's warranty team will troubleshoot during the warranty period.

11. **Commissioning report.** The final commissioning report will summarize all tasks, findings, and include any documentation from the commissioning process.

Equipment Commissioning Responsibilities'

Accountability:-

The equipment commissioning responsibilities involve all aspects of accountability to ensure that the commissioning is well organized.

You must regularly schedule inspections and oversee that the inspections are conducted in a safe manner.

You will also be responsible for testing and certifying the installed and combined facilities and the equipment to make them compliant with established performance parameters.

The testing and certification must have appropriate documentation and should be approved and reviewed in commissioning dossiers.

The ability to identify minor defects is an important part of the accountability process.

All reservations or deviations regarding performance of the equipment should be brought to the attention of appropriate personnel and cleared immediately.

To best protect yourself and the company, you should always properly document any agreed performance of equipment concessions.

Establishing Policies:-

- Your equipment commissioning responsibilities include establishing the philosophies and the development of systems with each individual contractor.
- These contracts need to be reviewed on a regular basis. This includes providing the Project Manager with support in the development and execution of all plans.
- You must have a clear definition about what must be maintained in the criteria used in commissioning, construction and strategies for maintenance of critical items.
- You must have in place a set of policies which will allow for the orchestration and facilitation of the commissioning process for all of the multi-disciplined projects.

Reviewing & Approving:-

- You must review and approve of all pre-commissioning, commissioning and start-up procedures/practices.
- This includes the availability of all the start-up resources and spare parts that might be needed. Furthermore, your responsibilities will include the control and management of all resources to ensure that all environmental targets and goals are met.
- You must ensure that all equipment and facilities are up to par and ready for use.
- You are responsible for the training of personnel in the pre-commissioning and commissioning process.
- You have to be sure that they understand their specific job roles and responsibilities regarding new equipment and safety procedures.

Equipment Commissioning Checklist

An equipment commissioning checklist is used as a tool for:-

- Approving completed installation of equipment that uses hazardous materials.
- The contents of the equipment commissioning checklist are not intended to address the safety and,
- Regulatory measures related to installation, but to review the safety, health and regulatory issues of the equipment installation itself.

Purpose

The main purpose of the equipment commissioning checklist is to ensure that all projects are designed and installed in a way that follows established codes and regulations as well as sound engineering practices. The checklist also aims to address issues related to safety, health and environment impact. Last, the document provides a record of each installation and review as required by law.

Two-Step Process

Implementation of the equipment commissioning checklist involves a two-step process based on its sections. The document is divided into two sections, with the first section covering electrical and mechanical issues and also the release of non-hazardous product materials. This section also facilitates their release. Section Two covers release of hazardous materials and physical hazards. The requirements of both sections must be fulfilled before the equipment can become operational.

Review of the Installation Process

Section One of the checklist is designed to ensure that the equipment is ready for use. Once the equipment is set and the connections are made, a review of the installation process up to that point is carried out. The purpose of this section is to enable the user to perform all the required system checks and make corrections if needed before the hazardous materials can be introduced.

Verify Equipment Is Ready for Use

Section Two of the equipment commissioning checklist is used to verify and make sure that the equipment can withstand mechanical hazards. Upon completion of this section, the equipment is approved to become fully operational and can then be released for process qualification and commissioned for use. In general, this section covers the topics associated with safety. It addresses the questions of whether new hazards can arise and whether there is a need for further training on the part of the emergency response team.

Electrical Safety Inspection Checklist

Electrical wiring and equipment can pose a danger in any home or workplace. Improper use of electrical appliances can increase the risk of electric shocks or produce a fire hazard. However, taking these simple steps can help reduce the safety risk posed by electrical systems.

Fuses:-

- Fuses and circuit breakers are essential to the safety of an electrical system.
- If a circuit becomes overloaded, the fuse will blow, preventing a dangerous buildup of electricity. When fuses do blow, be sure to replace them with the same type of fuse that is rated for the same ampere load.
- If you replace a home fuse box, install an S-type fuse box that will only allow the correct fuse to be installed, preventing any accidental use of the wrong type of fuses.

