RQF LEVEL 5

TRADE : SOLAR ENERGY

MODULE CODE: SOLSI 501

TEACHER'S GUIDE

Module name: SUBSTATION INSTALLATIONS MAINTENANCE

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Acronyms

RTB: Rwanda TVET Board

TVET: Technical and Vocational Education and Training

RQF: Rwanda Qualification Framework

HV: High Voltage

LV: Low Voltage

PM: Preventive maintenance

CM: Corrective maintenance

KW: Kilo-Watt

CB: Circuit Breaker

LT: Low tension

HT: High tension

OLTC: On-load tap changers

BDVT: Breakdown Voltage Test

SFRA: Sweep Frequency Response Analysis

DC: Direct Current

AC: Alternating Current

KV: Kilo Volt

PPE: Personal Protective Equipment

dBA *:* A-weighted decibel

PT: Potentiel Transformer

CVT: Capacitive Voltage Transformer

MOG: Magnetic Oil Gauge

RTCC: Remote Tap Changer Control Panel

OTI: Oil Temperature Indicator

WTI: Winding Temperature Indicator

DGA: Dissolve Gas Analysis

Introduction

This module describes the skills, knowledge and attitude required to maintain pneumatic and hydraulic systems in different areas such as industries, vehicle systems and in laboratory boards. The learner will be able to plan and execute preventive maintenance of HV switching and protecting devices, rectify HV switching and protecting devices, clean the working area and manage waste materials.

Maintenance is the combination of all technical, administrative and managerial actions during thelife cycle of an items intended to retain it in or restore it to a state in which it can perform the required function. or maintenance is all actions necessary for retaining an items or restoring to it

,a servicing ,repair , modification ,overhaul, inspection and condition verification . Maintenance increase availability of a system and keep system's equipment in working order.

Purpose of maintenance

Attempt to maximize performance of production equipment efficiently andregularly

Prevent breakdown or failure

Minimize production loss from failure

Increase reliability of the operating system

Types of maintenance

There arefour different types of maintenance: Preventative, Predictive, Breakdown or Failure, and Corrective.

Preventative Maintenance.

Preventative maintenance involves collecting data, maintaining equipment in suggested intervals

and maintaining up-to-date equipment files.

FUNCTIONS OF A MAINTENANCE DEPARTMENT

Following are the major functions of a maintenance department:

Maintenance of installed equipment and facilities

Installations of new equipment and facilities

PM tasks- Inspection and lubrication of existing equipment

CM tasks- monitoring of faults and failures using appropriate techniques

Modifications of already installed equipment and facilities

Management of inventory

Supervision of manpower

Keeping records.

Predictive Maintenance.

Predictive substation maintenance is the concept of using reliability-centered maintenance. Reliability is defined as the probability that a system will perform a given function satisfactorilyfor a specified time under specified operating conditions. The four (4) fundamental principles ofpure reliability centered maintenance theory are:

The primary objective of reliability-centered maintenance is to preserve the system function;

A good reliability-centered maintenance program identifies specific failure modes to define lossof function or functional failure;

A reliability-centered maintenance program prioritizes the importance of the failure modes; and

A reliability-centered maintenance program identifies effective and applicable preventive maintenance tasks. The fundamental goals of reliability-centered maintenance are to preserve thefunction or operations of a system and to schedule all preventive maintenance tasks to preserve the defined function. The substations system function to preserve is the delivery of safe, reliableelectric power to customers (missions).

Breakdown or Failure.

Breakdown or failure is simply repairing those item(s) that break. This is not optimal because itdoes not tend to analyze the origin of the failure.

Corrective.

Corrective maintenance is repair and analysis of a failure and determining the root cause of thefailure and attempting to mitigate the cause of failure.

Module Code and Title: SOLSI 501- SUBSTATION INSTALLATIONS MAINTENANCE

Learning Units:

1. Prepare preliminary activities.
2. Execute preventive maintenance.
3. Rectify faults in substation installations.
4. Clean the workplace.

Learning Unit 1: Prepare preliminary activities

STRUCTURE OF LEARNING UNIT

Learning outcomes:

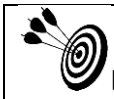
1.1: Plan preventive maintenance for HV switching and protection devices

1.2: Identify tools and measurement instruments used to maintain substation installations

1.3: Identify PPE (Personal Protective Equipment) according to their types

Learning outcome 1.1: Plan preventive maintenance for HV switching and protection devices

Duration: 2 hrs



Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Recommend practice for maintaining different equipment of a substation

2. Elaborate convenient maintenance schedule/plan

Resources

Equipment	Tools	Materials
		Books - Internet - Manual - service manuals - Handout notes

Advance preparation:

.Handout notes

Indicative content 1: Recommended Practice for Maintaining different equipment of a substation

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Recommended Practice for maintaining different equipment of a substation

Lightning Arresters: Lightning arrester is a most important protective device of distribution substation toprotect valuable equipment as well as working personnel. It arrests and dischargesover voltage to earth during lightning strokes. These are installed between line andearth near equipment.

Representative values of a lightningstroke:

Voltage: 2×10^{-8} volts

Current: 2×10^{4} Amps

Duration: 10^{5} seconds

Power: 8×10^{5} kW

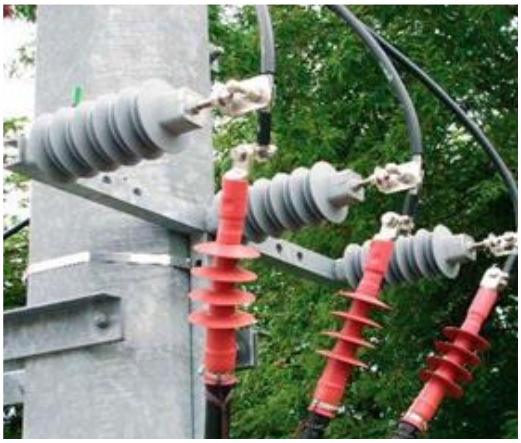


Figure:1 Porcelain housed surge arrester

Lightning Arrestors schedule

Daily :

Checking the readings of surge arrestor counters.

Monthly:

a) Cleaning of porcelains Insulators of LA.

Quarterly:

Removing of bird nests, if any.

Monitor the total leakage current (capacitive and resistive current) and resistive current.

Records of the number of operations of the Arrester should be maintained and if more numberof operations are seen then the same should be informed to the concerned authority.

Yearly:

a) Testing of counters Repairs:

a) Replacement of Lightening Arrestor pole.

Circuit Breakers

The circuit breaker is an equipment which automatically cut off power supply of the system when any fault or short circuit occurs in the system. It detect and isolate faults within a fraction of a second thereby minimizing the damage at the point where the fault has occurred.

The circuit breakers are specially designed to interrupt the very high fault currents, which may be ten or more times the normal operating currents.

There are many types of circuit breakers, e.g. Oil, minimum oil, Air blast, Vacuum, SF6, etc. being used at distribution substations. This list is generally in order of their development and increasing faultrupturing capacity, reliability and maintainability

Figure: 2 33 kV outdoor vacuum circuit breakers

. Circuit Breakers schedule

Hourly:

Check Air and Gas pressure.

Daily:

a) Check the operation of compressors /motors. Check timing and sound.

b) Check gas density in each shift.

Monthly:

Air cleaning with blower.

Cleaning of circuit breaker body and bushings.

Auxiliary contacts cleaning.

Tightening of nuts and bolts.

Checking breaker Operation (Local/Remote operation).

Check anti-condensation protection.

Check of motor control

Checking and sealing of cable entry holes.

Use of anti-corrosion spray where required.

Quarterly:

Check for SF6 leaks.(Gas leakage test)

Oiling and greasing of all moving parts.

Functional check of trip circuit.

Checking the settings of air and gas pressure switches.

Half-yearly:

Checking ON/OFF Timings of Circuit breaker poles.

Complete servicing, lubricating and greasing of all moving parts. Replacement of any defective part.

Measurement of contact resistance and contact gap.

Operation of control and Auxiliary circuits.

Recharge time of operating mechanism after specified sequence.

Checks on specific operations. g) Inspection and operation of control circuit.

Measurement of Humidity if necessary.

Yearly:

Touch up painting wherever required.

Checking contact resistance of Breaker main contacts.

Checking of circuit breaker position level by using sprit level indicator.

Mechanism checking and lubrication to all moving parts.

IR values of Power and Control Circuits.

Operating circuits power consumption during operations.

Verification of correct rated operating sequence.

Checking and adjustment of Track alignment and Interlocking mechanism.

Repairs:

a) Filling the breaker with SF6 – The CB may be filled only by or under the supervisionof qualified personnel and in accordance with the SF6 filling curve. SF6 filling kit and SF6 gas cylinder to be provided by CPRI

Transformers

The distribution transformer is a main and largest equipment of distribution substation. It is basically a static electrical device which steps down the primary voltage of 33kVor 11 kV to secondary distribution voltage of 415-440 volts between phases and 215 volts between phase and neutral through delta-star windings by electromagnetic induction without change in frequency

Transformer consists of the following parts and components.

Primary winding

Transformer tank

Cooling tubes

Buchholz Relay

Tap changer

Oil outlet valve

L.T. terminals

Temperature gauge

Secondary winding

Conservator

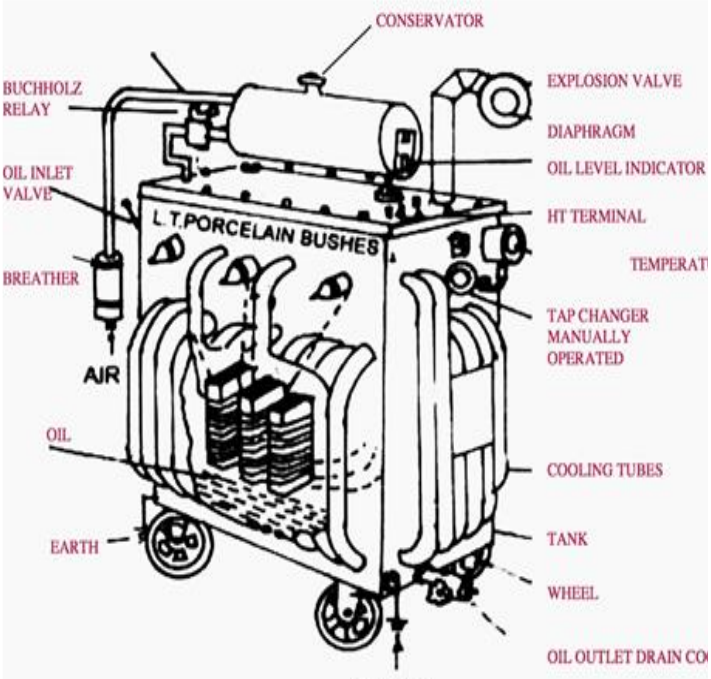
Breather

Explosion vent

Oil inlet valve

Oil level indicator

H.T. terminals



Important Transformer Components

Conservator

(Equipped with transformer of rating 500 kVA and above)

It is a drum containing transformer oil and mounted at the top of the transformer and connectedto the main tank by a pipe. As the volume of oil of transformer tank expands and

contracts according to heat produced, this expansion and contraction of oil causes the level ofthe oil in conservator to rise and fall.

The aim of conservator is to:

Maintain the oil level in tank

Provide space for the expanded oil

Breather

It is attached to conservator tank and contains silica gel, which prevents the moist air from entering into the tank during contraction of oil. When oil is hot there is expansion and gas passesto atmosphere through it. When oil is cooled, it contracts and the air enters in it. It prevents transformer oil from moisture contamination

Buchholz Relay

It is protective relay of transformer. This device signals the fault as soon as it occurs and cuts thetransformer out of the circuit immediately. This is gas operated protective relay. It is installed in between the pipe connecting the tank and the conservator.

N.B :This relay works on the formation of excessive oil vapors or gas inside the transformertank due to internal fault of transformer

It consists of two operating floats A and B. These are operated by two mercury switches separately provided for each float. The float A is for bell alarm and float B is for operating thetripping circuit.

 **Theoretical learning Activity**

Conduct brainstorming session with the student on recommended practices for equipment of a substation

Have students in their respective groups discuss different types of practices for equipment of a substation

 **Practical learning Activity**

Provide students with pictures of the different recommended practices for equipment of a substation

 Points to Remember (Take home message)

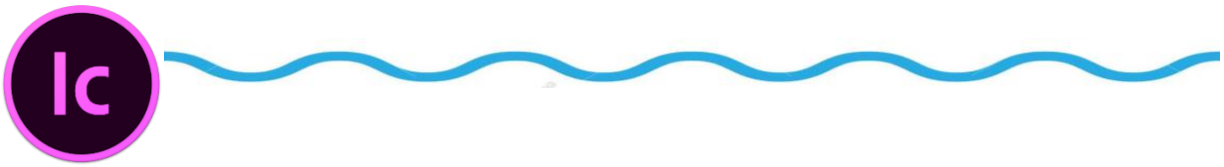
Recommended practice for maintaining different equipment of a substation are:

Daily activities

Weekly activities

Monthly activities

Annual activities



Indicative content 2: Elaboration of convenient maintenance schedule/plan

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Transformers schedule

Hourly:

Check oil & winding temperatures, check for abnormalities & recording them.

Observe and record Load (amperes) and Voltage. Check against rated figure.

Visual check for overheating if any at terminal connections (Red hots) and observation for

any unusual internal noise. This check is must in each shift.

Daily:

Observation of oil levels in:

main conservator tank

OLTC conservator

bushings and examining for oil leaks if any from the transformer.

Checking the colour of silica gel in the breather and also oil level of the oil seal. If silica gel colour changes from blue to pink by 50% the silica gel is to be reconditioned or replaced.

Visual check of explosion vent diaphragm for any cracks.

Monthly:

Physical examination of diaphragm of vent pipe for any cracks.

Cleaning of bushings, inspect for any cracks or chippings of the porcelain and checking of tightness of clamps and jumpers.

Measurement of IR values of transformer with suitable megger according to the ratingof the transformer. Recording of the values specifying the temperature at which measurements are taken

Cleaning of Silica gel breather.

Checking of temperature alarms by shorting contacts by operating the knob.

Quarterly:

Testing of main tank oil for BDV and moisture content.

Testing of OLTC oil for BDV & moisture content.

Testing of Bucholz surge relays & low oil level trips for correct operation.

Checking of all connections on the transformer for tightness such asbushings, tank earth connection.

Lubricating / greasing all moving parts of OLTC mechanism.

Yearly:

Testing of oil for dissolved gas analysis, acidity, tan delta, interfacetension specific resistivity.

Tan delta testing for Bushings.

Calibration & testing of oil & winding temperature indicators.

Measurement of magnetizing current at normal tap and extreme taps.

Measurement of winding resistance.

Turns ratio test at all taps.

Overhaul of tap changer and mechanism.

Calibration of tap position indicator.

Filtration of oil or replacement of oil in the main tank/OLTC whenthe BDV of the oil is found less than the acceptable limit

Changing the gaskets at all locations as and when leakage is found orthe gasket is damaged or else yearly.

Replacing of Buchholz relay, OTI, WTI if found malfunctioning.

OLTC mechanism shall be completely over-hauled for smooth andtrouble-free operation.

Replacement of bushing if required.

SFRA test

 Theoretical learning Activity

Conduct brainstorming session with the student on recommended practices for equipment of a substation

Have students in their respective groups discuss different types of practices for equipment of a substation

 Practical learning Activity

Provide students with pictures of the different recommended practices for equipment of a substation

Points to Remember (Take home message)

Substation maintenance inspections include testing, repairing and replacing vital substation equipment and schedule impending maintenance tasks via a preventative maintenance checklist.

