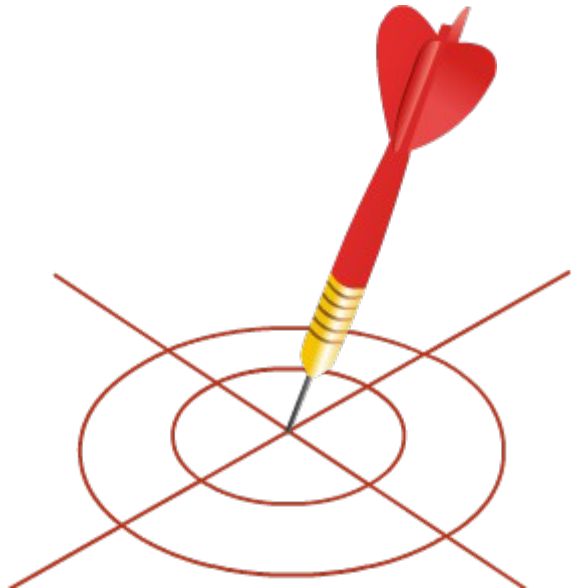

Welcome to the Session on
HT Distribution Network

Learning Objective

By the end of this session you will be able to:

•Explain the HT distribution network breakdown maintenance - possible faults, identification and rectification



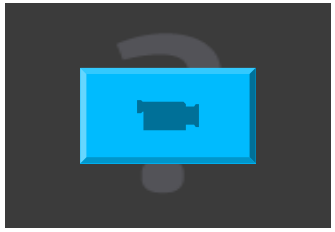
HT Distribution Network - Introduction

Sub-transmission network comprises 66kV, 33 kV and 11kV networks in a distribution company.

66 kV network

33 kV network

11 kV network



Causes for Faults in HT Distribution Network

The main causes for faults in HT distribution network are:

- Over current
- Over voltage
- External agency
- Accident
- Natural disasters
- And so on

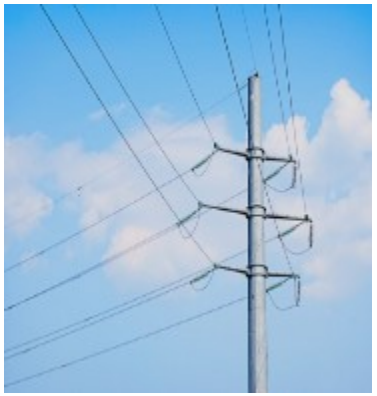
Classification of HT Distribution Network Faults

The faults in HT system network can be classified in four components. They are:

Transformer

Switchgears

Underground lines



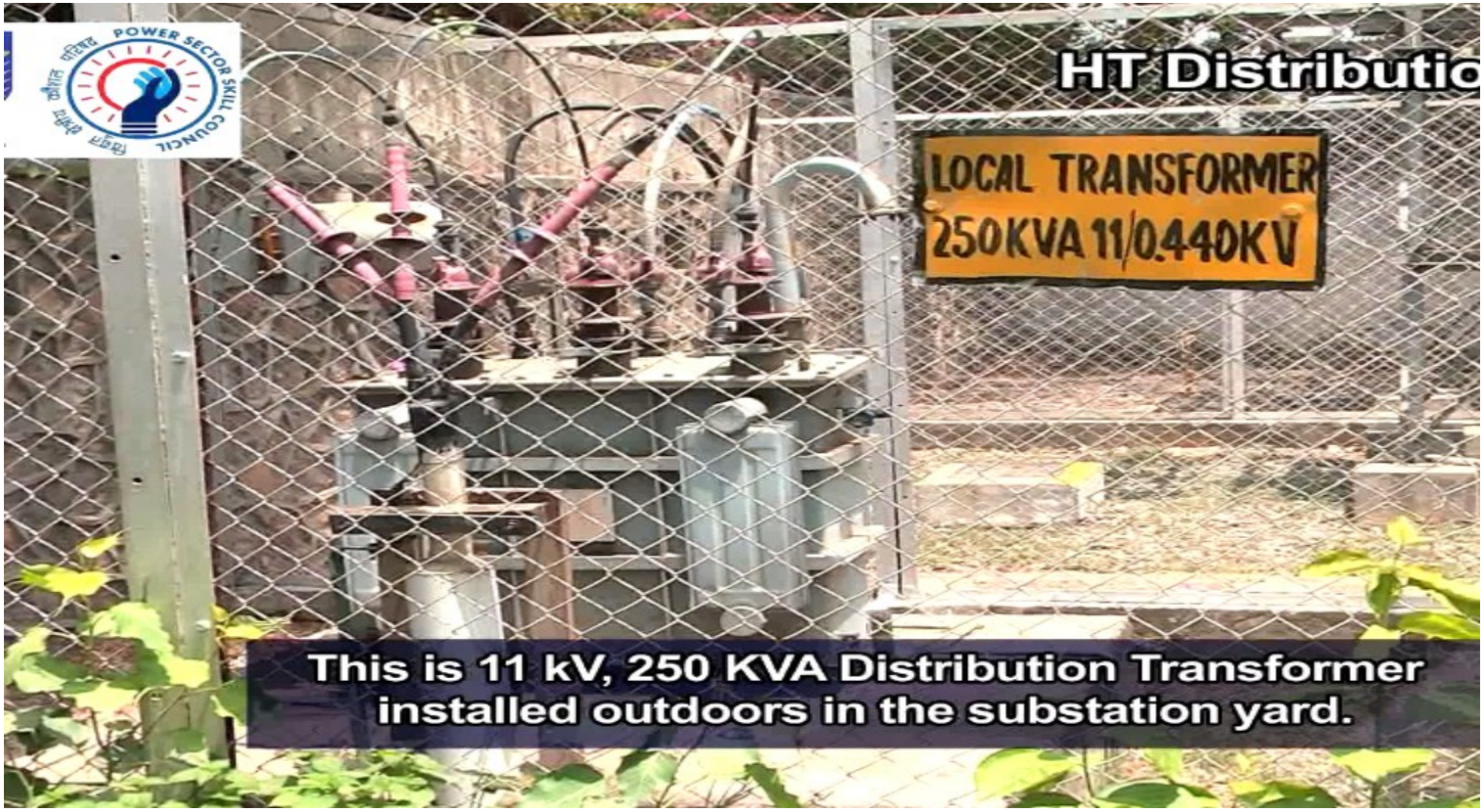
Overhead lines

Fault in Transformer of HT Distribution Network

Power transformer, which converts 33 kV and 66 kV line to 11 kV

Fault in Transformer of HT Distribution Network

Components and accessories of a transformer



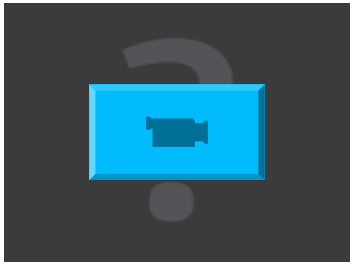
11 kV, 250 KVA distribution transformer

Fault in Transformer of HT Distribution Network

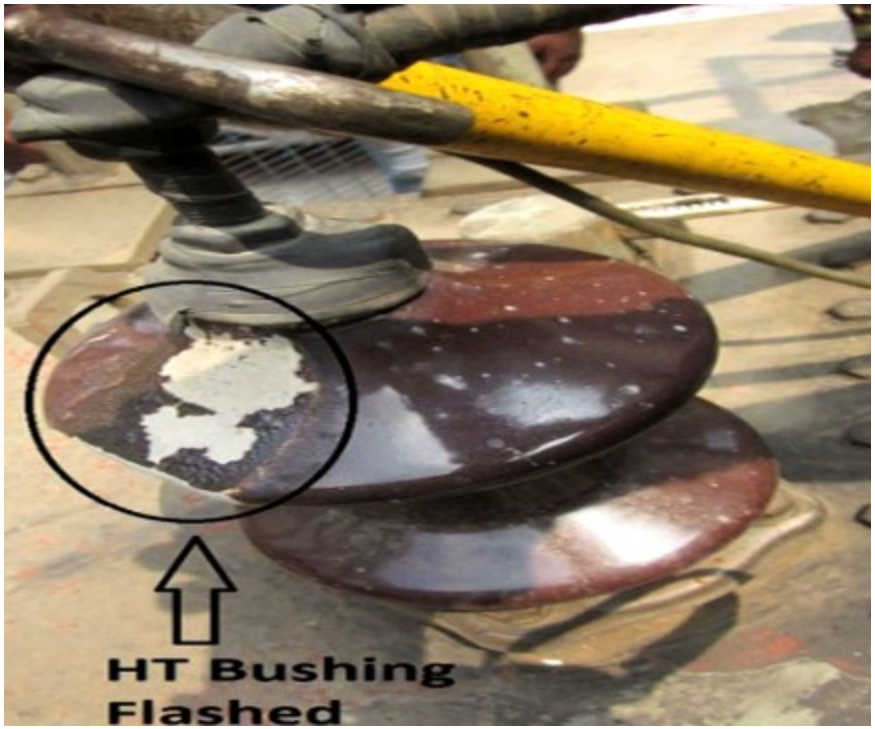
Common breakdowns occur in transformers

Cat is trapped on live wires and got electrocuted

Tree has fallen on plinth mount transformer



Fault in Transformer of HT Distribution Network



Damaged HT bushings

Fault in Transformer of HT Distribution Network

Replacement of damaged HT bushings

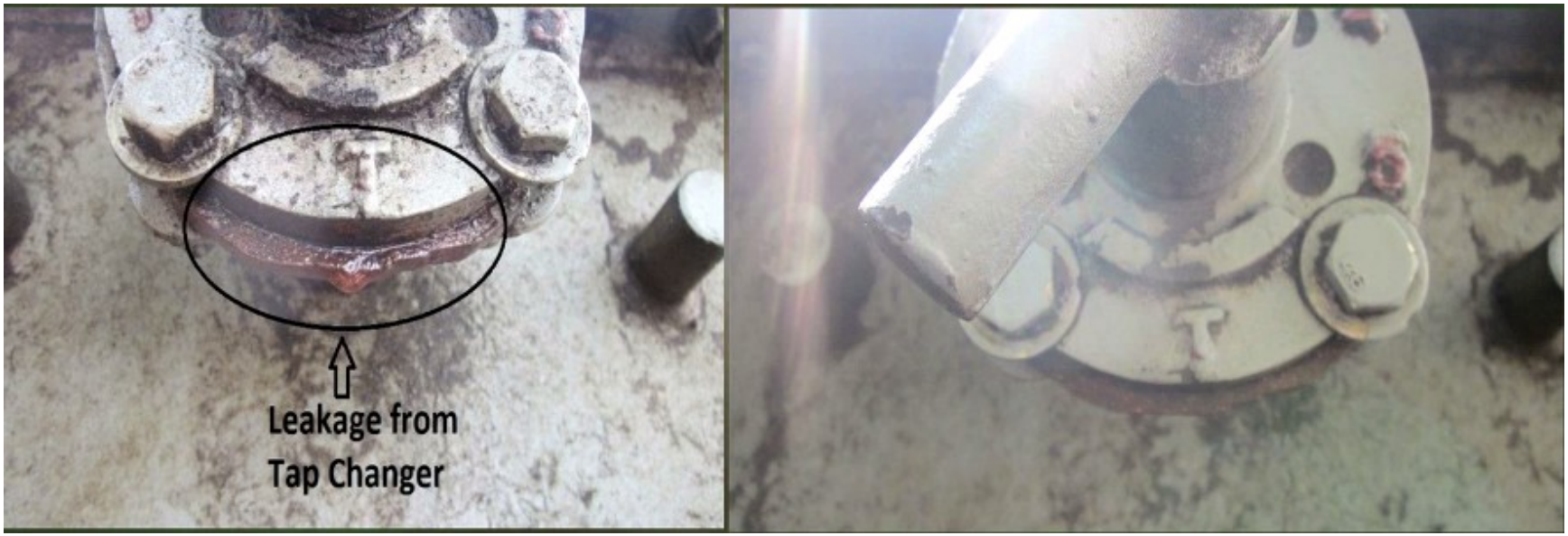
Fault in Transformer of HT Distribution Network