Outlets:-

- Never overload outlets with too many appliances or outlet splitters.
- Check outlets to ensure that they don't become hot to the touch or discolored over time, as this can indicate a potentially dangerous overload.
- If there are small children in the household, cover all unused outlets with a protective cover to safeguard against shocks

Wiring:-

- Always make sure that appliances are plugged in firmly without any strain or tension on the cord that could cause the plug to come partially loose.
- An electrical inspector will ensure that the wiring in a building is safe and meets local building codes before the building can be sold.
- However, it's a good idea to hire an electrician to check the wiring if you notice any irregularities, such as circuits that often trip or blow fuses, or heat coming from outlets or the fuse box.

Lighting:-

- Be sure to replace light bulbs with new bulbs of the same wattage.
- In addition, ensure that new light bulbs are always screwed in firmly, as a loose bulb can overheat and pose a fire danger.
- Keep all lamps and other lighting fixtures away from curtains or beds where flammable fabric can come into contact with the bulb.

Appliances:-

- Read the owner's manual before using any small appliances, including hair dryers, irons, power tools and portable space heaters.
- Make sure that the ampere requirements do not exceed the capacity of the circuit.
- Unplug appliances whenever they're not in use and seek professional repair to any damage to appliance cords.

Process Commissioning

Process commissioning services are provided by Process Technical Services (PTS). Process commissioning occurs between the time construction is complete and plant startup commences.

- During this period process commissioning managers are occupied with the task of ensuring the facilities have been constructed and assembled according to the engineering design and the equipment manufacturer's directions.
- Before any process commissioning activities can be undertaken, procedures that describe in detail how the various tests will be conducted and evaluated must be written.
- The process commissioning procedures must also describe safety precautions that must be taken before, during, and after the commissioning process.
- PTS provides qualified and experienced commissioning engineers and specialists in process commissioning to specify the tests to be conducted and to then follow the progress of this work in the field.
- Process commissioning begins with a detailed plan to synchronize construction turnover of process units with the commissioning effort.

- When construction on each process unit is declared as complete, process commission activities can then begin. Project planning software can be used to organize and control the commissioning process, so that resources can be scheduled and deployed in the most effective way to ensure that all elements are eventually commissioned and declared operable.
- Each element of the process unit is examined and tested. Process control valves must be stroked, sensors and analyzers must be calibrated, relief valve settings must be checked, and controller tuning coefficients must be checked.
- Equipment must be either hydrostatically tested or tested with inert gas to find and eliminate any leaks that might occur. Insulation must be inspected and steam tracing tested.
- Electrical connections must be checked and electrical equipment tested where and when it can be done safely.
- Rotating equipment must be checked for alignment and manually rotated to ensure there are no interferences.
- Electrical motors and other equipments need to be run to ensure the connections are correctly installed and that the equipments operate properly or the motor rotates in the right direction.
- Any defects found during the commissioning process must be corrected by the authorized body before the process unit commissioning can be declared as complete.
- Troubleshooting guides should be prepared for mechanical equipment to help identify and correct any mechanical malfunctions that might occur.
- A major part of process commissioning is in preparing the operating instructions for the startup of the process.
- The procedures for a newly constructed plant often differ from the procedures that would be placed in service after a successful production campaign.
- In the case of a newly constructed plant, the procedure may call for each upstream unit to be brought up to operating temperatures and pressure and held for a period of time to validate the integrity of the unit before process material is allowed to flow to the next downstream unit.

- PTS can provide experienced and skilled operators to undertake this initial startup, and can maintain the operation until the process stabilizes and the regular operators are prepared to take over.
- Process Technical Services has the management expertise and the skilled and experienced engineers and specialists to handle all aspects of process commissioning and plant startup. PTS operates as the project owner's representative in all respects.

Commissioning checklist format example

Table 1. commissioning checklist 1

No	**A. Cables, Wiring and Other Interconnections**	Items tested by technician	Items witnessed by supervisor
1	Are insulation test of all cables and wiring tested with all insulation resistance ≥0.5 MΩ?	*Yes/No	*Yes/No
2	Is the completed circuit tested as recommended by the equipment manufacturer?	*Yes/No	*Yes/No
3	Is earth continuity and earth-loop impedance tested with results in compliance with the Code?	*Yes/No	*Yes/No
	B. Electrical Equipment / Appliances		
1	Are the electrical equipment / appliances suitable for 380V/3 ph/50 Hz or 220V/1 ph/50 Hz?	*Yes/No/N.A.	*Yes/No/N.A.
2	Are the electrical equipment / appliances provided with isolating switch?	*Yes/No/N.A.	*Yes/No/N.A.
3	Are the electrical equipment / appliances provided with sufficient length of flexible cable with plug as specified?	*Yes/No/N.A.	*Yes/No/N.A.
4	Are the rating of the equipment / appliances matched that of the power supply switch or socket?	*Yes/No/N.A.	*Yes/No/N.A.