Examples of these checks include:

General inspection and cleaning of mechanisms (transformers, motors, circuit breakers, batteries, transmission lines etc)

Measure equipment condition.

Check oil and insulation liquid levels. Correct torque settings. Document asset data and record pressure gauges.

Test substations power output meter readings and create an inspection certificate.

Learning outcome 1.1 formative assessment

Written assessment

What do you understand by the term preventive maintenance?

The work carried out on equipment in order to avoid its breakdown or malfunction

Enumerate some advantages of preventive maintenance

Reduces maintenance costs from all of the benefits above, it's clear that preventive maintenance helps minimize equipment downtime, simplify repairs, schedule maintenance tasks, improve asset longevity, and reduce replacements. As a result, maintenance, replacement, and repair costs are significantly decreased

Which statement describes a characteristic feature of routine preventive maintenance?

1. Maintenance schedule needs to be decided, based on maintenance requirements entered in the manual

2. Maintenance could be done either during the working of the machine or during shut interval down period
3. Maintenance done at irregular frequencies
4. Maintenance is performed only if the machine has a fault or defect
5. None of these
Answer
Option 1 : Maintenance schedule needs to be decided, based on maintenance requirements entered in the manual

Maintenance that involves a system of periodic inspection and maintenance designed to keep machine in operation is called

preventive maintenance
total productive maintenance
predictive maintenance
breakdown maintenance
Answer
Option 1 : preventive maintenance

Answer true or false

Daily activities involve task of every week false

Maintenance increase the life span of a system true

Transformer is an equipment used in substation

Practical exercises

Perform recommended practices maintenance for equipment of a substation

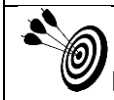
Indicator: Plan preventive maintenance for HV switching and protection devices

Checklist	yes	no
Elaboration of convenient maintenance schedule		
Recommended Practice for Maintaining different equipment of a substation		

Observation

Learning outcome 1.2: Identify tools and measurement instruments used to maintain substation installations

 Duration: 2 hrs

 Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify types of HV measurement instruments used in substation installations

2. Identify types of tools used in (electromechanical toolkit)

 Resources

Equipment	Tools	Materials
Electromechanical tool kit, High voltage multimeter tester, High voltage detector, Megohmmeter, Protection relay tester, High voltage insulation resistance tester, High voltage Insulation tester, Multi-meter	Circuit breaker tester,	Manual, Books

Advance preparation:

. Handout notes

.Equipment

. Tools

.materials

Indicative content 1: Types of HV measurement instruments used in substation installations

 Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Test equipment is necessary for determining proper set-up, adjustment, operation, andmaintenance of electrical systems and control panels.

Types of HV measurement instruments used in substation installations

High voltage insulation resistance tester

The high voltage system consists of generators, cables for power distribution, transformers, switch gear, and consumers. Here, consumers are large electric motors for propulsion, air conditioning compressors, bow thrusters, etc. Insulation resistance is the key parameter which gives the general condition of an electrical equipment. First of all, make sure IR values are to bechecked between phases and between phases and earth periodically. In addition, these IR valuesare recorded for future references. Also, high voltage equipment's are normally designed for a useful insulation life of 20 years and more. Hence proper operation within rated power, temperature and timely maintenance ensure prolonged life of the equipment.

In high voltage system, insulation resistance is measured using a 5000-volt DC megger, for voltages upto 6.6 kV. Furthermore, insulation resistance is measured under following conditions.

Routines test as per planned maintenance system (PMS)

After a major repair of the equipment, and

Troubleshooting purposes

What is the procedure / precautions for measuring insulation resistance of a high voltageequipment?

First of all, disconnect the power supply to the high voltage (HV) equipment by openingcircuit breaker and opening isolator.

In addition, confirm that all the phases are dead using an approved live line tester. Alsomake sure to check the live line tester for proper functioning using the testing tool provided along with the same.

Close the earthing switch now and make sure all the conductors are earthed.

Now connect the insulation resistance (IR) tester to the conductor, with safety earth connection ON. This is to ensure that the operator is not in contact with any unearthedconductor during insulation resistance (IR) measurement.

After connecting insulation resistance (IR) tester to the circuit, safety earth is to bedisconnected.

Now insulation resistance (IR) test is applied and recorded.

After completion of the testing, safety earth is to be reconnected.

Now disconnect the insulation resistance (IR) tester from the circuit.

This safety measure to be followed for each separate IR test.

Circuit breaker tester

The circuit breaker tester is used to check the operation and condition of circuit breakers on thepower systems; for this purpose, the circuit breaker tester applies different signals which are used to test the equipment under a range of system conditions or operation types.

Protection relay tester

The multiple protection function of today’s protection relay systems requires a new levelof sophisticated test hardware and software to completely analyse the operation of the unit in a "real life" situation. Every facet of relaytesting can be handled with the comprehensiveline of relay test equipment from Megger.

TEST-330 THREE PHASE RELAY MICROCOMPUTER TEST SYSTEM

- Three phase current output
- Five phase voltage output
- Accuracy class 0.2%
- AC current output 0-90A
- AC voltage output 0-260V

Megohmmeter

Megohmmeter or megger is a special type of ohmmeter used to measure the electrical resistance of insulators. Insulating components, for example cable jackets, must be tested for their insulation strength at the time of commissioning and as part of maintenance of high voltageelectrical equipment and installations. For this purpose megohmmeters, which can provide high DC voltages (typically in ranges from 500 V to 5 kV, some are up to 15 kV) at specified currentcapacity, are used. Acceptable insulator resistance values are typically 1 to 10 megohms, depending on the standards referenced

High voltage detector

Electric indicator High Low Mode 12-1000V Socket Wall AC Power Outlet Voltage DetectorVoltage Tester

Figure :High voltage detector

High voltage multimeter tester

This quality High Voltage Multimeter Probe has a maximum voltage of40KV DC and 28KV AC and is intended for use with a digital multimeter with an input impedance of 10MΩ. The probe is helpfully supplied with 1m of connecting lead and 900mm of earth lead as wellas meeting all relevant safety approvals: EN61010, UL3111-1, TUV/GS, IE1010, CATII Pollution 2.

Figure: HVP-40 digital multimeter high voltageprobe 0~40KV 1000:1

Types of tools used in (electromechanical toolkit)

 Theoretical learning Activity

Conduct brainstorming session with the student on recommended practices for equipment of a substation

Have students in their respective groups discuss different types of practices for equipment of a substation

 Practical learning Activity

Provide students with pictures of the different recommended practices for equipment of a substation

 **Points to Remember (Take home message)**

Types of HV measurement instruments used in substation installations are:

High voltage Insulation tester

High voltage insulation resistance tester

Circuit breaker tester

Protection relay tester

Megohmmeter

High voltage detector

High voltage multimeter tester

Indicative content 2: Types of tools used in (electromechanical toolkit)

 Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

The Electro-Mechanical kit is built with bigger industrial, manufacturing plant and all-around maintenance in mind and comes packed with Lifetime Warranty hand tools.

The main Tools List includes the following:

Pliers.

Screwdrivers and nut drivers.

Wire strippers.

Fishing tools.

Measuring devices.

Labeling machines.

Power drills and drivers, hammer/drills.

Power saws.

 **Theoretical learning Activity**

Conduct brainstorming session with the student on recommended practices for equipment of a substation

Have students in their respective groups discuss different types of practices for equipment of a substation


Practical learning Activity

Provide students with pictures of the different recommended practices for equipment of a substation


Points to Remember (Take home message)

The main tools list in (electromechanical toolkit) includes the following:

Pliers.

Screwdrivers and nut drivers.

Wire strippers.

Fishing tools.

Measuring devices.

Labelling machines.

Power drills and drivers, hammer/drills.

Power saws.


Learning outcome 1.2 formative assessment

Written assessment

What is the role of High voltage Insulation tester?

An insulation tester performs the basic measuring function a megohmmeter does—measuring very high resistance values by sending a high voltage signal into the object being tested—and it often does much more; it usually performs more functions, including more complex testing and recording of measurements

Write down 4 Types of HV measurement instruments used in substation installations

High voltage Insulation tester

High voltage insulation resistance tester

Circuit breaker tester

Protection relay tester

High voltage Megohmmeter

High voltage detector

High voltage multimeter tester

Answer true or false

Multmeter is used to measure solar radiation false

High resistance is measured in megawatt false

Screw driver are tools that can be used during maintenance of a substation true

Practical exercise

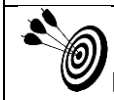
Prepare tools and measurements instruments for maintaining substation

Indicator: :Identify tools and measurement instruments used to maintain substation installations

checklist	yes	no
Identification of different types of measuring instruments		
Identification of different types of leads		
Identification of different types of tools		

observation

Learning outcome 1.3: Identify PPE (Personal Protective Equipment) according to their types

 Duration: 2 hrs		
 Learning outcome 1 objectives: By the end of the learning outcome, the trainees will be able to: 1. Identify types of PPE used in substation installation maintenance. 2. Identify types of tools used in (electromechanical toolkit).		
 Resources		
Equipment	Tools	Materials

- Overcoat and overall, Safety shoes - Helmet - Earmuff - Goggles - Nose protection mask, Gloves		Books - Internet
Advance preparation: . Personal protective Equipment		

Indicative content 3: Types of PPE used in substation installation maintenance.

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Personal protective equipment (PPE) is protective clothing, helmets, goggles, or other garmentsor equipment designed to protect the wearer's body from injury or infection.

The hazards addressed by protective equipment include physical, electrical, heat, chemicals, biohazards, and airborne particulate matter.

The purpose of personal protective equipment is to reduce employee exposure to hazards when engineering controls and administrative controls are not feasible or effective to reduce theserisks to acceptable level

Possible list of PPE

Overcoat and overall

Gloves

Safety shoes

Helmet

Earmuff

Goggles

Nose protection mask

Importance of Safety equipment used for sustation maintenance

Safety shoes for feet protection

Helmet or had hats for head protection against both mechanical and electrical hazards.

Overall is a type of garment which is usually used as protective clothing when working.

Safety Goggles for eye protection that combines both heat and optical radiation protection.

Nose protection mask

Earmuff is an objects designed to cover a person's ears for hearing protection or forwarmth.

Safety glovesare worn to cover and protect hands and wrists from potential hazards indomestic, work site and commercial environments.

Head Protection

Hard hats are common on construction sites. Just passing by a site, you can usually identify workers by their hard hats. They are designed to protect against flying or falling objects that would otherwise impact or penetrate the worker. Some hard hats are equipped with accessories such as face shields and earmuffs. Hard hats should be well-fitted; those that are too large or toosmall are inappropriate for use.

Eye and Face Protection

Eye and face protection are equally as important as head protection. Safety goggles, spectacles and full face shields can give you the protection needed for the eyes and face. Metal work, wood-work, hot-work and air-tool operations all require this type of protection. General laborers can also benefit from safety goggles since there is usually debris on construction sites.

Respiratory protection

Respiratory protection is vital on sites where toxic substances are present. Sometimes what you can't see *can* hurt you? Respiratory protections like respirators are designed to protect you fromdust, fumes, paint spray, pesticides and other dangerous substances that could cause permanent impairment. Respiratory protection should be used in environments with air contaminants. In work environments, respirators are relied upon when adequate ventilation is unavailable or otherengineering control systems are not feasible or inadequate.

Hand & Skin protection

Construction jobs typically require the use of hands. Each year, around 150,000 hand injuries are reported. Occupational skin diseases such as contact dermatitis, skin cancers, and other skin injuries and infections are the second most common type of occupational disease and can be verycostly. Because a lot of work is done with the hands, gloves are an essential item in providing skin protection. Some examples of gloves commonly used as PPE include rubber gloves, cut- resistant gloves, chainsaw gloves and heat-resistant gloves. Using gloves helps to avoid hazards usually involved when working with chemicals, glass, sheet metal, electricity, hot materials or slippery objects.

Hearing protection

Industrial noise is often discounted as an occupational hazard since it isn't visible to the eye. However, 22 million workers in the United States are exposed to potentially harmful noise levelsannually. According to the National Institute for Occupational Safety and Health, about 82% of occupational hearing loss cases occurred to workers in the manufacturing sector.

The Occupational Safety and Health Administration establishes occupational noise exposure standards. NIOSH recommends that worker exposures to noise be reduced to a level equivalentto 85 dBA for eight hours to reduce occupational noise-induced hearing loss. Earplugs and earmuffs are common hearing protection tools. It is important to note that earmuffs are more effective in reducing high-frequency noise while earplugs are more effective for reducing low-frequency noise.

Using PPE, and wearing it properly, is vital to avoid unnecessary injury in the workplace. Choosing not to wear PPE can be dangerous especially when it could save your life. Results Staffing always provides workers with necessary PPE unless otherwise noted. Never hesitate toask temporary staffing agencies if they have the necessary PPE. Safety is important and havingan understanding of these various protection devices can help to prevent hazardous injury

 **Theoretical learning Activity**

Conduct brainstorming session with the student on recommended practices for equipment of a substation

Have students in their respective groups discuss different types of practices for equipment of a substation

 Practical learning Activity

Provide students with pictures of the different recommended practices for equipment of a substation

 **Points to Remember (Take home message)**

Possible list of PPE (Personal Protective equipment)

Overcoat and overall

Gloves

Safety shoes

Helmet

Earmuff

Goggles

Nose protection mask

Importance of Safety equipment used for sustation maintenance

Safety shoes for feet protection

Helmet or had hats for head protection against both mechanical and electrical hazards.

Overall is a type of garment which is usually used as protective clothing when working.

Safety Goggles for eye protection that combines both heat and optical radiation protection.

Nose protection mask: It has the primary purpose of providing source control and to provide a degree of particulate filtration to reduce the amount of inhaled particulate material.

Earmuff is an objects designed to cover a person's ears for hearing protection or forwarmth.

Safety gloves are worn to cover and protect hands and wrists from potential hazards indomestic, work site and commercial environments.