Oil leakage from valve

Fault in Transformer of HT Distribution Network

Examples of leakage from valve before and after

Fault in Transformer of HT Distribution Network



Leakage from tap changer before and after

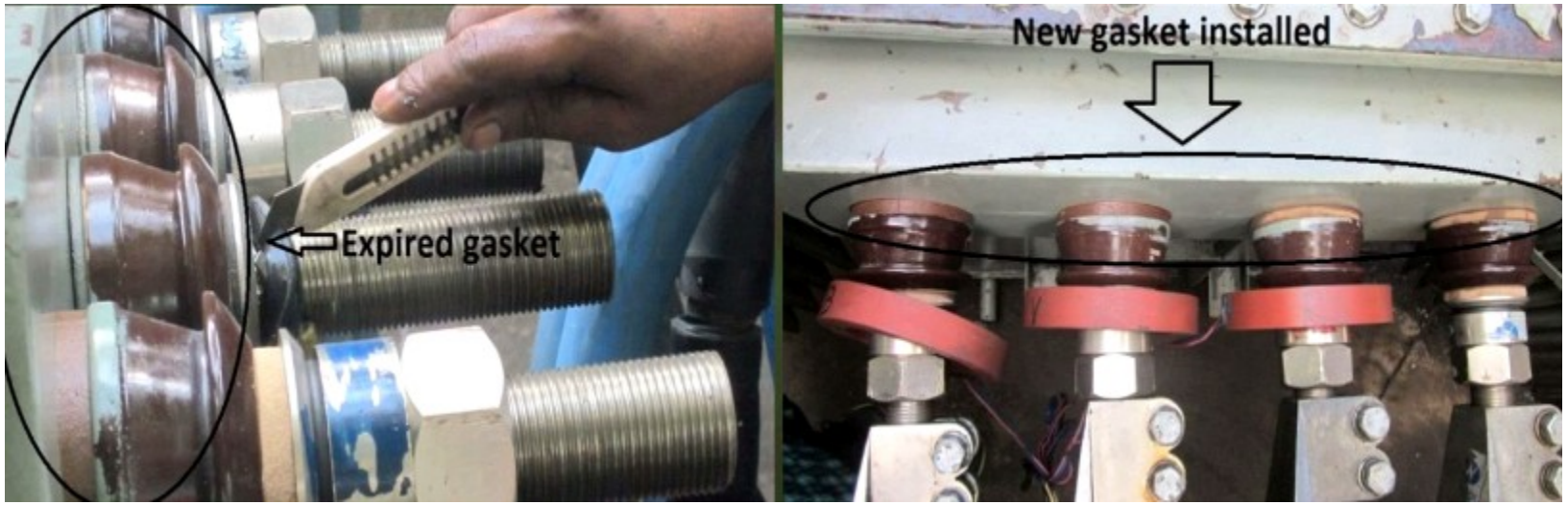
Fault in Transformer of HT Distribution Network

Oil leakage cannot be stopped by M-Seal.