Table 2. Commissioning checklist 2

No	C conduit installation and junction box fixing	Items tested by technician *Yes/No	Items witnessed by supervisor *Yes/No
1	Is the spacing between each junction box equal?		
2	Is the conduit installed correctly with the desired angel?		
3	Is the junction and outlet boxes installed in the right diameter i.e for connections 85 Ø and for outlets 65 Ø?		
4	Is the conduit left in the junction boxes between 0.5 and 1 cm?		
5	Are all conduits fix by using conduit clips?		
6	Is the diameter of the conduit is $13mm^2$		

Table 3. Commissioning checklist. 3

No	D. Wire installation and connections	Items tested by technician *Yes/No	Items witnessed by supervisor *Yes/No
1	Are the wires installed according to the design?		
2	Is color coddling system available in the installation?		
3	Is the wire used for the installation has Ø of $1.5mm^2$?		
4	Are the wires spliced and terminated correctly?		
5	Are the lengths of splices greater than 5mm?		
6	is the insulation resistance of the installation is greater than 0.5 MΩ		
7	Is the electrical system tested and approve that it is functional?		

Table 4. Commissioning checklist. 4

No	E Device installation	Items tested by technician *Yes/No	Items witnessed by supervisor *Yes/No
1	Are all pushbuttons operational?		
2	Is all push buttons fix properly?		
3	Are the two bells fix and work properly?		
4	Is the announceter installed properly?		
5	Is system function test conducted?		
6	Is testing conducted and approved that, the overall security system is functional?		
7	Is the appearance and function of the security system checked according to the owner requirement?		

Table 5. Approval sheet

Tested / Checked by :(Name of Technician Representative)	Signature -	Tel. No:	
		Date :	
Witnessed by : (Name(s) of Supervisor)	Signature -	Tel. No. :	
		Date :	

Self-Check–2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below

Instruction I: - Give short answer for the following questions not more than one paragraph (10 pts)

1. What is the main purpose of the equipment commissioning checklist?
2. What is the use of section two of the equipment commissioning checklist?

Note: **Satisfactory rating - Greater than or equal to 7 points** **Unsatisfactory - below 4 points**

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

Answer Sheet

Score = _____

Rating: _____

Operation sheet 1– Procedures for commissioning electrical installation work

Procedures for commissioning electrical installation work

1. Define the owner's requirements and expectations for the facility
2. Determine the commissioning scope and budget for the project,
3. List of on-site electrical systems to consider when determining the commissioning scope for a project.
4. Translate owner's requirements into construction documents.
5. Review and comment on the construction documents to verify that the goals and requirements set forth in the pre-design are being met.
6. commissioning procedures and acceptance criteria are outlined, and the contractor and manufacturer's expectations are identified
7. Inspect, test, and install in accordance with the construction documents
8. Oversee the factory testing, confirming that the results meet the acceptance criteria
9. installed equipment and systems are tested to verify and ensure that they perform in accordance with the design intent and owner's operational requirements

    - Individual equipment test
    - Discrete system test
    - Integrated system test.

10. Compare name plate data with design drawings
11. Inspect the physical condition
12. Inspect anchorage, alignment, and grounding
13. Verify that the unit is clean
14. Inspect connections
15. Verify breaker and timer settings.
16. Electrical and functionality tests are performed on the individual piece of equipment to verify operation.
17. Once the operation of each individual piece of equipment in the electrical system is confirmed, the equipment will be examined as a discrete system.
18. Fill the checklist

Lap Test-1	Demonstration

Name……ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hour. The project is expected from each student to do it.