Learning outcome 1.3 formative assessment

Written assessment

Identify Types of PPE used in maintenance of substation

Overcoat and overall

Gloves

Safety shoes

Helmet

Earmuff Goggles

complete the table below

EQUIPMENT	FUNCTION
	Protects the head
Overcoat	
	Protects nose
Goggles	
	Foot protection from injury

EQUIPMENT	FUNCTION
Protective helmets	Protects the head
Overcoat	to protect the worker from chemical, biological, mechanical, thermal, electromagnetic and electrical hazards.
Surgical masks	Protects nose
Goggles	Tight-fitting eye protection that completely cover the eyes, eye sockets and the facial area around the eyes and provide protection from impact, dust,, mists, and splashes.
Safety shoes	Foot protection from injury

Practical exercise

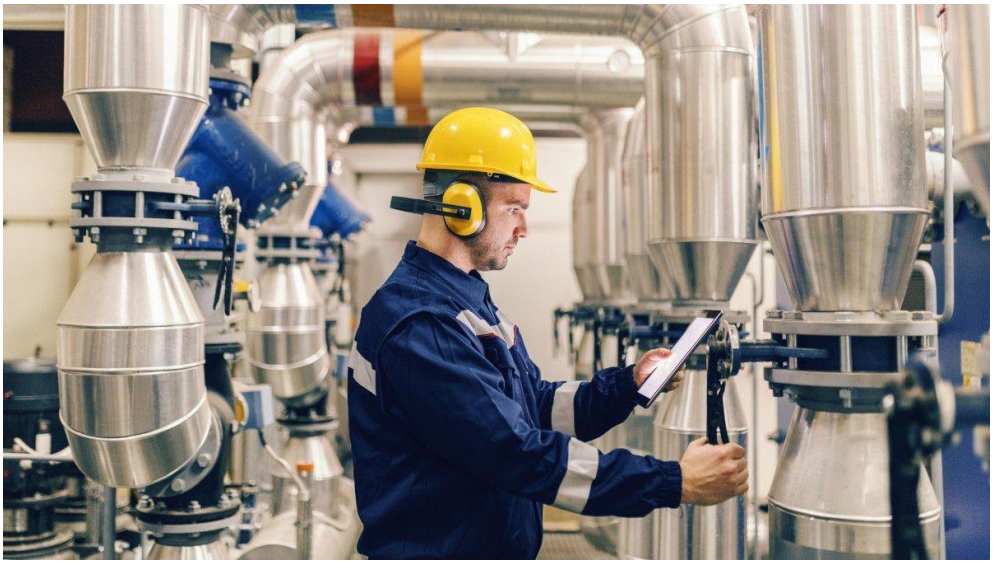
With learners, trainer demonstrate Personal Protective Equipment

Indicator: : Identify PPE (Personal Protective Equipment) according to their types

Checklist	yes	no
PPE usage		
Identification of PPE		

Observation

Learning Unit 2: Execute preventive maintenance

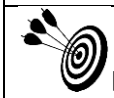


STRUCTURE OF LEARNING UNIT

Learning outcomes
2.1: Identify planned activities according to the preventive maintenance schedule
2.2: Test different equipment of a substation
2.3: Clean/Replace/ Lubricate/Adjust required devices according to their types
2.4: Complete maintenance report according to report format

Learning outcome 2.1: Identify planned activities according to the preventive maintenance schedule


Duration: 5 hrs


Learning outcome 1 objectives:

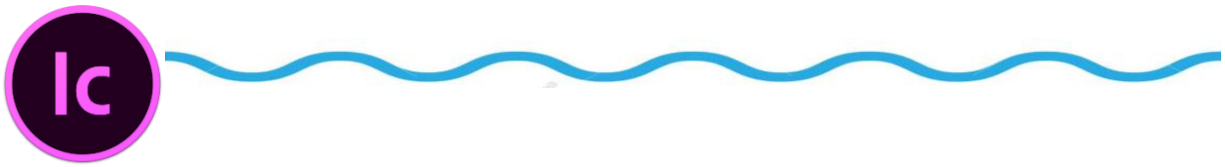
By the end of the learning outcome, the trainees will be able to:

1. Recommend maintenance activities for the different substation equipment
2. Interpret the maintenance records history
3. Identify the Maintenance steps for the different substation equipment


Resources

Equipment	Tools	Materials

		-Books - Internet - Manual - service manuals - Handout notes - Maintenance records
Advance preparation: . Handouts notes		



Indicative content 1: Maintenance steps for the different substation equipment

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Maintenance of Substation

- Daily maintenance:
  - Make record of power (MW) flow in each hour
  - Switchgear equipment's inspection
  - Load management
- Emergency Maintenance:

Emergency maintenance is required when any uncertain hazard is occurred in the electric system.

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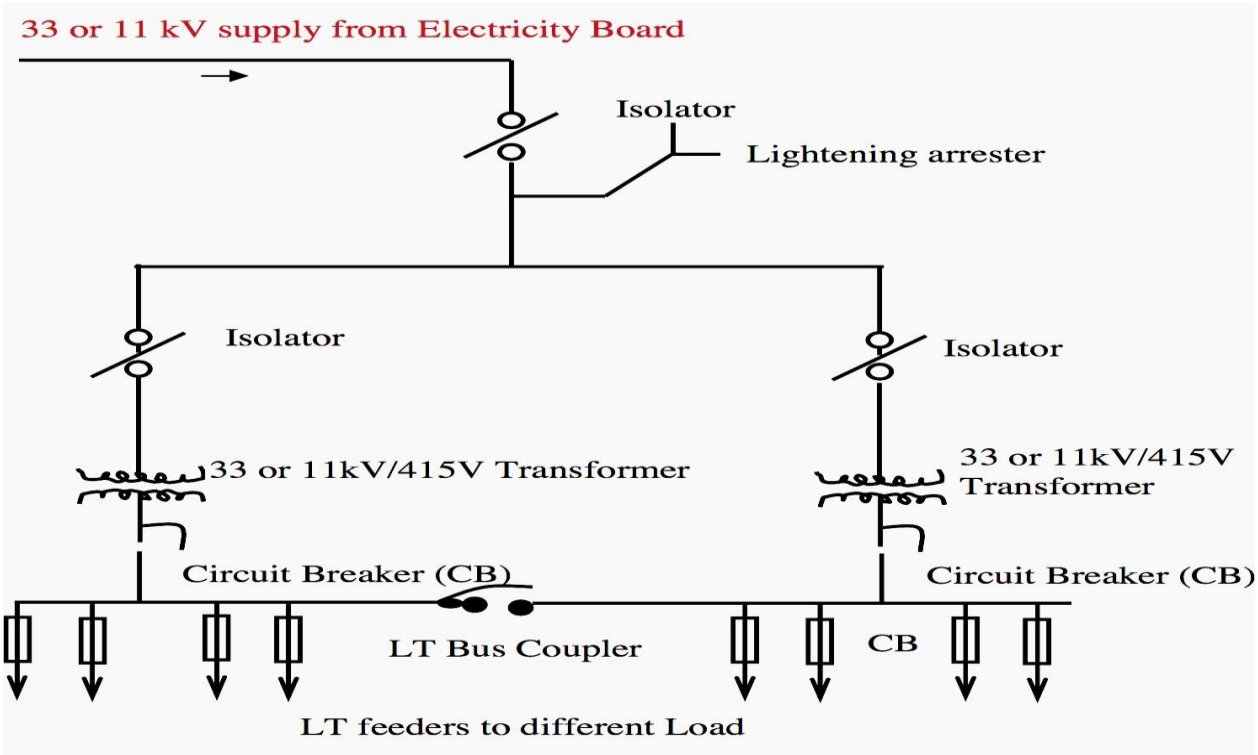
Maintenance steps for the different substation equipment



Bus-bar

A busbar (or bus bar) is a strip of metal used to conduct electricity within an electrical substation, distribution board, electric switchboard or other electrical equipment. A busbar isusually a flat or

hollow piece of copper, brass or aluminium.

When the bus bar maintenance should be done?

Bus bar maintenance can be done when the ship is in black out condition, i.e. ship's generators are not running and no power is supplied to main or emergency switchboards.

If the main switchboard bus bars are to be inspected or to be work on, keep emergencygenerator running.

INSPECTION

Visually inspect for corrosion, damage, or loose or missing hardware.

REMOVAL

Locate defective bus bar (1)

Tag electrical leads (2) connected to defective bus bar (1).

Remove self-locking nuts (3) flat washers (4), and screws (5) securing electrical leads (2) tobus bar (1).

Remove three self-locking nuts (6), six flat washers (7), and three screws (8) securing the busbar (1) to the mount (9).

Remove bus bar.

INSTALLATION

Position bus bar (1) in place.

Install three screws (8), three flat washers (7), and three new self-locking nuts (6).

Install leads (2), screws (5), flat washers (4), and new self-locking nuts (3) and remove tags.

Install two clear plastic covers using six screws and switch box cover.

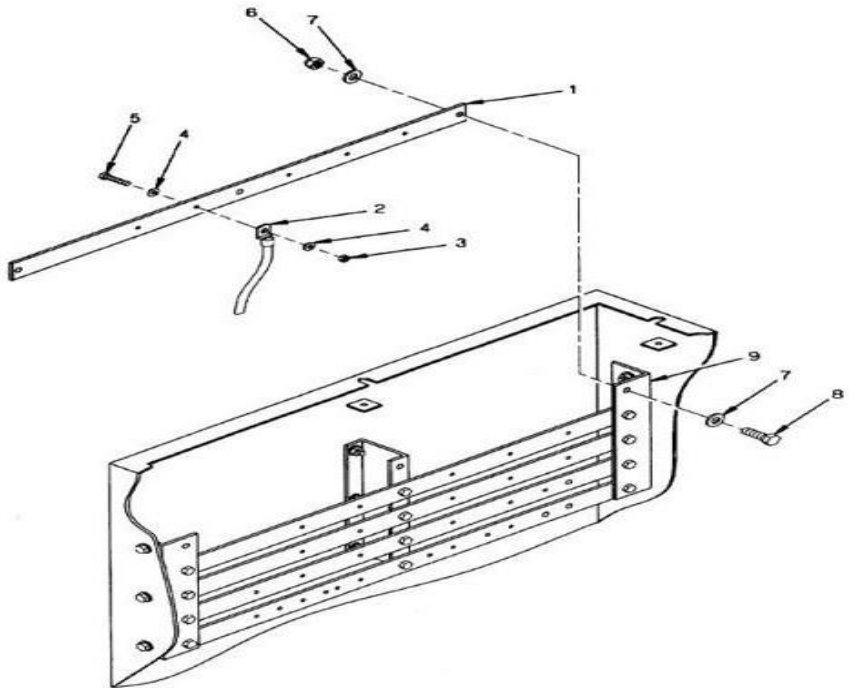


Figure: Bus Bar Maintenance.

Single-break isolating switch and Double-break isolating switch

Its main purpose is to isolate one portion of the circuit from the other and is not intended to beopened while current is flowing in the line. Isolators are generally used on both ends of the breaker so that repair or replacement of circuit breaker can be done without any danger.

Isolation switch does not have a special arc extinguishing device, can not be used to connect andbreak the load current and short circuit current, otherwise it will produce a strong arc, causing personal injury, equipment damage or cause interphase short circuit failure. So the isolation switch points, together with the general operation and circuit breaker with. The effect of the disconnector is:

Isolation of power In the maintenance of electrical equipment, in order to be safe, you need touse the disconnector to shut down the equipment and live equipment isolation, Isolation switch the formation of a clear fracture. Isolated power supplies are the primary use of disconnectors.

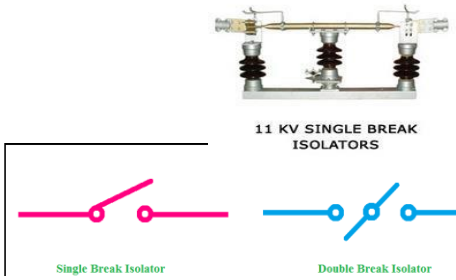
Switching operation when the double bus bar is bypassed or the bypass bus is connected,some disconnectors can be divided in the case of "equipotential", and the circuit breaker is connected with

the circuit breaker.

Points, and small current can be used to sub-combined, voltage transformer, arrester and no- load bus; sub-excitation current is less than 2A no-load transformer; closed capacitor current lessthan 5A no-load lines.

Isolated switch is an indispensable power system is one of the key equipment, Isolation switch it is used to isolate the power supply, play a significant role in disconnecting points in the substation electrical equipment in the largest proportion. The general isolating switch has a simple structure and is installed on the power supply side and the load side of the chopper. Sinceit is mechanical, it often fails.

.Disconnector is mainly used to high-voltage power distribution devices need to power off part of the live part of the reliable isolation to ensure the safety of ma disconnector are exposed to the air and have a clear disco arc extinguishing device and cannot be used to cut off the



short circuit current. Otherwise, under high pressure,

the breaking point will produce a strong arc , And it is

difficult to extinguish itself, and may even cause arcing (re ;
equipment, endangering personal safety,which is the so-called with a load pull on the switch serious accident.

Disconnectors, including load switches, Isolation switch such as the common HGL series of load disconnect switches and HH15 disconnectors, can also be used to switch some of the circuit to change the operation of the system. For example, in a double bus circuit, you can use a disconnector to switch the running circuit from one bus to another. At the same time, can also beused to operate some small current circuit.

1, For the isolation of power, the high-voltage maintenance equipment and charged equipment separated, so there is a significant visible break point.

2, Disconnector and circuit breaker with the system according to the needs of the operation of the switch operation to change the system running wiring.

3, To turn on or off the small current circuit. Such as points, combined with the voltage transformer and arrester; points, together a certain length of the bus, cable, overhead linecapacitance and a certain capacity of no-load transformer no-load current

On load switch disconnector:

it is switch disconnector that can open and close the circuit on load and perform theisolation required.

Off Load switch disconnector:

It is switch disconnector that must open and close the circuit when load is off (it cannotoperate on nominal load) - For example - Earthing switch used with CB during maintenance

Isolating switch with earth Blade

A metal-clad isolator switch for multiple interruptions divided in two parts insulated from each other and comprising means for connecting the interconnected movable switching contacts of theisolator switch with earth and a selectively operating signaling and protecting system which selectively indicates, when and in which one of the isolator switch parts an unwanted earth- connection occurs.

MAINTENANCE FOR DISCONNECTORS

Mechanisms should be adjusted to maintain full contact on the poles of a multi-poleswitch as simultaneously as possible.

Arcing horns shall be adjusted such that it should barely touch the movable switchmechanism when opened and closed.

Main contacts and arcing horns should be cleaned for dirt, oxides and pitting and livecontacts should be silvered or replace if necessary.

Electrical grounds should be checked for continuity and tightness. Ground sources shouldbe checked to be sure that their resistance is sufficiently low.

Disconnector hinges should be lubricated, but kept sufficiently stiff so that when the blades are open they will not fall back on the live stationary contacts. Other rotating partsshould also be lubricated.

All bolts and nuts, clamps, guide plates and other similar parts should be tightened andadjusted.

Supporting insulators should be cleaned and inspected for cracks and signs of flash overor fatigue.

The motors and electric supply and controls shall be checked periodically.

Locking arrangements shall be checked to make sure that they are reasonably safe frombeing tampered by unauthorized people.

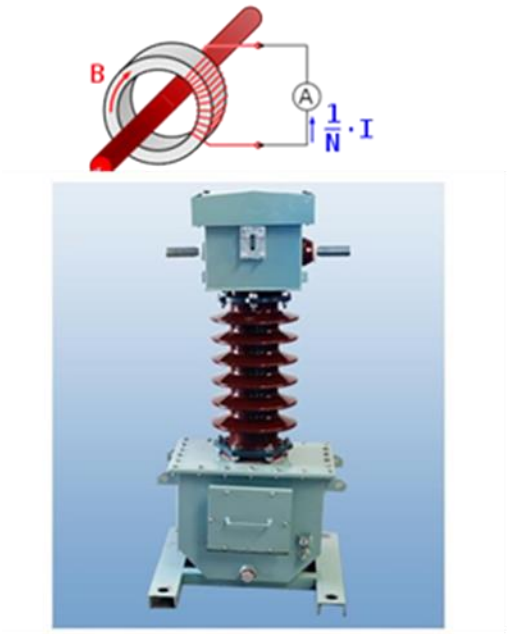
It is good practice to open and close Disconnector switches which are not in operation forlong

stretches of time to make sure that they are in good mechanical operating conditions.The frequency of such checking depends on their exposure to cold, rain, salt, polluted atmosphere and other local adverse conditions.

Check the Insulation and contact resistance of each pole of the disconnector.

Current transformer

A current transformer (CT) is a type of transformer that is used to reduce or multiply analternating current (AC). It produces a current in its secondary which isproportional to the current in its primary. Current transformers, alongwith voltage or potential transformers, are instrument transformers.