Fault in Transformer of HT Distribution Network

Usage of gaskets to plug the oil leakage

Fault in Transformer of HT Distribution Network

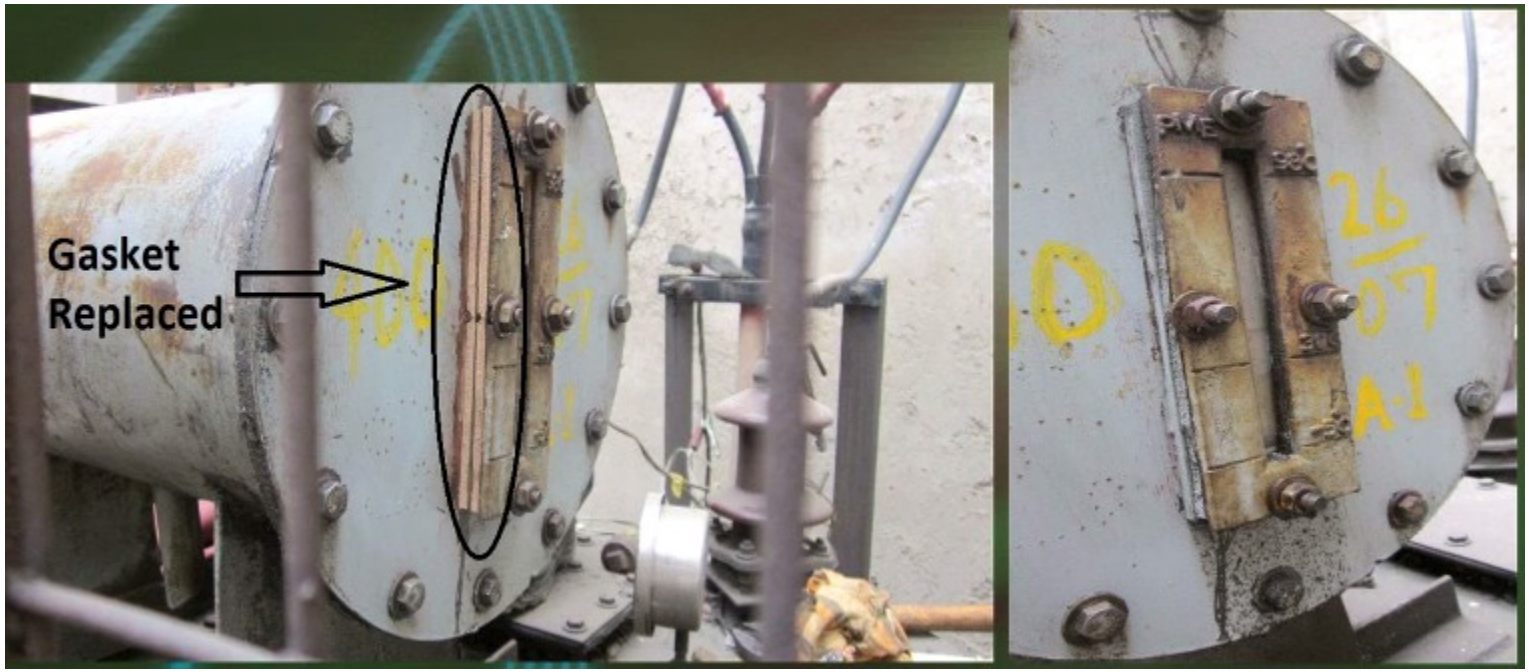


Replacement of gasket at LT bushing

Fault in Transformer of HT Distribution Network

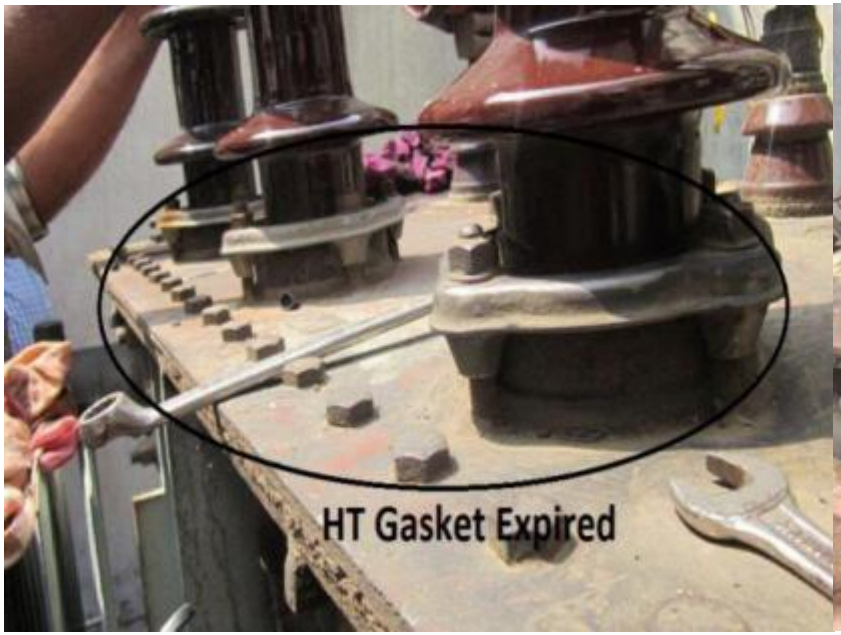
Replacement of gasket at oil level indicator

Fault in Transformer of HT Distribution Network



Replacement of gasket at oil level indicator

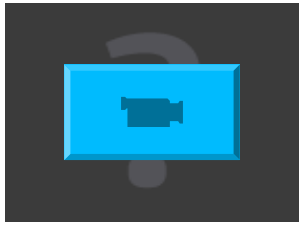
Fault in Transformer of HT Distribution Network



Replacement of gasket at HT bushing collar

Identification of Defects in Transformers and Their Remedies

Fault identified on HV bushing

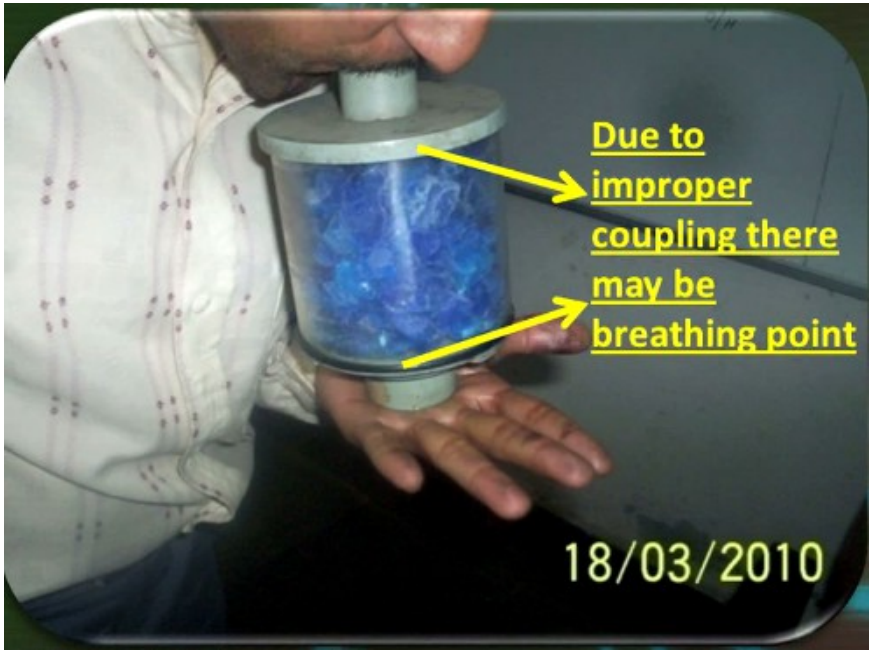


Identification of Defects in Transformers and Their Remedies

- Check bushings for cracks, chippings, overheating marks, flashover marks and replace the affected bushing
- For oil leakage, use tight oil seal caps and gaskets