Lap Test Title: **commission electrical installation work**

Information Sheet 3- Attending unplanned events

3.1 Unplanned events or conditions

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

Most Common Causes of Electrical Accidents

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

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

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

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

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

Self-Check–3	Written test

Name…… ID…… Date…….

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

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

_____1. What are the factors that most electrical accidents result from?

A. Unsafe equipment
B. Unsafe environment
C. Unsafe work practices
D. All

_____2. These accidents cannot be prevented with the use of_____?

A. safe equipment
B. guarding
C. Grounding
D. safe work practices
E. circuit protective devices
F. None

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

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

Answer Sheet

Score = _____

Rating: _____

Information Sheet 4- Undertaking ongoing checks of quality of work

4.1 Undertaking ongoing checks of quality of work

Quality control (QC) is a process through which a business seeks to ensure that product quality is maintained or improved. Quality control involves testing of units and determining if they are within the specifications for the final product. Quality control principles can also be utilized in service industries.

Construction quality control help to construct the project in accordance with the construction drawings and design details while also delivering to the client a project that meets and exceeds their standards and specifications. Quality control inspectors examine products and materials for defects or deviations from specifications

Before a utility will connect an installation to its supply network, strict pre-commissioning electrical tests and visual inspections by the authority, or by its appointed agent, must be satisfied.

The quality of electrical work tests and visual-inspection checks for installations in buildings include

- Electrical continuity and conductivity tests of protective, equipotential and earth bonding conductors
- Insulation resistance tests between live conductors and the protective conductors connected to the earthing arrangement
- Test of compliance of SELV (Safety Extra Low Voltage) and PELV (Protection by Extra Low Voltage) circuits or for electrical separation
- Insulation resistance/impedance of floors and walls
- Protection by automatic disconnection of the supply

- ✓ For TN, by measurement of the fault loop impedance, and by verification of the characteristics and/or the effectiveness of the associated protective devices (overcurrent protective device and RCD)
- ✓ For TT, by measurement of the resistance RA of the earth electrode of the exposed-conductive-parts, and by verification of the characteristics and/or the effectiveness of the associated protective devices (overcurrent protective device and RCD)
- ✓ For IT, by calculation or measurement of the current Id in case of a fist fault at the line conductor or at the neutral, and with the test done for TN system where conditions are similar to TN system in case of a double insulation fault situation, with the test done for TT system where the conditions are similar to TT system in case of a double insulation fault situation.

- Additional protection by verifying the effectiveness of the protective measure
- Polarity test where the rules prohibit the installation of single pole switching devices in the neutral conductor.
- Check of phase sequence in case of multiphase circuit
- Functional test of switchgear and controlgear by verifying their installation and adjustment
- Voltage drop by measuring the circuit impedance or by using diagrams

These tests and checks are basic (but not exhaustive) to the majority of installations, while numerous other tests and rules are included in the regulations to cover particular cases.

After verification and testing an initial report must be provided including records of inspection, records of circuits tested together with the test result and possible repairs or improvements of the installation.

Self-Check–4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I: Give short answer for the following questions not more than a paragraph (10 pts)

1. What is Quality control?
2. What is the use of quality control in Construction?

Score = _____
Rating: _____

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

Note: **Satisfactory rating - Greater than or equal to 6 points** **Unsatisfactory - below 5 points**

Information Sheet 5 - Responding unplanned events or conditions.

5.1 Responding unplanned events or conditions

When it comes to electrical hazards, prevention depends on safe equipment, safe environment and safe work practices. The Occupational Safety and Health standards cover many electrical hazards in a variety of industries. These accidents can be prevented with the use of safe equipment, guarding, grounding, circuit protective devices and safe work practices.

5.1.1 Safe Equipment

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

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

5.1.2 Guarding

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

5.1.3 Grounding

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

grounding substantially reduces the risk of an electrical accident if combined with safe work practices.

Grounding falls into two types:

- Service or system ground or
- Equipment ground

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

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

5.1.4 Circuit Protection Devices

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

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

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

5.1.5 Safe Work Practices

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

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

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

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

Self-Check–5	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I: write true if the statement is correct or write false if the statement is incorrect and write the answer on the space provided (4pts)

_____1. The equipment must be installed and used within its labeled capacity so as to not exceed the limitations of the equipment.