Maintenance of Current Transformer

A Current Transformer or CT is very essential equipment installed in an electrical substation for electrical measurementand protection purpose. If a current transformer does not perform properly, there may be a huge disturbance in the system due to malfunctioning of protection relays. So far accurate measurement and smooth operation of an electrical power system, CTs must be properly maintained. A schedule of such maintenance of current transformer is preferred belowfor ready reference. Let us first discuss the maintenance of CTwhich to be performed in a one-year interval.

figure: current transformer

Insulation resistance of the CT must be checked in yearly basis.

During insulation resistance measurement, it must be remembered that, in current transformerthere

are two level of insulation. The insulation level of primary of CT is quite high as it has to withstand full system voltage. But the secondary of the CT has low insulation level generally 1.1 KV. So primary to secondary and primary to earth of a current transformer are measured with 2.5or 5 KV megger. But this high voltage megger cannot be used for secondary measurement, as here insulation level is quite low in the view of economy of the design. So secondary insulation ismeasured with 500 V megger. Hence, primary terminals to earth, primary terminals to secondary measuring core, primary terminals to secondary protection cores are measured by 2.5 or 5 KV megger. In between secondary cores and secondary to earth resistances are measured by 500V megger.

Thermo vision scanning of primary terminals and top dome of a live CT should be performed atleast once in a year. This scanning can be done with help of infra-red Thermo-vision Camera.

All the CT secondary connections in CT secondary box and CT junction box must be checked, cleaned and tighten every year to ensure maximum possible low resistance path for CT secondarycurrents. It should also be ensured that CT junction box is properly cleaned.

There are some other maintenance of Current Transformer which to be performed in half yearlybasis, such as,

The porcelain housing of CTs should be checked for hire crack if any crack is observed oninsulator, necessary advice to be obtained from manufacturer.

The porcelain insulator housing of current transformer, to be cleaned properly by cotton clothes.

Now we will discuss about monthly basis maintenance of current transformer.

Oil leakage from any joint should be visually inspected if leakage found, it must be plugged bytaking shutdown.

The secondary terminals are also checked for oil leakage, if leakage found, immediate action tobe taken to plug the leakage.

In addition to these, tans or loss factor measurement to be performed on a current transformer, preferably above 66 KV class, once in two years.

Dissolve Gas Analysis of oil also to be done preferably once in 4 years. If the results are found unsatisfactory as per standard, the insulating oil must be replaced

Potential transformer

Maintenance of Voltage Transformer and Capacitor Voltage Transformer

Construction wise a voltage transformer and a capacitor voltage transformer are same. Hence basis scheme of maintenance of both voltage transformer and capacitor voltage transformer aremore or less same. As heavy current does not flow through PT and CVT, the defect and fault generally very low.

That is why monthly maintenance of voltage transformer and maintenance of capacitor voltage transformer may not be required. Moreover very frequent maintenance of bus PT or CVT may not also be possible as far taking shutdown of such PT or CVT total bus section would be out ofprotection and metering. Only yearly maintenance of such equipments are sufficient.

Yearly Maintenance of Voltage Transformer or Capacitor Voltage Transformer

The porcelain housing must be cleaned with cotton clothes.

The spark gap assembly to be checked on yearly basis. Remove the moveable part of spark gap as assembly, clean the braes electrode with emery paper and fix it back in position.

The high frequency earthing point should be visually checked yearly in the case, the point is notused for PLCC.

Thermo vision camera to be used for checking any hot spots in the capacitor stacks to ensure proaction of rectification.

The terminal connections PT junction box including earth connections to be checked for tightnessonce in a year. In addition to that, the PT junction box also to be cleaned properly once in a year.

The health of all gaskets joint also to be visually checked and replaced if any damaged gasketfound.

Note that in addition all yearly basis maintenance of potential transformer or capacitorvoltage transformer must also be checked for tan δ once in 3 years. An increase in the value of tan δ indicates deterioration of insulation whereas both increases in tan δ and capacitance indicate the entry of moisture into the insulation

Power transformer

Monthly Basis Maintenance of Transformer

Let us first discuss about the action to be taken on power transformer in monthly basis.

The oil level in oil cap under silica gel breather must be checked in a one-month interval. If it isfound the transformer oil inside the cup comes below the specified level, oil to be top up as per specified level.

Breathing holes in silica gel breather should also be checked monthly and properly cleaned ifrequired, for proper breathing action.

If the transformer has oil filled bushing the oil level of transformer oil inside the bushing must be vidually checked in the oil gage attached to those bushing. This action also to be done monthly basis.

If it is required, the oil to be filled in the bushing upto correct level. Oil filling to be done under shutdown condition.

Daily Basis Maintenance and Checking

There are three main things which to be checked on a power transformer on a daily basis:

Reading of MOG (Magnetic Oil Gauge) of main tank and conservator tank.

Color of silica gel in breather.

Leakage of oil from any point of a transformer.

In case of unsatisfactory oil level in the MOG, oil to be filled in transformer and also the transformer tank to be checked for oil leakage. If oil leakage is found take required action to plugthe leakage. If silica gel becomes pinkish, it should be replaced.

Yearly Basis Transformer Maintenance Schedule

The auto, remote, manual function of cooling system that means, oil pumps, air fans, and other items engaged in cooling system of transformer, along with their control circuit to be checked inthe interval of one year. In the case of trouble, investigate control circuit and physical condition of pumps and fans.

All the bushings of the transformer to be cleaned by soft cotton cloths yearly. During cleaning the bushing should be checked for cracking.

Oil condition of OLTC to be examined in every year. For that, oil sample to be taken from drain valve of

divertor tank, and this collected oil sample to be tested for dielectric strength (BDV) andmoisture content (PPM). If BDV is low and PPM for moisture is found high compared to recommended values, the oil inside the OLTC to be replaced or filtered.

Mechanical inspection of Buchholz relays to be carried out on yearly basis.

All marshalling boxes to be cleaned from inside at least once in a year. All illumination, space heaters, to be checked whether they are functioning properly or not. If not, required maintenanceaction to be taken. All the terminal connections of control and relay wiring to be checked an tighten at least once in a year.

All the relays, alarms and control switches along with their circuit, in R&C panel (Relay andControl Panel) and RTCC (Remote Tap Changer Control Panel) to be cleaned by appropriatecleaning agent.

The pockets for OTI, WTI (Oil Temperature Indicator & Winding Temperature Indicator) on the transformer top cover to be checked and if required oil to be replenished.

The proper function of Pressure Release Device and Buchholz relay must be checked annually. For that, trip contacts and alarm contacts of the said devices are shorted by a small piece of wire,and observe whether the concerned relays in remote panel are properly working or not.

Insulation resistance and polarization index of transformer must be checked with battery operated megger of 5 KV range.

Resistive value of earth connection and rizer must be measured annually with clamp on earthresistance meter.

DGA or Dissolve Gas Analysis of transformer Oil should be performed, annually for 132 KV transformer, once in 2 years for the transformer below 132 KV transformer and in 2 years intervalfor the transformer above 132 KV transformer.

The Action to be taken once in 2 years:

The calibration of OTI and WTI must be carried once in two years.

Tan & delta; measurement of bushings of transformer also to be done once in two years.

Maintenance of Transformer on Half Yearly Basis

The transformer oil must be checked half yearly basis that means once in 6 months, for dielectric strength, water content, acidity, sludge content, flash point, DDA, IFT, resistivityfor transformeroil.

In the case of adistribution transformer, as they are operating light load condition all the time ofday remaining peak hours, so there are no maintenance required.

Oil circuit breaker

Oil circuit breaker is such type of circuit breaker which used oil as a dielectric or insulating medium for arc extinction. In oil circuit breaker the contacts of the breakerare made to separate within an insulating oil.

When the fault occurs in the system the contacts of the circuitbreaker are open under the insulating oil, and an arc is developed between them and the heat of the arc is evaporated

in the surrounding oil. The oil circuit breaker is divided into two categories

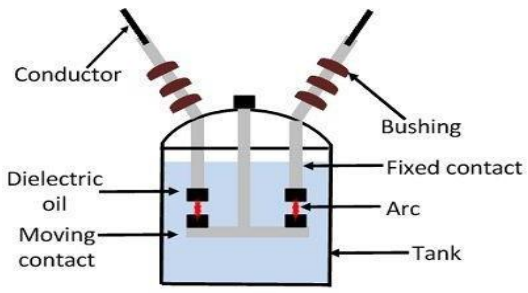
Maintenance of oil circuit breaker

After a circuit breaker has interrupted by short-circuit current, sometimes their contacts may getburnt due to arcing. Also, the dielectric oil gets carbonized in the area of the contacts, thereby losing its dielectric strength. This results in the reduced breaking capacity of the breaker.

Therefore, the maintenance of oil circuit breaker is essential for checking and replacement of oiland contacts.

Air blast circuit breaker

Air blast circuit breaker used compressed air or gas as the arc interrupting medium. In the air blast, circuit breaker compressed air is stored in a tank and released through a nozzle to produce a high-velocity jet; this is used to extinguish the arc. Air blast circuit breakers are used for indoorservices in the medium high voltage field and medium rupturing capacity



Bulk Oil Circuit Breaker

Negligible Maintenance:

The ability of the air-blast circuitbreak
maintenance is required. For example
circuit breaker need an installation of
requirement arises with an air-blast c

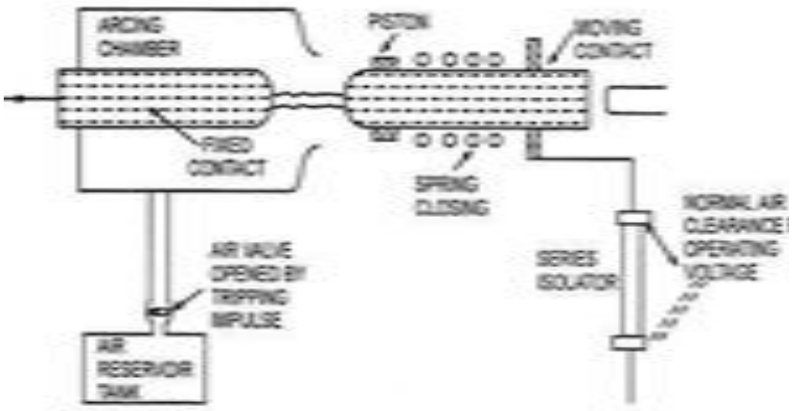


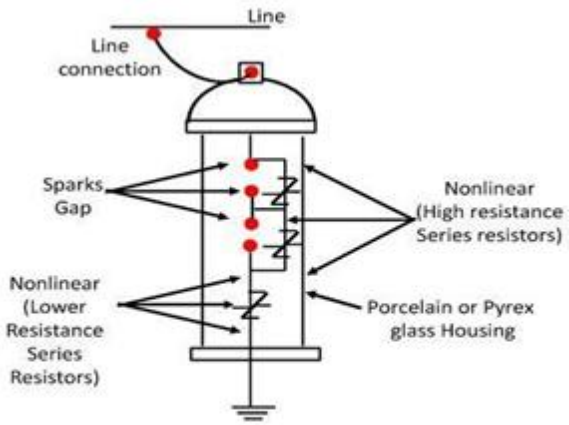
Fig. 16.15. Axial Blast Air Circuit Breaker

Lightning arrester (active gap)

The lightning arrester protects the ele
equipment and when the lightning oc
ground. The selection of arrester dep
The lightning arrestor is mainly classif

Lightning arrester (valve type)

The lightning arrester which consists the single
controlling element, such type of arrester is kn
electrodesintercepts the flow of current throu
raises beyondthe critical gap flashover. The va
silicon carbide surge diverter with a series gap



Valve Type Lightning Arrester

Maintenance of lightning arrestor

When it comes to viable lightning protection solutions, first rule is, you must have it! If you do have it, the equipment needs to be in good working order to be effective. Like any other technology or equipment, it needs to be installedproperly, inspected and maintained.

Now, when dealing with the extraction, refining and storage of combustible liquids, as widely practiced in the Oil and Gas industry, do you really want to take the chance of your systems notworking? I think

not. Inspection is imperative and should be part of responsible and good risk management and emergency best practices plan for business continuance.

Over current relay

Overcurrent Relay is a type of the protection relay, which operates when the current increases beyond the operating value of the relay Over Current conditions are the one where there is short circuit occurs in the system or the faults which causes the current in the conducter to increase exponentially

Earth fault relay

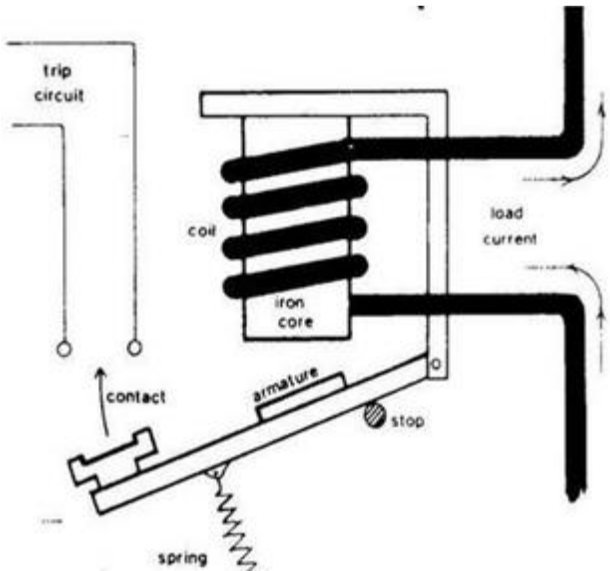
The earth fault relay is basically a protection device used selectively for earth fault protection. These can be used for both primary and backup protection in an electrical system

Maintenance of relay

A ship engineer or electrical officer has to make sure that relay is efficiently in operation and allthe maintenance is carried out on the same as per schedule or as per continuous monitoring.

If during inspection, the relay is found out to be defective it must be replaced immediately with aspare one.

A simple electromagnetic Relay is shown inthe below diagram and it will get activated when the magnetic effect of the iron core is sufficiently increased by the excess or high current in the coil which will attract the ironarmature held against the spring force to trip the circuit.



A brief maintenance for relay is given asfollows-

Checks to be carried out on relay contacts for damage due to arcing.

Polish the contact with emery paper toremove rust and deposits.

Check the closing linkage for free movement.

Check the continuity of the contacts with multimeter.

There are arc chutes provided to quench the arcing. Check for burnout of the same.

Check the tension of the spring.

Open circuit and short circuit test to be performed on the coil by multimeter.

Check the continuity of the trip circuit by multimeter.

Check tightness of the supply terminals.

Theoretical learning Activity

Brainstorming on the interpretation of the maintenance records

Group discussion on recommended maintenance activities

Group discussion on maintenance steps

Documentary Research

Practical learning Activity

Points to Remember (Take home message)

Maintenance steps for the different substation equipment:

Bus-bar

Single-break isolating switch

Double-break isolating switch

On load isolating switch

Isolating switch with earth Blade

Current transformer

Potential transformer

Capacitive voltage transformer

Oil circuit breaker

Air circuit breaker with overcurrent tripping device

Air blast circuit breaker

Lightning arrester (active gap)

Lightning arrester (valve type)

Arcing horn

Three-phase Power transformer

Over current relay

Earth fault relay

Indicative content 2.2: Interpretation of the maintenance records history

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Interpretation of the maintenance records history

A type of paper based or electronic record of a list of the necessary and vital maintenance that isrequired to be completed by a maintenance person, the status of the task and the closure of the task when it is completed.

A maintenance record is a helpful tool to assign tasks to a maintenance person and update othermembers of a team in relation to any type of maintenance that has been recorded and track the status of the record until it is completed.