Identification of Defects in Transformers and Their Remedies

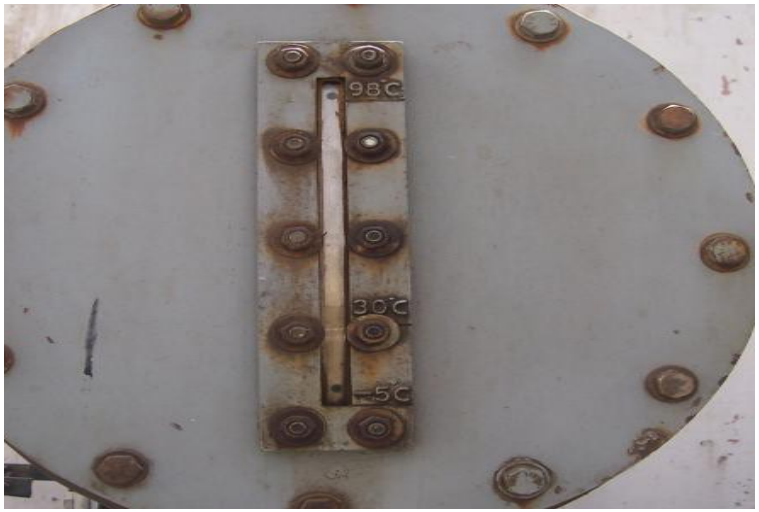
Palm connector surface pitted due to loose connection



Breather

Identification of Defects in Transformers and Their Remedies

Inside view of conservator tank



Conservator tank and oil gauge

Identification of Defects in Transformers and Their Remedies

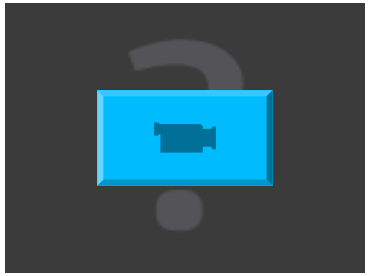
Explosion Vent Diaphragm

IR value test with insulation tester

Faults in Switchgears of HT Distribution Network

Flash in RMU cable chamber

OCP tripping and flash at cable termination



Types of Faults in Yard, Switchgear and Their Maintenance

Healthy condition of RMU

Types of Faults in Yard, Switchgear and Their Maintenance

Sulphated Bus Bar Due to loose Joint resulting in to Hot Spot.(Thermo scanning is best Preventive Technique)

Hotspot at palmtop conductor's bus bar

Types of Faults in Yard, Switchgear and Their Maintenance

Deteriorated C B Connection Plate due to Sulphation , Remedy: Thermo scanning and Effective Maintenance.

Hotspot at circuit breaker connection

Types of Faults in Yard, Switchgear and Their Maintenance

Deteriorated Isolator Fixed Contact Due To Rusting Resulting in to loosening of Power Contact and further generation of Hot Spot.

Hotspot at joints

Types of Faults in Yard, Switchgear and Their Maintenance

Control and relay Panel for 33kV Switchyard

11-kV Switchgear Panel

Breakdowns Due to Natural Disasters

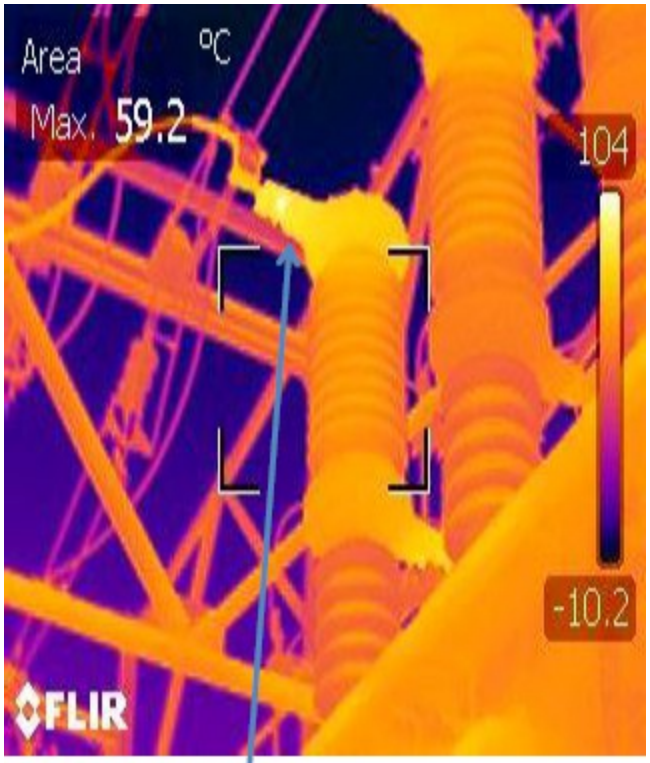
33 kV Circuit Breaker

11-kV Vacuum Circuit Breaker

Factors Affecting Switchgear Life

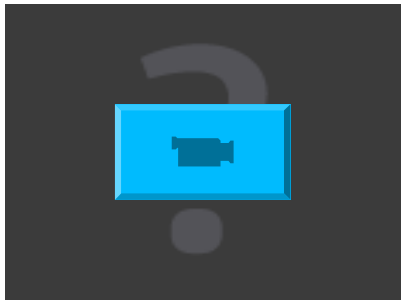
- **Pollution** - Mainly affects the insulation properties of insulators
- **Climate** - Affects the insulation of the equipment
- **Loading of equipment** - Life of equipment deteriorates if overloaded or underloaded
- **Maintenance practices** - Determine the life of equipment