_____2. Fuses and circuit breakers open or break the circuit automatically when too much current flows through them.

Score = _____

Rating: _____

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

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

LG #44	LO #3- Inspect and notify completion of work

Instruction sheet

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

- Undertaking final inspection
- Notifying work completed to a supervisor
- Cleaning work area and made safe
- Cleaning, checking and storing Tools, equipment and surplus materials

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, **upon completion of this learning guide, you will be able to**:

- Undertake final inspection
- Notify work completed to a supervisor
- Clean work area and made safe
- Cleaning tools, equipment and surplus materials
- Checking tools, equipment and surplus materials
- Storing tools, equipment and surplus materials

Learning Instructions:

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

Information Sheet 1- Undertaking final inspection

1.1 Undertaking final inspection

Inspection is the testing procedures that electricians use to ensure that a circuit is working correctly and safe for use before being energized. Inspection and testing should also be carried out for all electrical installations at regular intervals. It is carried out before the testing and the installation is normally disconnected from the supply.

The point of inspection is to verify that the installed equipment:

- Complies with relevant standards – this is normally a mark of certification by the installer or manufacturer
- Is the correct type and installed in accordance to the Regulations
- Not damaged or defective which would cause a safety issue

The Inspection includes the checking of several items which are relevant to the installation. The checking can also take place, if necessary, during installation.

Before Inspection and testing is carried

Protecting yourself

It is important that other people know you are carrying out inspection and testing, particularly other workers on site

Protecting Others

It is important to ensure that safety precautions are carried out before starting. This is to protect the health and safety of others and also yourself.

It is important to protect the safety of people, livestock and property against the dangers and damage that electrical installations can cause. In basic terms this means assessing risk of injury from things such as:

- Electric shock
- Burns/fire
- Other moving equipment
- Power supply interruptions
- Arcing or burning

.

Table 6. electrical appliances inspection check list

Industrial Problems & Solutions	FORMAT NO.	
ELECTRICAL APPLIANCES INSPECTION CHECKLIST	REV. NO.	
	REV. DATE	
	CHECKLIST NO.	

ELECTRICAL APPLIANCE INFOMRATION			
SERIAL NO	MODEL NO.	NAME OF APPLIANCE	CAPACITY
DESCRIPTION OF APPLIANCE			

INSPECTION DATE	INSPECTED BY	SIGN.	LOCATION	RECORD #

CHECKLIST				
#	CHECKLIST	REF. DOC	OBSERVATION	STATUS

IDENTIFICAITON			
CHECKLIST POINT NO.	FINDINGS	ACTION TAKEN	DATE ACTION COMPLETED

Self-Check–1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction I: - write true if the statement is correct or write false if the statement is incorrect and write the answer on the space provided (6pts)

_____1. Inspection and testing should also be carried out for all electrical installations at regular intervals?

_____2. It is not important to protect the safety of people, livestock and property against the dangers and damage that electrical installations can cause?

_____3. The Inspection includes the checking of several items which are relevant to the installation.

Note: **Satisfactory rating - Greater than or equal to 4 points** **Unsatisfactory - below 4 points**
You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 2- Notifying work completed to a supervisor

2.1 Notifying work completed to a supervisor

The supervisor Provides motivation and assistance when necessary inspecting and commissioning work is done. This includes reading and interpreting design schematics to ensure the proper installation of electrical systems. Maintaining a safe and clean work area, the responsibilities of this Electrical Site Supervisor role include overseeing electrical work and site electricians, scoping work and ordering materials, issuing permits and ensuring electrical safety rules are followed

Supervisors approved the installation work by

- Inspect in detail in accordance with national standard requirements
- Insulation resistance test result i.e. should not be less than 0.5MΩ for single phase installation
- Earthing system loop impedance
- Earthing electrode resistance test result shouldn't be greater than 3 ohm
- Voltage level (220V/380V for our country)
- Polarity test i.e. controlling and protective only should be connected in phase wire
- Functionality of the installation

  Based on the above point the supervisor notifying the installation work

Self-Check–2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below

Instruction-Give short answer for the following questions not more than a paragraph (5pts)

1 What is the Task of the supervisor?

Note: **Satisfactory rating - Greater than or equal to 3 points** **Unsatisfactory - below 3 points**
You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 3- Cleaning work area and made safe

3.1 Cleaning work area and made safe

A clean workplace also ensures the safety and health of employees and visitors. Workplace injuries can be prevented by taking action to ensure a clean, safe work environment.