Theoretical learning Activity

Brainstorming on the interpretation of the maintenance records

Group discussion on recommended maintenance activities

Group discussion on maintenance steps

Documentary Research

Practical learning Activity

 **Points to Remember (Take home message)**

A maintenance record is a helpful tool to assign tasks to a maintenance person and update othermembers of a team in relation to any type of maintenance that has been recorded and track the status of the record until it is completed.

Learning outcome 2. 1 formative assessment

Written assessment

What are the recommended activities planned during substation equipment maintenance?

daily activities

Weekly activities

Monthly activities

Annual activities

"What should be stated in the maintenance record?
The records must include:

A description (or reference to data acceptable to the Administrator) of the work performed; and

The date of completion of the work performed; and

The signature, and certificate number of the person approving the aircraft for return to service

Answer true or false

The following equipment are included in substation's equipment

Instrument transformer true

Current transformer measures the potential difference false

Practical exercise

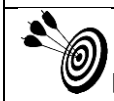
With learners, trainer demonstrate guide learners to perform preventive maintenance

Indicator: : identify planned activities according to the preventive maintenance schedule

Checklist	yes	no
identification of recommended maintenance activities		
interpretation of maintenance record		
identification of maintenance steps for different parts of a substation		

Observation

Learning outcome 2.2: Test different equipment of a substation

<table>
<tr><td colspan="3">  Duration: 5 hrs</td></tr>
<tr><td colspan="3">  Learning outcome 2 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify general faults that occurs in substation installations</td></tr>
<tr><td colspan="3">  Resources</td></tr>
<tr><td>Equipment</td><td>Tools</td><td>Materials</td></tr>
<tr><td>Electromechanical tool kit, High voltage multimeter tester, High voltage detector, Megohmmeter, Protection relay tester, High voltage insulation resistance tester, High voltage Insulation tester, Multi-meter</td><td>- Handout notes</td><td>Books –

Internet –

Service manuals</td></tr>
<tr><td colspan="3">Advance preparation:

. site visit

. Site engineer

. Simulations</td></tr>
</table>

Indicative content 2.1: General faults that occurs in substation installations

 Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

General faults that occurs in substation installations

Switching equipments faults

Equipment failures: Various electrical equipments like generators, motors, transformers,reactors, switching devices, etc causes short circuit faults due to malfunctioning, ageing, insulation failure of cables and winding.

Protection equipments faults

The devices that are used to protect the power systems from faults are called protectiondevices.

Arc-fault circuit interrupter.

Earth leakage circuit breaker.

Residual-current device (GFI)

Power-system protection.

Protective relay.

Digital protective relay.

Sulfur hexafluoride circuit breaker.

Insulating materials faults

All faults associated with the unit may be classified as either insulation failure or abnormal running conditions. An insulation failure will result in either an interturn fault, a phase-to-phasefault, or an earth fault, but more commonly the last one because most insulation failures eventually bring the winding into direct contact with the core.

The abnormal running conditions to be protected against comprise are:

(a)Overloading (b)Loss of excitation

(c)Unbalanced load (d)Lubrication oil failure (e)Failure of prime mover

(f)Overspeeding (g)Rotor displacement

Excessive vibration

Conductors faults

Open Conductor Faults: When one or two phases of a balanced three-phase line opens it createsan unbalance in the system and results in the flow of unbalanced currents. Such open

conductor faults can also be analysed with the help of [¯ZBus] matrices of sequence networks.

Power transformers faults

A number of transformer fault conditions can arise practically in any time following some special situations. These include the following 5 most common internal faults and few external:

Earth faults

Core faults

Inter turn faults

Phase-to-phase faults

Tank faults

External factors

Earth faults

A fault on a transformer winding will result in currents that depend on the source, neutral grounding

impedance, leakage reactance of the transformer, and the position of the fault in thewindings. The winding connections also influence the magnitude of fault current.

N.B: In the case of a Y-connected winding with neutral point connected to ground through an impedance Zg, the fault current depends on Zgand is proportional to the distance of the fault fromthe neutral point.

Core faults

Core faults due to insulation breakdown can permit sufficient eddy-current to flow to cause overheating, which may reach a magnitude sufficient to damage the winding.

Interturn faults

Interturn faults occur due to winding flashovers caused by line surges. A short circuit of a fewturns of the winding will give rise to high currents in the short-circuited loops, but the terminal currents will be low.

Phase-to-phase faults

Phase-to-phase faults are rare in occurrence but will result in substantial currents of magnitudes

similar to earth faults

Tank faults

Tank faults resulting in loss of oil reduce winding insulation as well as producing abnormaltemperature rises.

External factors

In addition to fault conditions within the transformer, abnormal conditions due to externalfactors result in stresses on the transformer.

These conditions include:

Overloading,

System faults,

Over voltages, and

Under-frequency operation.

 **Theoretical learning Activity**

Brainstorming on general faults that occur in substation system.

Group discussion on general faults that occur in substation system.

Documentary Research

 **Practical learning Activity**

 **Points to Remember (Take home message)**

General faults that occurs in substation installations are:

Switching equipments faults

Protection equipments faults

Insulating materials faults

Conductors faults

Power transformers faults

 Learning outcome 2.2 formative assessment

Written assessment

Clarify the common faults that occur in substation installation

Switching equipment faults

Protection equipment faults

Insulating materials faults

Conductors faults

Power transformers faults

List some causes of electrical faults that occur in a substation

Mechanical causes

Breakdown of insulating materials

Overloading

Lighting and transient’s voltage

fill in the blanks by appropriate words/ figures :

A sub-station ..... some characteristic of electric supply.

Most of the sub-stations in the power system change..... of electric supply.

An ideal location for the sub-station would be at the ..... of load.

Pole-mounted sub-stations are used for ..... distribution.

Answer:

((i) changes (ii) voltage level (iii) centre of gravity (iv) secondary)

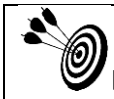
Practical exercise

With learners, trainer demonstrate and guide learners to test different equipment of a substation

Indicator: : **Test different equipment of a substation**		
Checklist	yes	no
power transformer testing		
measuring transformer testing		

Learning outcome 2.3: Clean/Replace/ Lubricate/Adjust required devices according to their types

 Duration: 5 hrs


Learning outcome 3 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify Cleaning techniques of different parts of substation equipments

2. Identify assembling and disassembling techniques of different parts of substation equipment

3. Differentiate equipment of a substation that need lubricating

4. Identify lubricating procedures of mechanical parts

5. Identify Adjustment/replacement of defective parts


Resources

Equipment	Tools	Materials
- Electrician toolbox, PPE, - Power transformer	Service and user manuals	Books - Internet Journals, Handout notes - Fuses - Circuit breakers - Switchgears - Protective relay - Bus bar

Advance preparation:

. Handout notes

. PPE

.Equipment

Indicative content 1: Cleaning techniques of different parts of substation equipments

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Cleaning techniques of different parts of substation equipments

Personnel should be properly qualified before cleaning electrical equipment.

Rags and Brushes. ...

Liquid Solvents and Water. ...

Vacuum Cleaning. ...

Sweeping and Moping.

Theoretical learning Activity

Brainstorming on the cleaning techniques

Group discussion on the faults detection and repairs

Documentary Research

Practical learning Activity

Points to Remember (Take home message)

Personnel should be properly qualified before cleaning electrical equipment.

Rags and Brushes. ...

Liquid Solvents and Water. ...

Vacuum Cleaning. ...

Sweeping and Moping.

Indicative content 2: Assembling and disassembling techniques of different parts of substation equipment

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Assembling and disassembling techniques of different parts of substation equipment

Techniques of assembling and dissembling different part of substation depend on kind of

equipment you are going to repair they are non-common techniques any technician can use.

 **Theoretical learning Activity**

Brainstorming on the cleaning techniques

Group discussion on the faults detection and repairs

Documentary Research

 **Practical learning Activity**

Physical demonstration of lubricating oils

Practical exercises on the repair works

 Points to Remember (Take home message)

Techniques of assembling and dissembling different part of substation :

Indicative content 3: Lubricating procedures of mechanical parts

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Lubrication Techniques for Circuit Breaker Mechanisms

circuit breaker analyzers are used to determine operating speeds and velocity of the lift rod and contacts. This information enables the technician to determine if a breaker is safe to place back into service. The data recorded by a test set allows technicians to measure the time it takes fromthe moment the trip or close button is activated until the breaker closes or opens fully. This is anelectrical testing method to determine the mechanical health of the operating mechanism used toopen and close the current carrying contacts. Subsequently, the results can be compared to the manufacturer's design specifications.

As with any load interruption device, contact speed is paramount. However, most companies spend the majority of their time and money ensuring that the contact resistance and interrupting media quality meets specification, and fail at the most basic of maintenance tasks that contributesthe most to breaker health – that task is lubrication.

Many companies have no breaker lubrication standards, and in many cases, are not familiar withthe different types of lubrications that can be used. Often, they are also unsure of how specific lubrications should be applied and how often they should be used.

Degraded Lubrication

Circuit breaker failure due to degraded and desiccated lubrication is the number one failure modefound in circuit breakers. Degraded lubrication causing slow mechanism operation results when bearings begin to freeze up as a result of rust forming between the moving and stationary portions of the bearing. Grease is nothing more than a carrier, such as soap injected with oil, which holds the lubricant in the bearing and race.

Over time, the oil evaporates or drips out leaving a hygroscopic carrier behind to absorb water and initiate rust and corrosion formation. The rust adheres to both the fixed and moveable portion of the bearing, and begins reducing torque available from the operation mechanism. Thisresults in a slowing of the mechanism during operation, which can be detected while running a timing test. As the rust accumulates, it will continue to slow the mechanism, eventually causing the breaker operation parameters to exceed those specified in the protection scheme.

Consequently, other breakers on the same line may be called upon to interrupt excess fault current and possibly fail as well.

Benefits of Using Lubrication Procedure

There are many types of lubrications such as penetrating fluids, greases and oils. Each type of lubrication has its place, but needs to be applied properly and in the correct amounts in order to be effective in prolonging reliable operation of a circuit breaker. Integrating lubrication procedures into yourtest and maintenance program can greatly increase the reliability of circuit breakers over time. It is a basicand cost-effective step to ensure proper breaker operation when it is called upon to open or close.

 **Theoretical learning Activity**

Brainstorming on the cleaning techniques

Group discussion on the faults detection and repairs

Documentary Research

 Practical learning Activity

Physical demonstration of lubricating oils

Practical exercises on the repair works


Points to Remember (Take home message)

Lubricating procedures of mechanical parts:

Types of lubricating oils:

Lubricating oil, sometimes simply called lubricant/lube, is a class of oils used to reduce the friction, heat, and wear between mechanical components that are in contact with each other. Lubricating oil is used in motorized vehicles, where it is known specifically as motor oil and transmission fluid.

There are two basic categories of lubricating oil: mineral and synthetic.

-Mineral oils are lubricating oils refined from naturally occurring crude oil.

-Synthetic oils are lubricating oils that are manufactured.[2] Mineral lubricating oils are currently the most commonly used type because of the low cost of extracting the oils from crude oil. Additionally, mineral oils can be manufactured to have a varying viscosity, therefore making them useful in a wide range of applications.

Parts needing lubrication:

Transformers

Circuit breakers

Disconnecting switches

Substation bus bar

Lightning arresters

Protective relays

Fuses

Indicative content 4: Adjustment/replacement of defective parts

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)


Theoretical learning Activity

Brainstorming on the cleaning techniques

Group discussion on the faults detection and repairs

Documentary Research


Practical learning Activity

Physical demonstration of lubricating oils

Practical exercises on the repair works


Points to Remember (Take home message)

Lubricating procedures of mechanical parts:

Types of lubricating oils:

Lubricating oil, sometimes simply called lubricant/lube, is a class of oils used to reduce the friction, heat, and wear between mechanical components that are in contact with each other. Lubricating oil is used in motorized vehicles, where it is known specifically as motor oil and transmission fluid.

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Parts needing lubrication:

Transformers

Circuit breakers

Disconnecting switches

Substation busbar

Lightning arresters

Protective relays

Fuses


Learning outcome 2.3 formative assessment

Written assessment

Identify different methods of cleaning electrical substations

Equipment.

Answer: methods of cleaning electrical substations equipment include the:

use of vacuums,

pressure-washing,

compressed air,

sandblasting or

harsh chemical cleaners.

All of these methods require a significant, on-average 5-7 days of substation downtime

answer true or false

Different equipment of a substation need lubrication. true

Lubricating process of mechanical parts is not important for substation equipment false

Substation's component can fail to work if not well maintained true

Outline the techniques used to dismantle/assemble electrical equipment

Answer: unplugging, desoldering, removal of screwed, clamped and crimped connections

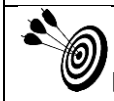
Practical exercise

With learners, trainer guide learners to Clean/Replace/ Lubricate/Adjust required devices according to their types

Indicator: : **Clean/Replace/ Lubricate/Adjust required devices according to their types**		
Checklist	yes	no
identification of different substation equipment that need lubricating		
Application of cleaning techniques		
application of assembling and disassembling techniques		
appropriate lubricating oil		
application of lubricating techniques		

Learning outcome 2.4: Complete maintenance report according to report format


Duration: 5 hrs


Learning outcome 3 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Preparation of the maintenance report
2. Keeping records of maintenance activities
3. Analysis of the maintenance report.


Resources

Equipment	Tools	Materials
		- Books - Internet - Service manuals - Maintenance report

Advance preparation:

Indicative content 4. Preparation of the maintenance report

 Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

4: Complete maintenance report according to report format

Preparation of the maintenance report

To prepare maintenance report is important because remind technician to maintenancedate and show also the action of the worker. Maintenance report should be in form of table

Maintenance report format

Company	institution name	technician name	Date of maintenance	planned activities planned date for next maintenance	Equipment specifications	Checklist table	recommendation

Keeping records of maintenance activities on normal place and also as evidence after allAnalysis of the maintenance report and give clarification

Indicative content 2.4. Keeping records of maintenance activities

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Documenting every repair or maintenance work done on your equipment will help you process warranty claims much easier. Keep a record of the type of maintenance work done to your equipment as well as the exact time and date repairs were done as this information will help determine your rights for the warranty claims

Maintenance records are written notes that provide documentation about the upkeep of a certain piece of equipment. Most of the time when people talk about these sorts of records in an industrial setting they're referring to the formalized reports and files kept by fleet owners, industrial plant operators, or other business people engaged in some sort of work with machines. Keeping an adequate log of mechanical service and repairs in these scenarios is usually considered good business practice, and may also be required by law. Records are particularly useful in maintenance management because they help businesses ensure that their equipment is kept in good condition, and they also offer a way to manage and track repair and preventative upkeep expenses.

Records can also be used by individuals, however. Many people keep detailed records of personal automobile maintenance, and may also record service performed on home

appliances like air conditioning units and back-up generators. This can streamline needed repairs and can also make re-sale a lot smoother.

Why They’re Kept

Regardless of the setting specifics, maintenance record management is often important for a number of reasons. For instance, a maintenance schedule can be invaluable in assisting service technicians with diagnosing repeat problems with a machine or vehicle. In addition, good records help department managers, employees, and even sometimes individuals, ensure that a piece of equipment is performing in line with any manufacturer warranties. They can also help companies track when a piece of equipment needs to undergo preventive maintenance.


Learning outcome 2.4 formative assessment

Written assessment

Why do you have to prepare maintenance report?