Thermal Imaging

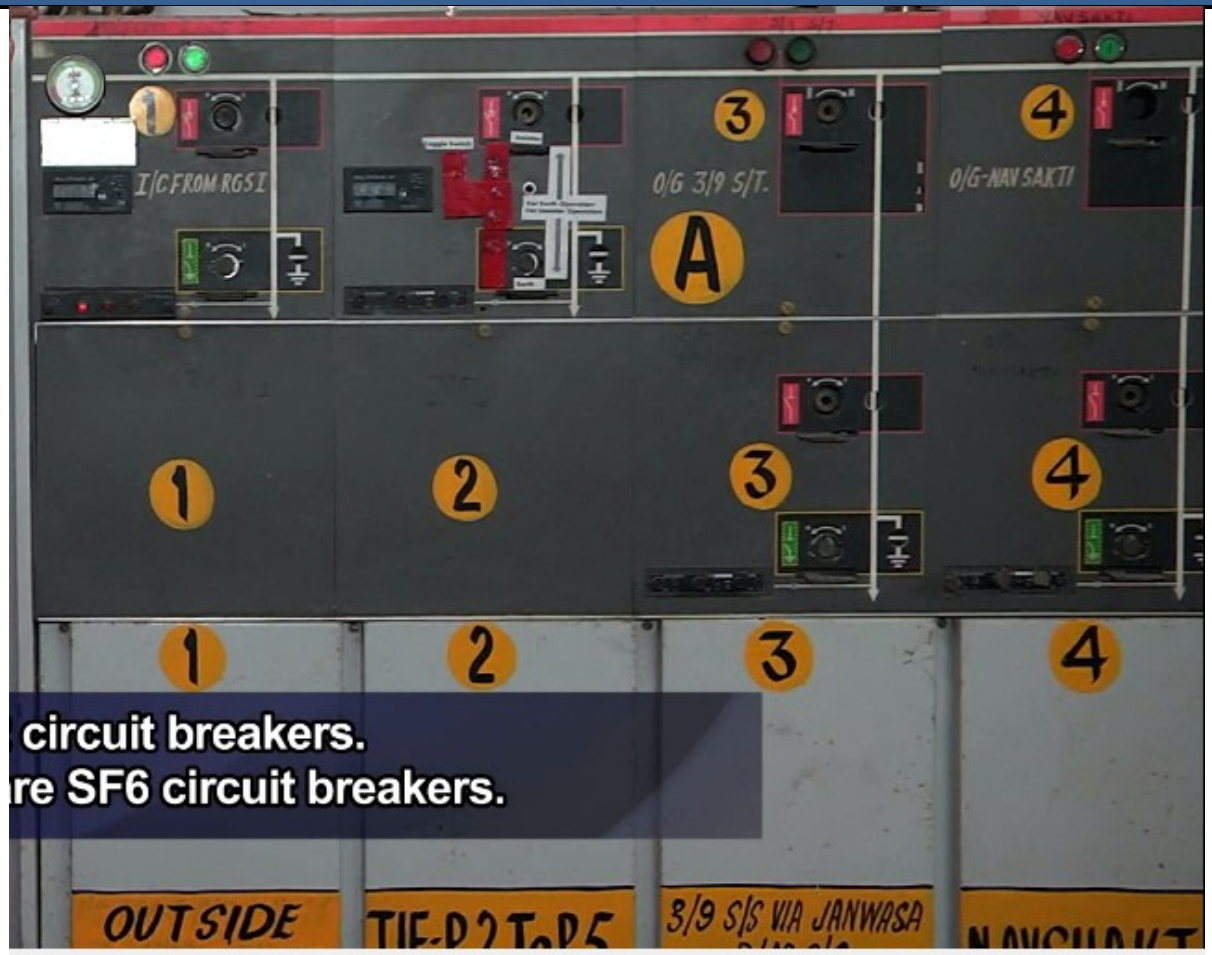


Thermal Imaging Showing Hot Spot

- A thermal imaging camera is used
- Detects the changes in heat in the area to which they are pointed
- An essential tool for preventative maintenance
- The cost for replacing the breaker at this point will be small



Switchgears Installed in 11kV Sub-Station



Ring Main Unit (RMU)

Switchgears Installed in 11kV Sub-Station

Voltage Presence Indicator System (VPIS)

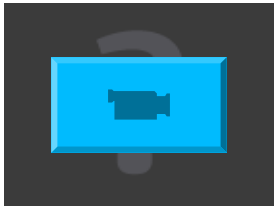
SF6 circuit breakers

Gas manometer

showing arc quenching medium of SF6 gas

Faults in Cables of HT Distribution Network

Faults in Cables
Cable faults have become very common as many civic agencies work for development projects.
Excavation is an integral part of water and sewage lines, optic fibre, communication and gas pipeline works.
These agencies damage our cables during digging activities.
We need to get them repaired within 12-18 hours.
Fault Locating Vans (FLC) pinpoint the exact location of fault in underground cable.
Straight-through faults are repaired by jointing cables through straight through joint boxes.
The technicians are experts in repairing the transformers on the site.
In transformers, problems such as dissolved gas analysis (DGA) are handled by in-house staff.

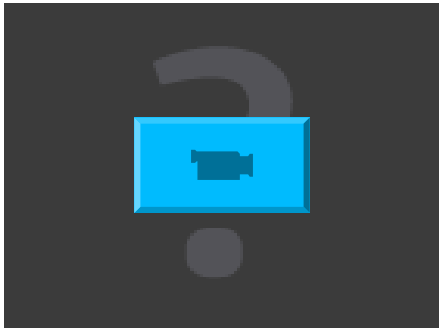


Underground Cable Faults and Rectification

Fault locating van

Instrument indicator

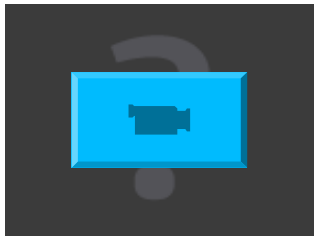
Instrument that pin points the cable fault



Cable Testing, Fault Location and Recording Using Compact System

About Compact System

Compact System is one of the latest technologies of self-contained cable testing system.