Keeping workshop and storage spaces clean and dry can help prevent many accidents.

Sparks can ignite scraps, sawdust and solvents. Water can conduct electricity.

- Do not stand in water, on damp floors or in the rain when working with electrical tools. Keep hands and tools dry.
- Make sure workshops and storage areas have the proper electrical wiring and outlets needed to run power tools. Install adequate wiring to handle the electrical load required.
- All outlets should have three pronged plugs or be double-insulated. Any outlets that may come in contact with water should have ground fault circuit interrupters.
- Never use indoor tools outside. Use only approved outdoor extension cords. Use one long extension cord instead of several short ones. Do not damage or cut extension cords.
- When working on ladders or scaffolding rest power tools on a flat surface or in a bin secured to the ladder itself. A falling tool can seriously injure a co-worker or bystander. Never carry heavy power tools up and down ladders.
- Stop working and turn off the power tool you are working with if distracted by something or someone. Never look away from your work when operating a power tool.
- Cutting tools can be particularly dangerous. If one stalls, switch off the power and unplug the tool before trying to restart it. When using a power saw, let the saw reach full speed before cutting and support the work firmly so it won't shift..
- Take extra care when working with hazardous materials. Handle fiberglass with care. Its particles can irritate the skin, eyes and respiratory system.

- When soldering, remember that lead solder is toxic. The work area should be ventilated and flammable material properly stored.

Self-Check–3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Instruction-write true if the statement is correct or write false if the statement is incorrect and write the answer on the space provided (4pts)

_____1. A clean workplace also ensures the safety and health of employees Tolerance

_____2. Keeping workshop and storage spaces clean and dry cannot help prevent many accidents.

Note: **Satisfactory rating - Greater than or equal to 2 points** **Unsatisfactory - below 2points**
You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 4- Cleaning, checking and storing Tools, equipment and surplus materials.

4.1 Cleaning, checking and storing Tools, equipment and surplus materials

Cleaning is the process of removing unwanted substances, such as dirt, infectious agents, and some items and materials require specialized cleaning techniques, due to their shape. Tools and equipment should be cleaned and checked after using them. Both hand tools and equipment needs regular cleaning before storing them in their proper space. And plant should be cleaned regularly. These tools and equipment's should be maintained regularly and stored at their appropriate places. This activity is used to use our resources for a long period of time and increases the safety of tools and equipment's.

Maintain mean, to keep in a condition of good repair, efficiency or to keep in an existing state, preserve or retain.

Work area is cleared and materials disposed of or recycled in accordance with project environmental management plan. After the accomplishment of the project, the area should be cleaned up according to the quality requirement.

Methods of Cleaning Electrical Apparatus

1. Rags and Brushes. Wiping off dirt with a clean, dry, lint-free cloth or soft brush is usually satisfactory if the apparatus is small, the surfaces to be cleaned are accessible, and only dry dirt is to be removed.
2. Liquid Solvents(Chemicals are found throughout the electronic assembly and repair process, but no solvent is more common than isopropyl alcohol)
3. Vacuum Cleaning.
4. Sweeping and Moping

Self-Check–4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction-Give short answer for the following questions not more than a paragraph (6pts)

1. List Methods of Cleaning Electrical Apparatus?
2. What is the commonly used Liquid Solvents used for Cleaning Electrical Apparatus?

Score = _____

Rating: _____

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

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

Reference Materials

Book:

1. Trevor linsley**, (**2005 GC**).*Basic Electrical Installation Work,*** Fourth Edition Senior Lecturer Black pool and the Fylde College.

WEB ADDRESSES

1. *https://www.referenceforbusiness.com/small/Qu-Sm/Quality-Control.html#ixzz6htfpvujh*
2. *https://www.greatsampleresume.com/job-responsibilities/electrical/supervisor*
3. *https://electrical-engineering-portal.com*

AKNOWLEDGEMENT

We wish to extend thanks and appreciation to the many representatives of TVET instructors and respective experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

We would like also to express our appreciation to the TVET experts of Amhara Regional TVET bureau and Federal Technical and Vocational Education and Training Agency (FTVET) experts who made the development of this Teaching, Training and Learning Materials (TTLM) with required standards and quality possible.