Maintenance report is a document that holds specific data about inspections and tasks as well as their effects on overall maintenance operations. You use them to gain visibility on your operations, which you can then leverage into better.

What elements that are found in Maintenance report format

Answer:

Company/institution name,

technician name,

Date of maintenance,

planned activities

planned date for next maintenance,

Equipment specifications,

Checklist table,

recommendation)

why is it necessary to keep record of maintenance?

Prevent expensive repair work from happening

Helps you create specialized maintenance programs

Prevent problems warranty claims

It increases the safety of operators

Helps you tracks who is accountable for a piece of equipment

Practical exercise

trainer guide learners to Complete maintenance report according to report format

Indicator :Complete maintenance report according to report format		
Checklist	yes	no
Identification of substation installations troubleshooting procedures		
Troubleshooting circuit breaker		
Troubleshooting fuses		
Troubleshooting power transformer		
Troubleshooting measuring transformer		
Troubleshooting power conductors		

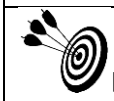
Learning Unit 3: Rectify faults in substation installations

STRUCTURE OF LEARNING UNIT

Learning outcomes:
Appropriate identification of faults according to troubleshoot procedures

Correct rectification of detected faults according to the types of faults Convenient completion of repair report according the format

Learning outcome 3.1 Appropriate identification of faults according to troubleshoot procedures

 Duration: 6 hrs		
 Learning outcome 1 objectives: By the end of the learning outcome, the trainees will be able to: 1 Identify Substation installation troubleshooting procedures and techniques. 2. Explain different equipment of a substation 3. Recognize the different materials used in troubleshooting 4. Explain the importance of equipment used in troubleshooting.		
 Resources		
Equipment	Tools	Materials
Multi-meter High Voltage Insulation tester High voltage insulation resistance tester Circuit breaker tester Protection relay tester Megohmmeter - High voltage	Detector, High voltage multimeter, tester, Electromechanical tool kit	Books Manual Wires insulators

Indicative content 1: Substation installation troubleshooting procedures and techniques

 Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Substation installation troubleshooting procedures and techniques The procedure for finding fault are:

Visual inspection: Visual inspection is a technique for detecting defects using the naked eye to ensure equipment is working properly or that manufactured products are being made to specification. This can include visual inspections done in person or remotely using digital images.

Inspecting equipment, products and materials with the human eye is the oldest and simplest form of visual inspection. It is still used today in manufacturing, the energy industry and the medical field because it has proven to be an effective method for detecting surface-level defects.

In the pre-digital era, inspectors were trained to identify defects, sometimes with the naked eye, and in other cases, using the simplest of tools, such as lights and magnifying glasses. With the advancement of portable, high-quality cameras and drones, visual inspection has evolved to a new stage; today, companies collect digital images and videos of machinery, manufactured products and other aspects of physical operations to conduct visual inspections. Inspections with video footage and imagery can be done in real-time from a remote location or reviewed at a later time once the camera collecting imagery has been retrieved.

Implementing a visual inspection process

Every industry and organization will have its own process for conducting visual inspections. Yet, there are commonalities within the inspection workflows often found

across visual inspection processes. These include:

Identifying all equipment, materials, products and infrastructures that need to be inspected.

Defining which conditions should trigger an inspection.

Creating clear guidelines as to what constitutes a defect.

Noting how often these inspections should be performed.

Creating a means for reporting, documenting, and addressing defects and downtime when detected.

Incorporating visual inspections into maintenance checklists.

Visual inspection methods

Once a process has been established, organizations may use a variety of methods to carry out visual inspections, including:

Random sampling. Quality checks are performed on randomly selected products or physical assets. In manufacturing, products are often checked right at the production line for obvious visual defects.

Full manual sampling. All products are inspected manually by a person trained to identify defects. This can be a physically demanding job with repetitive actions that should be accompanied with safety policies, ergonomic equipment and appropriate tools.

Remote visual inspection (RVI). Using remote cameras, edge technology and drones, organizations can observe equipment safely from afar. This inspection solution may be conducted in real-time; or in remote areas where connectivity may be an issue, the inspections can be performed by retrieving the images and analyzing them at a later time.

Automated visual inspection (2:48) Products are inspected in real-time using cameras, image processing methods, and machine learning algorithms. Unlike RVI where teams take inspection equipment into the field, automated visual inspections are typically done onsite in one location.

Benefits of visual inspection

Visual inspection has been used for many years to ensure quality and safety. In addition, it also offers these benefits:

Savings: By identifying defects as early as possible, companies can reduce the costs of scrapping defective products or identify assets that need repair faster.

Safety: RVI lets companies perform visual inspections safer than ever by helping them

identify defects in environments that could be harmful.

Optimization: Visual inspections are a quick, inexpensive and non-intensive way to assess quality. When using automated visual inspections, organizations can further optimize the inspection process by reducing hands-on time.

Speed: When using automated visual inspection, the inspections are performed much faster than with human workers and can occur anytime, 24-7.

Accuracy: Automated visual inspections can be more accurate than inspections with the human eye, because they can catch slight defects that are imperceptible or easy to miss.

Visual inspection use cases

When quality control and safety are paramount, visual inspection is used, and may be required, including in these use cases:

Manufacturing: Whether manufacturing cars, pharmaceuticals or semiconductors, visual inspection identifies assembly and cosmetic defects on the manufacturing floor.

Healthcare: From manufacturing medical devices to inspecting equipment before surgery, visual inspections are key to patient health and safety.

Energy: Visual inspections improve the safety of equipment in many different facets of the energy industry, from mining and fuel extraction to power generation.

Civil Infrastructure: Inspecting roads, bridges and tunnels for potential issues is mandated for public safety, can take months, and requires attention to minute detail.

Testing:

What is Maintenance Testing?

Maintenance testing is a test that is performed to either identify equipment problems, diagnose equipment problems, or confirm that repair measures have been effective. It can be performed at either the system level (e.g., the HVAC system), the equipment level (e.g., the blower in an HVAC line), or the component level (e.g., a control chip in the control box for the blower in the HVAC line).

Once a system is deployed it is in service for years and decades. During this time the system and its operational environment is often corrected, changed or extended. Testing that is provided during this phase is called maintenance testing.

Usually maintenance testing is consisting of two parts:

First one is, testing the changes that has been made because of the correction in the

system or if the system is extended or because of some additional features added to it.

Second one is regression tests to prove that the rest of the system has not been affected by the maintenance work

Assumptions (possible cause) Cherry choppers:

Cause 1: Improper operation

There are a whole bunch of people who might be in and around critical equipment on a daily basis who could have a significant impact on its overall operating condition.

Equipment operators are one such group. They typically receive in-depth training on appropriate operating procedures, basic troubleshooting, and best practices for safe equipment use relevant to the machines they'll be working with. However, the day might come when an operator ends up working on a machine they haven't been adequately trained for. Sometimes this situation arises as a result of short staffing or unexpected absences. Other times emergencies come up that require quick remediation with available staff who might not necessarily have the expertise that your most experienced operators have.

One solution is to ensure that you have enough trained operators to allow for flexibility during staff shortage emergencies. If possible, all of your operators should have some training on every piece of equipment—even assets they don't typically work with.

Cause 2: Failure to perform preventive maintenance

Most equipment requires regular maintenance for optimal performance, but too often, preventive maintenance is the first task to go when you're short-staffed and overwhelmed. It's easy to brush off regular maintenance when things seem to be running just fine, and many companies work under the assumption that experienced workers will identify impending trouble before total equipment failure.

Equipment failures aren't easily detectable and often go unnoticed. In other cases, companies simply lack efficient planning methods for ensuring that ongoing maintenance is performed. Tracking equipment and machinery with asset tags can help to keep maintenance schedules on track and equipment operating at maximum operational efficiency.

Preventive maintenance is one ongoing function that should never be allowed to fall by the wayside. Taking care of your equipment with regular tune-ups will extend the usable life of your equipment, ultimately giving you more for every dollar. Additionally, preventive maintenance can identify small problems with inexpensive solutions before they become major, costly breakdowns. When you use effective inventory control strategies to ensure that you have the right spare parts in supply for the most common maintenance tasks and malfunctions, equipment downtime for routine maintenance and repairs is minimal.

Cause 3: Too much preventive maintenance

“Surely this is a mistake,” you’re thinking. “You just told me that NOT doing preventive maintenance will cause things to break.” It’s true— there’s a bit of a Goldilocks situation going on when it comes to preventive maintenance. Not enough can be problematic for the reasons we outlined above, but too much is also a major cause for concern.

Every time you get into a machine to maintain it, you open up that piece of equipment to a whole set of risks, and over time those risks can compound and lead to machine failure.

Cause 4: Failure to continuously monitor equipment

So how do you find the right balance of preventive maintenance? The cure here is simple in concept but a bit more complex in execution: condition-based maintenance. This is maintenance that’s done based on the operating condition of a piece of equipment, instead of just a ‘set it and forget it’ schedule. It takes a lot of things into account, from manufacturer information equipment history to real-time data like vibration analysis.

Continuous monitoring relies on sensor data to establish a baseline for what good equipment condition looks like in order to detect subtle changes, which can be used to predict breakdowns and failures. This allows more time for contingency planning and scheduling downtime to minimize production interruptions. This type of monitoring, and the data that’s collected in the process, can help companies identify the causes of increased stress on equipment, and adjust the workloads and schedules to prevent asset failure.

Cause 5: Bad (or no) reliability culture

Everyone has been there— major pressure from the top means there’s not a second to spare if you have any hope of hitting your production goals. In these circumstances, it can be so tempting (and so easy) for an operator or maintenance worker to notice something’s not working at 100%, slap a band-aid solution on it and say, “I’ll figure this out when things calm down”. The problem is that realistically, things never calm down to the extent where you’ll have time to revisit that work. Which means that band-aid solution becomes a semi-permanent solution until it stops working and becomes a full-fledged failure. This kind of fix can lead to personal injury, a major accident, or damage.

Theoretical learning Activity

Conduct brainstorming session with the student on different types of troubleshooting

Have students in their respective groups discuss different types of fault rectification

Brainstorming on how to prepare the repair report

Practical learning Activity

Physical demonstration on troubleshooting procedures and techniques

Practical exercises on troubleshooting procedures and techniques

Practical exercises on faults rectification

Points to Remember (Take home message)

Substation installation troubleshooting procedures and techniques:

Visual inspection

Testing

Assumptions (possible cause)

Indicative content 2: Ttroubleshoot different equipment of a substation

Troubleshoot power transformer

Electrical transformers come in many shapes, sizes, and types. There are potential transformers and current transformers. There are power transformers, audio transformers and signal transformers. There are step-up transformers and step-down transformers. There are autotransformers and isolation transformers and many other types. No matter what their purpose they all suffer from the same basic problems--turn to turn shorts, open windings, winding to ground shorts, for example. All these problems can be detected using a few simple tests and a DMM (Digital Multimeter). For this tutorial we will practice using a 110-volt step-down transformer with a 18-volt, CT (Center Tapped) secondary.

Power transformer

How to Troubleshoot Electrical Transformers

1. Test the transformer for a primary winding to secondary winding short. ...

2. Test the transformer for winding to lamination shorts. ...

3. Test the primary winding and the secondary winding(s) for continuity by placing the DMM probes across each winding's terminals. ...

4. Check the transformer’s output voltage.

Troubleshoot switchgears Electrical switchgear:

what is it? As shown in figure.1

it’s a device in a metal-enclosed structure used to isolate and de-energize electrical equipment. It contains combination of disconnectors, fuses or circuit breakers and

protection relays for the aim of isolation and protection, control panel for the aim of control and current and potential transformers for the aim of measurement. It is also filled with oil and replaced now with air, insulating gas like SF6 or vacuum in high ratings

After knowing what the switchgear is, it's obvious that we don't want to lose it. So knowing the problems that usually switchgears have is very important to be able to avoid them.

Switchgears play an important role in the distribution and control of electrical power in manufacturing or power plant and in a utility distribution system. Negligent maintenance practices can lead to power system inefficiency and loss of system reliability.

Troubleshoot fuses

Troubleshoot protective relay

Troubleshoot measuring transformer

Troubleshoot bus bar

Troubleshoot- circuit breaker

2: After-repair Testing

Complete the repair report according to the format

Preparation of the repair report

Repair report format (Company/institution name, technician name, Date of repair, Equipment specifications, Fault description, repair work description)

Keeping records of repair activities

Analysis of the repair report

Billing of repair work

Theoretical learning Activity

Conduct brainstorming session with the student on different types of troubleshooting

Have students in their respective groups discuss different types of fault rectification

Brainstorming on how to prepare the repair report

Practical learning Activity

Physical demonstration on troubleshooting procedures and techniques

Practical exercises on troubleshooting procedures and techniques

Practical exercises on faults rectification

Points to Remember (Take home message)

Power transformer: a power transformer is a static machine used for transforming power from one circuit to another without changing the frequency

Switchgear: it's a device in a metal-enclosed structure used to isolate and de-energize electrical equipment. It contains combination of disconnectors, fuses or circuit breakers and protection relays for the aim of isolation and protection

"Troubleshooting is a form of problem solving, often applied to repair failed products or processes on a machine or a system. It is a logical, systematic search for the source of a problem in order to solve it, and make the product or process operational again.

Learning outcome 3.1 formative assessment

Written assessment

What do you understand by the term troubleshooting?

Troubleshooting is a form of problem solving, often applied to repair failed products or processes on a machine or a system. It is a logical, systematic search for the source of a problem in order to solve it, and make the product or process operational again. Troubleshooting is needed to identify the symptoms.

Complete the table below

Fault	causes	Rectification
		Perform lubrication
Circuit breaker trip		
	Overload	

Answer:

Fault	causes	Rectification
Transformer winding get hot	Overload, low lubrication	Perform lubrication
Circuit breaker trip	Short circuit, lightning	Conduct a troubleshooting process
Substation fail	Overload	Reduces loads

How do you troubleshoot a relay?

Using Power Source (Battery)

Remove the relay if it is in any circuit.

Identify the coil terminals.

Connect the battery with the coil terminals.

Listen, if you hear a click sound as soon as you connect the coil

terminals, the relay works.

If it does not click, that means the coil is open & damaged

Answer true or false

Switchgear is a broad term that describes a wide variety of switching devices that all fulfill a common need: controlling, protecting, and isolating power systems. Answer: true

Finding electrical faults, you will not need basic knowledge of electrical faults identification Answer: false

Power transformer fault includes overheating and burning Answer: true

Practical exercise

Learners under the supervision of trainer perform the troubleshooting procedures

Indicator : Identify faults according to troubleshoot procedures

Checklist yes no

Identification of substation installations troubleshooting procedures

Troubleshooting circuit breaker

Troubleshooting fuses

Troubleshooting power transformer

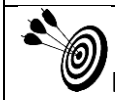
Troubleshooting measuring transformer

Troubleshoot protective relay

Troubleshooting bus bars

Learning Outcome 3.2: Rectify detected fault according to the types of faults


Duration: 6 hrs


Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

identify procedures for fault rectifications

Circuit breaker faults rectification techniques

Switchgears faults rectification techniques

Fuse faults rectification techniques Protective relay

faults rectification techniques


Resources

Equipment	Tools	Materials
Multi-meter High Voltage Insulation tester High voltage insulation resistance tester Circuit breaker tester Protection relay tester Megohmmeter - High voltage	Detector, High voltage multimeter, tester, Electromechanical tool kit	Books Manual Wires Insulators Bus bar
Advance preparation:		

Indicative content 2: Procedures for fault rectifications

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Rectify detected fault according to the types of faults

Procedures for fault rectifications

Circuit breaker faults rectification techniques

Switchgears faults rectification techniques

Fuse faults rectification techniques

Protective relay faults rectification techniques

Bus bar fault rectification

Power transformer fault rectification

Measuring transformer fault rectification

Rectify detected fault according to the types of faults

1.Fault detection

Fault detection is the process of discovering the presence of a fault in any equipment before it manifests itself in the form of a breakdown. It is the most important stage of FDD as all of the downstream processes depend on its accuracy.