Cable Testing, Fault Location and Recording Using Compact System

About Compact System

It is a small instrument, which is encased and is relatively a light computer aided system.

Cable Testing, Fault Location and Recording Using Compact System

Compact System

- Exact pre-location, new method introduced i.e. Arm plus
- Easy for testing, adjusting surge voltages and time

Cables

Cables of Compact System
There is now considerable preference for U/G cables over O/H lines.
In metropolitan cities, it is not feasible to have transmission and distribution with O/H lines due to non-availability of land for constructing O/H lines.
O/H lines mar the aesthetic value of a city's skyline.
U/G system is preferred as it is unaffected by abnormal weather conditions, storms, tree falling, trees touching, snowfall and other objects.

Cable Testing, Fault Location and Recording Using Compact System

Causes for Cable Faults

- Mechanical damage
- Damage of sheath or insulation - External agents
- Sheath corrosion - due to chemical action
- Vibration - due to heavy traffic on road
- Thermal damage - increase in thermal resistance of soil, hot pipe
- Operational problems
- Cable deterioration - due to overloading
- Joint deterioration - migration of semi-fluid compounds from joints, electrical tracking along insulation owing to poor stress control
- Terminal defects
- Poor workmanship - joints
- Manufacturing defects - cracked lead sheath

Cable Testing, Fault Location and Recording Using Compact System

Testing

IR Measurement

- IR measurement is done by using MEGGER
- Phase to phase and phase to ground is tested using 5 kv MEGGER for 1 minute or till reading stabilises
- Minute IR value for healthy phase is 50 Mohm (11 kv), 100 Mohm (33 kv), 500 Mohm (66 kv)
- U/G system is preferred as it is unaffected by abnormal weather conditions, storms, tree falling, trees touching, snowfalls and foreign objects

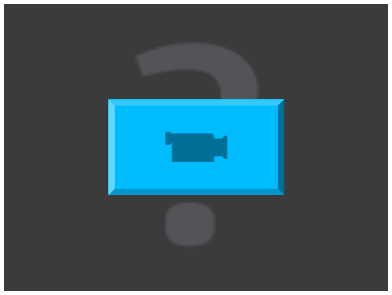
Testing

HVDC testing

- High Voltage DC testing (Pressure Testing) is done only after IR values are not found satisfactory
- Each phase is tested for 5 minutes with regard to ground and other phases grounded at 6.5 kv (11 kv cable),19.5 kv (33 kv), 38 kv (66 kv)
- The leakage current pattern is observed during the testing period (shown graphically in compact system)
- If the leakage current has a rising trend, the cable is faulty and if there is downward trend, cable may be healthy
- By testing, faulty phase(s) is detected

Instruments in the FLC Van

Damaged HT cable



Pit for new cable joint

New HT cable joint

Instruments in the FLC Van

Sand bed

- 75mm (3-inch) sand bed is prepared below and above the cable joint
- It is covered with RCC docket and brick lining to protect it from mechanical damage
- A route marker is placed before refilling the trench with soil after completion of docketing

Instruments Used to Identify Faults in HT System

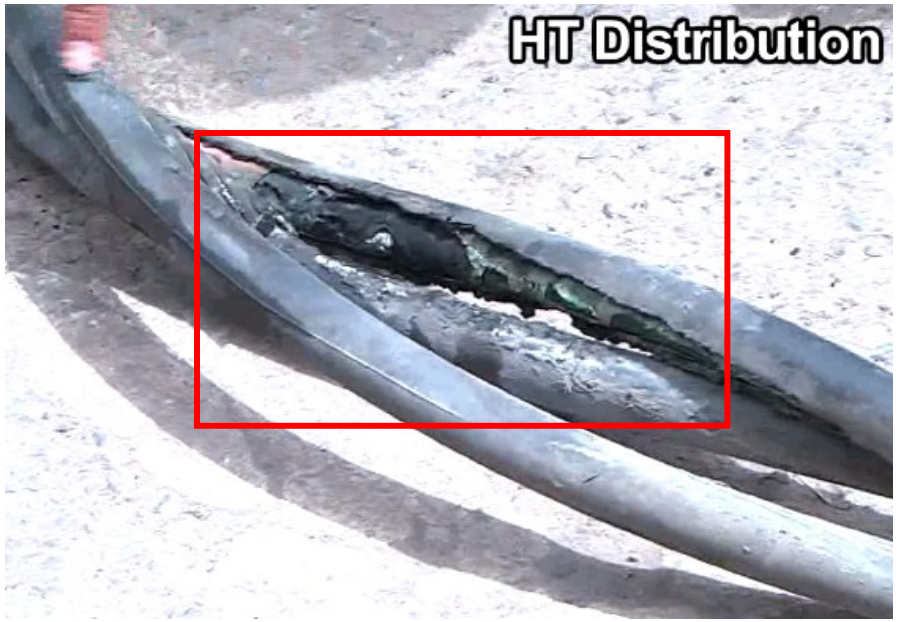
The common instruments used to identify faults in HT system are:

- MEGGER - To test insulation
- High pot - To test voltage sustainability of cable
- Thermo vision camera - To test hidden weak joints or links and
- FLC van

Fault in ABC (Air Bunch Conductor) Cable

- This is due to corona discharge in 11 kV ABC cable
- The cause for fault is that metallic screens of ABC cable are not grounded at the end terminations
- Induced voltage develops at the sheath of ABC. This causes short circuit and gets damaged
- It is mandatory to ground messenger wire with proper earthing

Replacement of Faulty HT Cable



Burnt AB cables

Lineman replacing the burnt cable with the new one

Overhead System Faults and Their Rectification

Tree fallen on the HT lines

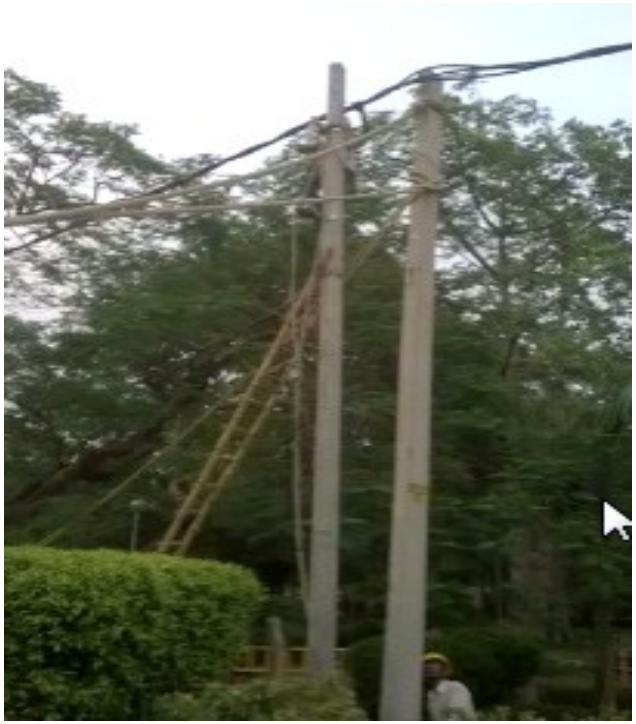
Damaged HT lines due to tree fall

Overhead System Faults and Their Rectification

Uprooted PCC pole carrying HT ABC line

Branch of tree damaged the HT line

Overhead System Faults and Their Rectification



Replacement of uprooted pole

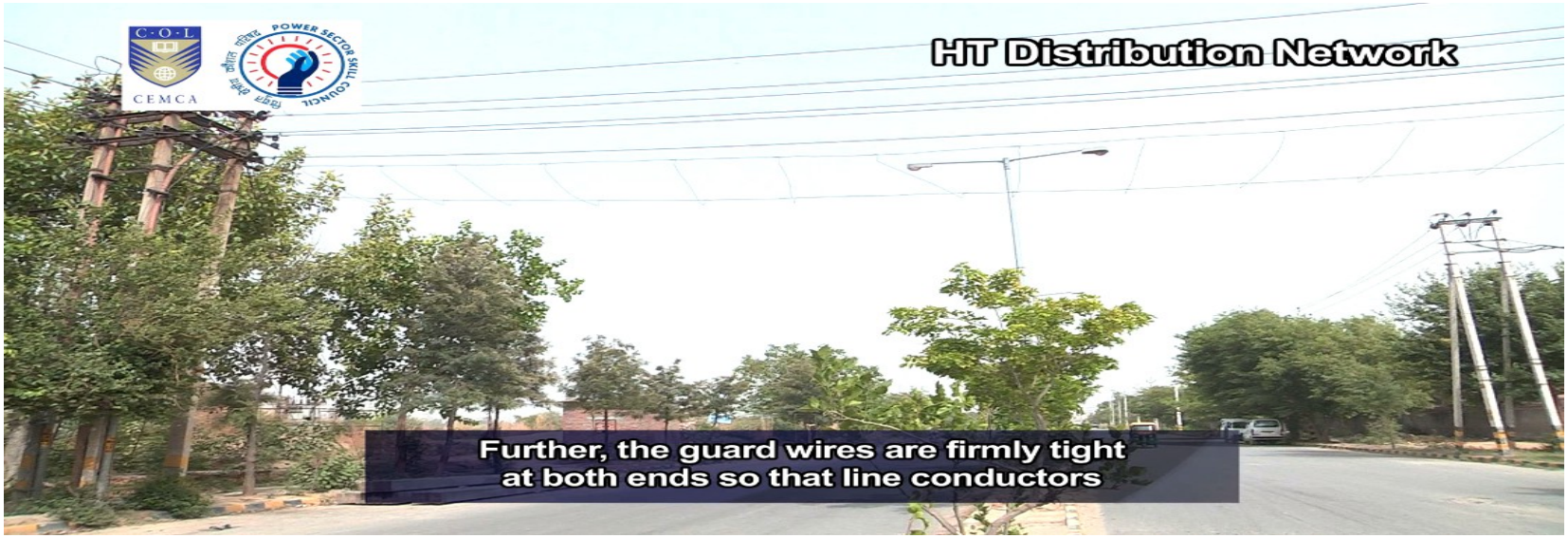
Damaged HT lines in a flood-affected area

Overhead System Faults and Their Rectification

Lineman removing the HT disc insulators

New pole is grounded on cement mortar

Overhead System Faults and Their Rectification



HT overhead line

- The height of lowest conductor (earth guard wire) from ground is more than 5.8 metres as per CEA regulations
- Guard wires are firmly tight at both ends so that line conductors may not touch ground

Key Learning Outcomes

- Sub-transmission network comprises 66kV, 33 kV and 11kV networks in a distribution company
- The faults in HT system network can be classified into transformer, switchgears, underground lines or overhead lines
- Factors affecting switchgear life are pollution, climate, loading of equipment and maintenance practices
- In thermal imaging, thermal cameras detect the changes in heat in the area to which they are pointed
- RMU or Ring Main Unit has 2 LBS or load break switches and 2 circuit breakers
- Fault Locating Vans (FLC) pinpoint the exact location of fault in underground cable
- Compact System is one of the latest technologies of self-contained cable testing system
- IR measurement is done by using MEGGER