This Teaching, Training and Learning Materials (TTLM) are developed on December 2020 at Adama, Comfort International Hotel.

The trainers who developed the learning guide

No	Name	Qualification	Educational background	Region	E-mail
1	ASSEN AHMED	B	Civil Engineering	Amhara	nuredinahmed999.na@gmail.com
2	ABEL MOLLA	B	Electrical Communication	Amhara	mollaabel1@gmail.com
3	BETELIHEM GIZACHEW	B	Electrical Engineering	Amhara	betelihemgiz@gmail.com
4	EYAYA MULIE	B	Building construction Technology	Amhara	Eyaya4040@gmail.com

TVET Coordinators

No	Name	Work position	Email and Tel.	Remark
1	TILAHUN TESFAYE	TVET Curriculum TTLM Expert	tilahuntesfayeewnetu@gmail.com	

LO#1- Plan and prepare to commission electrical system

Information Sheet 1- Understanding Work instructions

Self check 1 Answers

1. A. Work Instructions
2. C. Standard Operating Procedures

Information Sheet 2- Planning Commissioning procedures

Self check 2 Answers

1. C. commissioning plan
2. B. phase sequence
3. C. 120

Information Sheet 3- Obtaining Materials and PPE to complete job requirements

Self check 3 Answers

1. B. Blueprints
2. D.All

Information Sheet 4- Electrical Tools and Equipment

Self check 4 Answers

1. C. Screw driver
2. D.All
3. A. wattmeter

LO #2- Commission electrical system

Information Sheet 1- Following Safety policies and procedures.

Self check 1 Answers

1. False
2. True
3. True

Information Sheet 2- Performing commissioning activities

Self check 2 Answers

1. The main purpose of the equipment commissioning checklist is to ensure that all projects are designed and installed in a way that follows established codes and regulations as well as sound engineering practices. The checklist also aims to address issues related to safety, health and environment impact. Last, the document provides a record of each installation and review as required by law.

2. Section Two of the equipment commissioning checklist is used to verify and make sure that the equipment can withstand mechanical hazards. Upon completion of this section, the equipment is approved to become fully operational and can then be released for process qualification and commissioned for use. In general, this section covers the topics associated with safety. It addresses the questions of whether new hazards can arise and whether there is a need for further training on the part of the emergency response team.

Information Sheet 3- Attending unplanned events

Self check 3 Answers

1. D. All

2. F. None

Information Sheet 4- Undertaking ongoing checks of quality of work

Self check 4 Answers

1. Quality control (QC) is a process through which a business seeks to ensure that product quality is maintained or improved. Quality control involves testing of units and determining if they are within the specifications for the final product. Quality control principles can also be utilized in service industries.

2. Construction quality control help to construct the project in accordance with the construction drawings and design details while also delivering to the client a project that meets and exceeds their standards and specifications. Quality

control inspectors examine products and materials for defects or deviations from specifications

Information Sheet 5 - Responding unplanned events or conditions.

Self check 5 Answers

1. True
2. True

LO #3- Inspect and notify completion of work

Information Sheet 1- Undertaking final inspection

Self check 1 Answers

1. True
2. False
3. True

Information Sheet 2- Notifying work completed to a supervisor

Self check 2 Answers

1. The supervisor Provides motivation and assistance when necessary inspecting and commissioning work is done. This includes reading and interpreting design schematics to ensure the proper installation of electrical systems. Maintaining a safe and clean work area, the responsibilities of this Electrical Site Supervisor role include overseeing electrical work and site electricians, scoping work and ordering materials, issuing permits and ensuring electrical safety rules are followed

Information Sheet 3- Cleaning work area and made safe

Self check 3 Answers

1 True

2 False

Information Sheet 4- Cleaning, checking and storing Tools, equipment and surplus materials.

Self check 4 Answers

1 . Methods of Cleaning Electrical Apparatus

5. Rags and Brushes..
6. Liquid Solvents
7. Vacuum Cleaning.
8. Sweeping and Moping

2. isopropyl alcohol