2.Fault isolation

The goal of the fault isolation process is to localize the fault to the lowest component that can be replaced. In some applications, fault detection and isolation go hand in hand; they can, of course, be separate modules of the process. This is because the processes of detecting and localizing the fault are happening at basically the same time, both done by the Fault Detection and Isolation (FDI) algorithm.

Learning outcome 3.2. Formative assessment

What do you understand by the term fault rectification?

Answer: Act of correcting an error or a fault

Indicate the faults rectification techniques

Answer:

1. Gather Information – Ask as many people as possible who, where there, when & how the fault occurred

2. Analyze Information – decide the probable cause based on past experience & training 3. Investigate – now attempt to find the fault from your analysis

4. Rectify – once found, safely repair the fault

5. Test – when the fault is put right & restored, test your work before re-energizing

How fault transformer can be measured?

Evaluates the insulation resistance between coils and windings

Measures electrical variables such as voltage, current, and other variables

Check the state of oil

Control the winding connection/ configuration

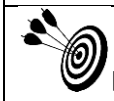
Practical exercise

Learners under the supervision of trainer perform the rectification of faults

Indicator : Rectify detected fault according to the types of faults		
Checklist	yes	no
Identification of substation installations troubleshooting procedures		
Troubleshooting circuit breaker		
Troubleshooting fuses		
Troubleshooting power transformer		
Troubleshooting measuring transformer		
Troubleshoot protective relay		
Troubleshooting bus bars		

Learning Outcome 3.3: Complete the repair report according to the format


Duration: 6 hrs


Learning outcome 3 objectives:

By the end of the learning outcome, the trainees will be able to:

Preparation of the repair report Equipment specifications, Fault description, repair work description)

Keep records of repair activities

Analysis the repair report

Bill of repair work


Resources

Equipment	Tools	Materials
Multi-meter High Voltage Insulation tester High voltage insulation resistance tester Circuit breaker tester Protection relay tester Megohmmeter - High voltage	Detector, High voltage multimeter, tester, Electromechanical tool kit	Books Manual Wires Insulators Bus bar
Advance preparation:		

Indicative content 3.3: Complete the repair report according to the format

 Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Maintenance reports play a critical role in keeping your equipment, machinery, and business in good health. It should be done regularly and correctly to ensure productivity, safety, and efficiency. Regardless of your industry, proper documentation for routine and emergency maintenance services helps to keep your business running smoothly. While there is no “one-size-fits-all” report, Device Magic’s platform makes it easy to create custom maintenance reports for your team in minutes.

What is a Maintenance Report?
A maintenance report is a detailed document that covers any routine or emergency maintenance services performed on a specific vehicle, piece of equipment, or machine. It serves as a guide outlining the proper care of the equipment in your workplace and can help your company avoid duplicate service requests. This document also helps catch small problems before they become big problems while allowing you to track the maintenance history for the machines, equipment, and commercial vehicles you use daily.

If your workers need access to a specific maintenance report and don’t have the actual paper with them out in the field, they may not be able to do their job effectively. However, with access to maintenance reports on their smartphones and tablets, they can have all of the information they need to do their job right at their fingertips—even if they are offline!

What to Include in Your Maintenance Report
Organization is critical when creating a custom maintenance report for your business. While the specifics of your report will depend on the needs of your company, you can start your report with these six things, then modify it to reflect the unique needs of your company or equipment:

Category. Maintenance managers and engineers should be able to organize and filter these reports by category. Maintenance can be broken down into a variety of categories, including corrective, preventive, condition-based, predictive, and predetermined.

Location. Along with what type of maintenance is being performed, your report should allow users to document the location of the maintenance request. Device Magic Geomapping features allow you to pinpoint the actual location of a machine or piece of equipment that needs to be serviced. This saves time for workers in the field and reduces confusion.
Date. A maintenance report should include a place to input the date(s) in which maintenance or repairs were completed. Having this record is crucial to ensure upkeep. It can also be useful to reference in cases of equipment failure, so you can check to see if any missing maintenance issues may have caused the problem.
Pictures. One of the most significant benefits of going paperless is the ability to incorporate digital photos into your maintenance reports. This can serve as evidence that the job has been completed or used to clarify questions or concerns about a specific machine.
Free Text. Traditional maintenance reports often provide little room to write detailed notes or concerns. When you create a custom maintenance report with Device Magic, however, you can incorporate free text blocks that allow the maintenance engineer or technician to elaborate on their findings or jot down concerns, questions, or suggestions for further repair.
Signature. A signature box ensures that whoever is responsible for performing the maintenance can sign off on their work.

Define a repair report

"Report of Service/Repair means appropriate documentation in a format acceptable to the Enforcement Official that verifies proper repairs or maintenance have been performed

Identify the elements found in repair report

(Company/institution name,

technician name,

Date of repair,

Equipment specifications,

Fault description,

repair work description

choose the correct answer: 1. who write repair report company manager data manager

store keeper the one who repairs the machine, equipment or a system

answer: **the one who repairs the machine, equipment or a system**

answer true or false:

billing means the relative position in which a performer or act is listed on handbills, posters, etc.: **true**

The show was a sellout week ahead of the opening because of advance billing. **true**

the amount of business done by a firm, especially an advertising agency, within a specified period of time. **true**

an act or instance of preparing or sending out a bill or invoice. **true**

the total amount of the cost of goods or services billed to a customer, usually covering purchases made or services rendered within a specified period of time **true**

Practical exercise

Learners under the supervision of trainer Complete the repair report according to the

format

Indicator : Complete the repair report according to the format		
Checklist	yes	no
Format of the report		
Content of the report		

Learning Unit 4: Clean the workplace

STRUCTURE OF LEARNING UNIT

Learning outcomes: Collect tools and equipment Arrange non-used materials (consumables) Clean tools and working area Manage waste materials.

Learning outcome 4.1 Collect tools and equipment

Duration: 6 hrs

Learning outcome 1 objectives :

By the end of the learning outcome, the trainees will be able to:

Identify different tools/equipment used for cleaning:

method of collecting tools and equipment used in hydraulic and pneumatic systems

Arrange tools/equipment according to their use

Resources

Equipment	Tools	Materials
Blower machine Books Electromechanical tool kit Plumber tool kit	Brushes Sponge	Hoses Lubricants Insulators Manual soap

Advance preparation:

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Indicative content 4.1: Collect tools and equipment

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

1: Collect tools and equipment Identification of different tools/equipment used for cleaning:

Brushes for cleaning sharp edges

Lubricants

Blower machines

Sponge Method of collecting tools and equipment used in hydraulic and pneumatic systems

Arrangement of tools/equipment according to their use

1. Scrub brushes
Get yourself at least one great cleaning brush. A plastic one with strong bristles and a handle with a rubber grip is enough to tackle most messes, including scrubbing a bathtub or sink. Consider buying a brush set that comes with multiple brush heads so you can tackle different spaces, like corners and even your shower head.

2. Toilet brush
Make sure to buy a dedicated toilet brush because, well, you don't want to use that brush anywhere but the toilet bowl. One that comes with a stand is especially convenient, as you can store it next to or behind the toilet. Some brushes even come with a cleaning solution compartment in the handle for an all-in-one cleaning experience.

3. Multi-purpose duster
An extendable wand duster will serve you well once you notice the cobwebs gathering on the ceiling fan in the living room. Look for one that has a pivoting head and enough length to reach your ceiling height, and you'll never have to worry about how to dust those tough-to-reach nooks and crannies.

4. Sponges
For doing dishes, look for sponges that have a soft side for delicate dishes and a rough side to blitz stuck-on food. Use non-metal, non-abrasive sponges to clean cast iron cookware, if you have it. Purchase heavy-duty sponges made of tough material for floor cleaning, ovens, and other surfaces that need a thorough scrubbing. Make sure to store your sponges separately, so that you aren't cleaning your dishes with the same sponge you use on the floor!

5. Vacuum
Your vacuum is your secret weapon to tidy up quickly and keep dust at bay. When choosing one, think about your space and needs. If you're short on storage space, consider a cordless stick vacuum that can be hung up behind a door. If you're in a tiny space, there are small handheld vacuums that are great for sucking up spills.

6. Spray bottle
When you're trying to evenly distribute cleaning solutions, a regular water bottle won't do the trick. Invest in a few glass spray bottles and you'll always have an easy way to kick off a cleaning spree. Get a roll of painter's tape and a sharpie to make quick, easy-to-remove labels for your bottles so that you and your roommates always know which cleaning solution they are reaching for.

7. Microfiber cleaning cloths
Microfiber cloths are gentle on surfaces and ideal for picking up dust. They're perfect for tidying up flat screens or furniture, and they don't leave streaks on mirrors or stainless steel. You can even buy them in the form of a glove to clean tricky spaces like baseboards.

8. Broom and dustpan
A broom and dustpan are essential for cleaning up spills, such as a knocked-over box of cereal on the kitchen floor, or sweeping up clippings on your patio. They're also great for doing a little pre-cleaning before you vacuum. Opt for a pan with a rubber lip, which will grip the floor and allow you to neatly sweep all of the dust and debris into the pan.

9. Mop

A mop is your go-to tool for cleaning hard floor surfaces like tile, wood, or laminate and making them shine. You can buy one that has a handle you can fill with cleaning fluid, or a simple stick mop with a sponge head. Another option is a steam mop which uses hot water, and sometimes cleaning fluid, to clean floors. They also often have washable, reusable cleaning pads that you never have to wring out like a traditional mop head.

10. Bucket

If you do opt for that simple mop, you're also going to need a bucket to hold your water and cleaning fluid. Buckets are also great for rinsing out sponges or rags, for soaking items, and for storing cleaning products when not in use.

11. Cleaning solutions

A trip to the cleaning products aisle can be a bit daunting because there are so many choices. Make it easy on yourself by opting for a multi-purpose cleaner that is safe for multiple surfaces, or make a DIY solution—like a simple mix of vinegar and water—so you'll always have something on hand to tidy up the kitchen counter or the floor. Note that store-bought multi-purpose cleaners may not be suitable for tasks like cleaning stainless steel, so make sure to check the label before you spray on different materials.

12. Gloves

Cleaning fluids, hot water, and soap scums can be tough on your hands, so take care to protect them. Invest in a pair of sturdy rubber gloves that will help you tackle messier home cleaning tasks with confidence. Look for a set with a textured surface, so you can get a good grip on your brushes and other tools.

Looking for a home where monthly cleaning is always on the books? Bungalow's homes are designed for roommates, located in the best neighbourhoods, and set up for seamless living. Common spaces come furnished, cleanings are scheduled monthly, and payments are handled individually on our app. Whether you already have roommates or are looking for new ones, there's a Bungalow with your name on it. Find your Bungalow.

 **Theoretical learning Activity**

Conduct brainstorming session with the student on different types of cleaning tools

Have students in their respective groups discuss different types of cleaning methods

Brainstorming on how to clean workplace

Practical learning Activity

Physical demonstration on cleaning procedures and techniques

Practical exercises on cleaning procedures and techniques

Practical exercises on cleaning

Practical exercises on arranging cleaning tools

Points to Remember (Take home message)

Cleaning workplace is very important as well as for environment and for human being

1.Give a good impression to clients
The appearance of your premises sends a message to your clients about who you are and what your business represents.

2. Increase the productivity of your employees
Studies show that cluttered and untidy environments are distracting. Since distraction in the workplace can cost your business valuable man-hours.

3. Make your employees happy
Of course, your employees will also be happy for keeping their workspace clean – after all, wouldn't you rather work in a clean office instead of a messy one?

4. Safeguard your employees' health
Cleanliness also reduces the chances of your employees getting sick.

5. Reduce hazards
As well as preventing your employees from getting sick, cleanliness can also save lives.

6. Keep your office running smoothly

When your workplace is clean and free of clutter, you'll find it easier to stay organised. It's easier to keep track of papers, for one thing.

Different tools and materials can be used:

Scrub brushes
2. Toilet brush
3. Multi-purpose duster
4. Sponges
5. Vacuum
6. Spray bottle
7. Microfiber cleaning cloths
8. Broom and dustpan
9. Mop
10. Bucket
11. Cleaning solutions
12. Gloves

 Learning outcome 1 formative assessment

Written assessment

differentiate between tools and material

It is a tangible item that can be used again and is only subjected to maintenance or repair when broken. While in contrast, materials are items that form the electrical system itself. It is consumable and it could pertain to the components or parts of the electrical system

Identify different tools/equipment used for cleaning

Answer:

Brushes for cleaning sharp edges

Lubricants

Blower machines

Sponge

How cleaning equipment should be cleaned and stored
answer: Facility managers are always looking for ways to save money. One way to potentially cut expenses is to better maintain and even perform light repairs on the cleaning equipment they use every day—specifically, vacuum cleaners and automatic floor machines

Answer true or false

Scrubbers are designed to clean stains from hard floored regions **true**

A polisher is able to turn a dirty hard floor it a brand new in a timely fashion **true**

Pressures cleaners These are large machines with a rotatory sweeping head located underneath the front of the machine **true**

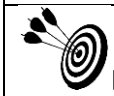
Practical exercises on filling the repair report

Learners under the supervision of trainer clean and organize the workplace

Indicator : collect tools and equipment		
checklist	yes	no
Identification of types of tools and equipment		
Applications of methods of tools and equipment collection		
Arrangement of tools and equipment		

Learning Outcome 4.2: Arrange non-used materials(consumables)


Duration: 6 hrs


Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

select area for storing non consumable and non-used materials

Prioritize tools/materials and equipment according to their nature

Discard unused tools and equipment

Disposal of waste materials: Sharp pieces of materials Lubricants

Resources		
Equipment	Tools	Materials
Manual – Brushes Blower machine Recycle bin Compressor	Hoe, spade Electromechanical tool kit, sprayer	Books Manual Lubricants Books - Internet
Advance preparation: . . .		

Indicative content 4.2: Arrange non-used materials (consumables)

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Shelving: Shelves are an effective way to organize a space. Shelves can be custom built to fit the specific function of your space, and they can be stationary or modular, depending on your needs. Shelving units can be made of wood, metal, or plastic, and you can purchase them at your local hardware store and assemble them at home. Alternatively, if you're handy with wood—or even metal—you can build your shelving from scratch or scrap.

Pegboards: One of the classic storage solutions is the wall-mounted pegboard. Made of a compressed fiber or wood, pegboards have evenly-spaced holes that can fit metal studs or hooks to support or hang your tools. Pegboards can help organize hand tools, like pliers, screwdrivers, hammers, and saws; power tools like drills, chargers, and electric

saws; and woodworking tools like awls, planes, drill bits, saw blades, and chisels.
Magnetic strips: Magnetic strips can be a great solution if you have the right equipment. Like magnetic strips in kitchens for storing knives, you can use magnetic strips to hang metallic tools containing enough iron to be magnetized.
Drawers: Drawers are another option that can work for the DIY home storage system. Sets of drawers come in many sizes—you can use tiny ones for screws and washers or bigger ones for cordless power tools. You can build drawers into a workbench, sit drawers on top of a workbench, or rest a set of drawers on the floor. You can also place drawers on casters so that you can move them throughout the workspace.
Storage bins: Bins tend to work better for long-term storage. If you have tools you use every once in a while or are too large and cumbersome to hang on a wall or rest on a narrow shelf, putting them in a bin might be the best choice. Storage containers like bins come in all shapes and sizes, many of them made from heavy-duty plastic. A toolbox is perhaps the best storage container and its portability is a significant asset.
Storage cabinets: Often, you will want to store tools close by in a protected place. Tool cabinets can offer your tools protection from dust and moisture, and they can also protect your space from substances and chemicals that are corrosive, flammable, or otherwise harmful. Tools involving paints or solvents, gasoline, or cleaning materials, are best kept in a secure metal cabinet.
Meet One of Your New Instructors

 **Theoretical learning Activity**

Conduct brainstorming session with the student on different types on waste management of materials

Have students in their respective groups discuss different types Area for storing non-used and non-consumable materials

Brainstorming on how to Arrange non-used materials after a given work

 **Practical learning Activity**

Physical demonstration on Arrangement of non-used materials after a given work

Practical exercises on waste management

Practical exercises on materials, equipment and tools storing

Practical exercises on storing tools.

Points to Remember (Take home message)

Arrange non-used materials (consumables)

Selection of area for storing non-consumable and non-used materials

Prioritize tools/materials and equipment according to their nature

Discard unused tools and equipment

Disposal of waste materials: Sharp pieces of materials , Lubricants


Learning outcome 1 formative assessment

Written assessment

Why do we properly store cleaning tools materials and equipment?

A failure by cleaning employees to follow storage practices increases the risk to the health and safety of the cleaners as well as other parties. Improper storage can also result in costly claims and damage to property and equipment.

How do you store equipment safely?

"Make sure all your items are clean and dry before storing them, to prevent the buildup of mould. Keep loose pieces of electrical equipment in an airtight container to keep it safe from dust, air, and moisture

Waste disposal methods
answer:

Recycling. Incineration. ...

Other thermal treatment plants. Chemical-physical and biological treatment. ...

Chemical-physical and biological treatment. Landfills. ...

Landfills.

Collection and logistics.

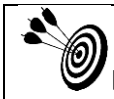
Practical exercise

Learners under the supervision of trainer, learners arrange non-used materials(consumables)

Indicator : collect tools and equipment		
checklist	yes	no
Area for storing non-used and non-consumable materials		
Prioritization of tools, materials and equipment		
Discard of unused tools and materials		
Disposal of waste materials		

Learning outcome 4.3: Clean tools and working area

Duration: 6 hrs



Learning outcome 3 objectives :

By the end of the learning outcome, the trainees will be able to:

differentiate methods of cleaning tools and equipment

differentiate methods of cleaning the working area

Dispose waste materials according to their nature

Resources

Equipment	Tools	Materials
Overcoat and overall Gloves/ Helmet Safety shoes	Brushes Sponge	Hoses Lubricants Insulators Soap Cleaning cloth / Brush lubricating oil Cooling water/ coolant

Advance preparation:

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Learning outcome 4.3: Clean tools and working area

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Cleaning Tools

Personal protective equipment (PPEs)

There's a lot that goes into professional cleaning - it's not just about spraying and wiping down surfaces. Professional cleaners take precautions to protect themselves from harmful chemicals and bacteria, and one of the most important pieces of equipment they use is personal protective equipment (PPE).

Professional cleaners are exposed to a variety of potential health hazards while on the job, including chemicals, bacteria, mold, and other irritants. Wearing PPE helps to reduce their exposure to these hazards and keeps them safe while they're working.

Cleanser & detergent

Cleansers are agents that break up soil and remove dirt from surfaces. Detergents are surfactants that lower the surface tension of water, making them more effective at wetting and removing soils. Professional cleaners rely on cleansers & detergents to clean surfaces and remove dirt, dust, and stains.

Cleansers come in many different varieties, each with its own specific purpose. Some are designed to remove dirt and grease, while others are meant for combating tough stains.

Different types of brushes

Some common types of brushes that are used by professional cleaners are as follows:

Resin set bristle brushes: This type of brush is commonly used to clean food contact surfaces, walls, and floors. The bristles on this brush are hard, medium or soft and will not damage the surface being cleaned.

Stainless steel brush: This type of brush is commonly used to clean ovens, grills, and other cooking surfaces. The bristles on this brush are tough and can withstand high temperatures.

Scrubbing brush: This type of brush is commonly used for specialised cleaning tasks. These types of brushes allow machinery to be cleaned without the need to dismantle.

Miscellaneous
Brooms, sponges, and microfiber cloths are general cleaning supplies that professional cleaners also rely on to get an effective cleaning job done.

Cleaning Equipment

Floor scrubber

A floor scrubber is a floor cleaning device. It can be in the form of a walk-behind or a ride-on machine to clean floor areas by injecting water with cleaning solution, scrubbing, and lifting the residue off the floor. Professional cleaners use this powerful equipment to clean large areas of floors.

Floor scrubbers can quickly and easily remove dirt, dust, and debris from a variety of surfaces, making them an essential tool for any cleaning arsenal. They allow cleaners to cover large floor areas speedily and efficiently.

Industrial Vacuum cleaner

When it comes to industrial cleaning, one of the most important pieces of equipment in a professional cleaner's toolkit is the vacuum cleaner. An industrial vacuum cleaner is a machine used for general cleaning in the industrial environment and other specific applications. Industrial vacuum cleaners can come in many different types This device can make quick work of large areas that need to be cleaned and is, therefore, an essential part of the cleaning process.

Pressure washer machine

Cleaning factories can be a dirty and hazardous job. The floors, equipment, and machinery need to be kept clean so that the product being produced is safe and meets regulations. This is where pressure washers come in. Professional cleaners utilise this equipment to blast remove dirt, grease, and other contaminants from surfaces. From removing tough dirt and grime to restoring surfaces to their original condition, a pressure washer can make quick work of any cleaning task.

The cleaning tools and equipment used by professional cleaners are not only effective but also safe for both the users and the environment. At Hygiene Group, we are committed to providing our clients with a cleaning service done with top-of-the-line cleaning products and supplies.

 **Theoretical learning Activity**

Conduct brainstorming session with the student on different types of cleaning tools

Have students in their respective groups discuss different types of cleaning methods

Brainstorming on how to clean workplace

 **Practical learning Activity**

Physical demonstration on cleaning procedures and techniques

Practical exercises on cleaning procedures and techniques

Practical exercises on cleaning

Practical exercises on arranging cleaning tools

 **Points to Remember (Take home message)**

Cleaning workplace is very important as well as for environment and for human being

1.Give a good impression to clients
The appearance of your premises sends a message to your clients about who you are and what your business represents.

2. Increase the productivity of your employees
Studies show that cluttered and untidy environments are distracting. Since distraction in the workplace can cost your business valuable man-hours.

3. Make your employees happy
Of course, your employees will also be happy for keeping their workspace clean – after all, wouldn't you rather work in a clean office instead of a messy one?

4. Safeguard your employees' health
Cleanliness also reduces the chances of your employees getting sick.

5. Reduce hazards
As well as preventing your employees from getting sick, cleanliness can also save lives.

6. Keep your office running smoothly
When your workplace is clean and free of clutter, you'll find it easier to stay organised. It's easier to keep track of papers, for one thing.

Different tools and materials can be used:

Scrub brushes
2. Toilet brush
3. Multi-purpose duster
4. Sponges
5. Vacuum
6. Spray bottle
7. Microfiber cleaning cloths
8. Broom and dustpan
9. Mop
10. Bucket
11. Cleaning solutions
12. Gloves


Learning outcome 1 formative assessment

Written assessment

Identify different methods of cleaning tools and equipment

Water Different

Detergents

Air blowing

Why is it important to clean the working area?

First impressions count

Elevate your brand

Reduces accident and hazards

Keep your working place clean and tidy

Provide air quality

Less destruction of working area

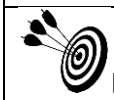
Practical exercise

Learners under the supervision of trainer, learners arrange non-used materials(consumables)

Indicator : collect tools and equipment		
checklist	yes	no
Application of tools/equipment cleaning methods		
Application of working area cleaning techniques		
Disposal of waste materials		

Learning outcome 4.4: Manage waste materials


Duration: 6 hrs


Learning outcome 4 objectives :

By the end of the learning outcome, the trainees will be able to:

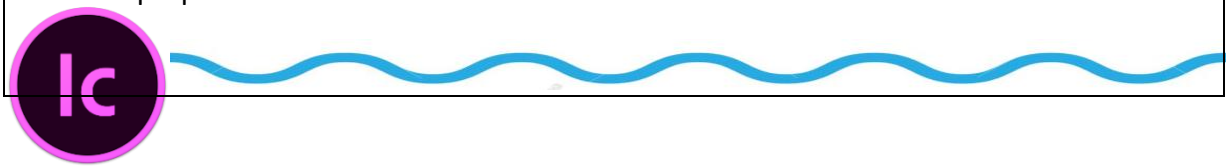
Arrange waste materials according to their nature

Dispose of waste materials


Resources

Equipment	Tools	Materials
Overcoat and overall Gloves/ Helmet Safety shoes	Brushes Sponge	Hoses Lubricants Insulators Soap Cleaning cloth / Brush lubricating oil Cooling water/ coolant

Advance preparation:



Learning outcome 4.4: Manage waste materials

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Cleaning Tools

Personal protective equipment (PPEs)

The generation of waste material is an integral feature of the human mode of life and of organizational activities. Commonly considered as refuse and trash, waste materials are often considered as materials that no longer have any value. Yet, already since the last few decades, the concept of waste-resource is tending to change the ways in which waste materials management is conceptualized. The idea that waste materials are resources whose value can be enhanced comes from the concept according to which matter produced in nature in the form of closed loops is constantly recycled. However, numerous challenges still exist in the way of a healthy management of these materials.

Issue
The management of waste materials is not a minor affair. Apart from generation of waste, the problem often occurs in the superficial management of such materials where there is little or no consideration of their environmental consequences. Viewed from a sustainable development perspective, the possibility of material recovery should not be under estimated, let alone dismissed by organizations. Often companies that are generators of substantially higher volumes have an important role to play with regard to the management of refuse produced by their operations. They need to undertake well-thought out processes that effectively prioritize their actions. The integration of the 3R-RD principles within a waste management system is an efficient tool for all organizations.

The 3R-RD hierarchy is an approach according to which certain actions need to be prioritized with the aim of prolonging the service life of resources. Reduction at source, reuse, recycling, Reclaim and Disposal represent the order of priority according to which reduction should always be the first action while disposal is the last recourse. In the absence of a life cycle analysis in which an objective evaluation of the environmental consequences of the different options adopted by the waste materials management system is done, the 3R-RD approach proves to be the most environment friendly management system.

Reduction at source: Reducing the generation of waste material constitutes the basis of the 3R-RD approach. The maximum economy of resources during manufacturing, distribution and usage of products should always be the primary objective.
Reuse: Reuse is the act of recovering that is prioritized with the aim of putting 3R-RD into practice. It greatly contributes to the economy of resources. It is the repeated use of a product or a wrapping, without significantly modifying its properties or its appearance.
Recycling: Recycling comes second in the act of recuperation that is prioritized with the aim of putting 3R-RD into practice. It reintroduces a waste material in the process of

manufacturing or transformation from which it is derived, resulting in a product of the same nature. The idea of recycling also involves the reintroduction of a putrescible organic material in the biological cycle, commonly called composting.
Material and Energy Reclaim: Reclaiming is also an act of recuperation and it can be divided into two sub-categories, namely material reclaim also called reuse, and energy reclaim. Material reclamation consists of using a waste material in place of another material with the aim of creating a product that is different from the initial product. In other words, it is the possibility of introducing a recovered material in a production cycle that is different from the one that generated it. Reuse is an act of recovery that is prioritized but not at the cost of the first three "R" of this approach. Energy reclaim can be defined as the usage of materials that cannot be reused or recycled, but that have substantial calorific potential to produce useful energy (heat, steam or electricity). This form of recovery through chemical transformation of waste is the last action to be considered before resorting to complete disposal of this material.
Disposal: Getting rid of waste materials, either by burying or incineration, without creating a secondary material should never take precedence over the other actions mentioned previously in the 3R-RD approach. Very often, disposal is used as a simple and fast way to dispose of waste materials without considering their potential and the environmental impact of bad waste disposal management.
Integrating the 3R-RD within a waste management system
The principles of the 3R-RD are known the world over, but their application and their complete integration within waste management systems of organizations is not a simple task. The establishment of a structured system and a thoroughly thought out process is the key to ensuring effective management within organizations.

Advantages
A waste management system that integrates the 3R-RD without compromising on the process of reflection associated with it, has several advantages:

Financial advantages:
Make savings by maximizing the efficiency of raw materials necessary to operations;
Reducing operational costs;
Avoiding storage, handling and waste disposal costs;
Achieving financial gains by re-using equipment, by the sale of recyclable material in the market, through the transformation of residual material into new marketable products or through energy recovery;
Improving its image in the eyes of its client, employees and citizens;
Generating employment and wealth.
Environmental advantages
Reducing the consumption of raw materials that are not essential for the operations;
Reducing the demand for raw material or new material thanks to the recovery of residual material;
Reducing the production of greenhouse gases caused by the transportation of waste material;

Reducing the production of biogas associated with burying and avoiding the risk of leachate contamination.
Advantages for the organization:
Avoiding the organization’s costs linked to pollution;

Theoretical learning Activity

Conduct brainstorming session with the student on different types of waste management

Have students in their respective groups discuss different types of waste management methods

Brainstorming on advantages of waste management

Practical learning Activity

Physical demonstration on waste management procedures and techniques

Practical exercises on waste management procedures and techniques

Practical exercises on waste management disposal

Practical exercises on arranging waste management

Points to Remember (Take home message)

"A waste management system or waste disposal is a streamlined process that organizations use to dispose of, reduce, reuse, and prevent waste. It is also an approach where companies implement comprehensive strategies to efficiently manage wastes from their origin until their final disposal to stay organised. It’s easier to keep track of papers, for one thing.

"Waste management disposal methods
Recycling. Incineration. ...

Other thermal treatment plants. Chemical-physical and biological treatment. ...
Chemical-physical and biological treatment. Landfills. ...
Landfills. Collection and logistics

"There are three steps necessary to properly manage waste:
Identify Wastes.
Evaluate Waste.
Manage Wastes"

Learning outcome 1 formative assessment

Written assessment

Classify solid waste Solid waste can be classified into two categories by its characteristics.

These are:

Organic solid waste

Inorganic Solid Waste Organic solid waste: Wastes that are generally biodegradable and decompose in the process of which emits offensive and irritating smell when left unattended. Putrescible wastes e.g. Garbage Solid and Liquid Waste Management

Inorganic solid waste: Solid matter that does not decompose at any rate This category of waste matter may be combustible depending on the type of the nature of the material they constitute. ⇒ Non-putrescible wastes e.g. Rubbish

What is the importance of disposal of waste material?

The main benefits of effective waste disposal include: Environmental protection – from pollution or contamination. Money generation – companies may buy recyclable materials due to their value. Additionally, the waste management industry creates employment opportunities.

Practical exercise

Learners under the supervision of trainer, learners create and keep the waste materials

Indicator : collect tools and equipment		
checklist	yes	no
Arrangement of waste materials		
Disposal of waste materials		

References: