**DEVOLTAGE TRAINING CENTRE**

**SELF-STUDY ONLINE TRAINING MODULE**

**MODULE 1**

# INTRODUCTION TO LOW VOLTAGE AND MEDIUM VOLTAGE OVERHEAD DISTRIBUTION NETWORKS

**Course:** Line Patrol and Maintenance of LV and MV Overhead Lines

**Target Group:** Construction Level Workers

**Duration:** 2 Hours

**Module Assessment:** 10 Multiple Choice Questions

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## Learning Outcomes

After successfully completing this module the learner will be able to:

- Explain the purpose of the City of Cape Town electrical distribution network.
- Identify the main components of LV and MV overhead systems.
- Understand the difference between Medium Voltage and Low Voltage networks.
- Identify common pole structures.
- Understand the flow of electricity from the substation to the customer.
- Identify equipment found on overhead line routes.
- Understand the responsibilities of Construction Level Workers.
- Recognise electrical hazards before commencing work.

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## Introduction

The City of Cape Town operates one of the largest municipal electricity distribution networks in Africa.

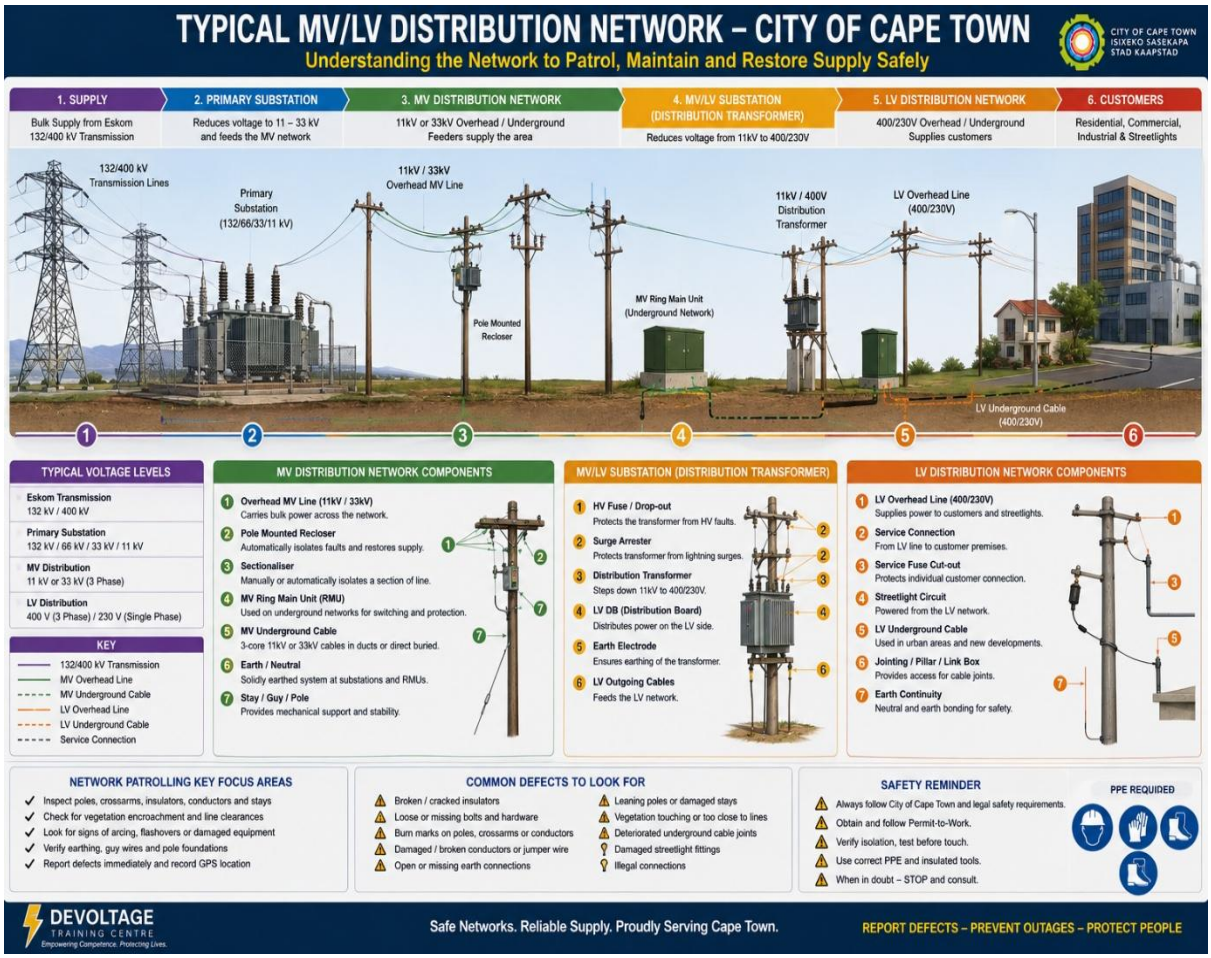
This network supplies electricity safely and reliably to residential, commercial and industrial customers through an extensive system of substations, transformers, overhead lines, underground cables and service connections.

Construction workers are responsible for constructing, maintaining and inspecting these overhead networks while complying with:

- Occupational Health and Safety Act 85 of 1993

- Electrical Machinery Regulations
- Construction Regulations
- City of Cape Town Distribution Standards
- NRS Standards
- Devoltage Safe Working Procedures

No work may commence unless all safety requirements have been met.



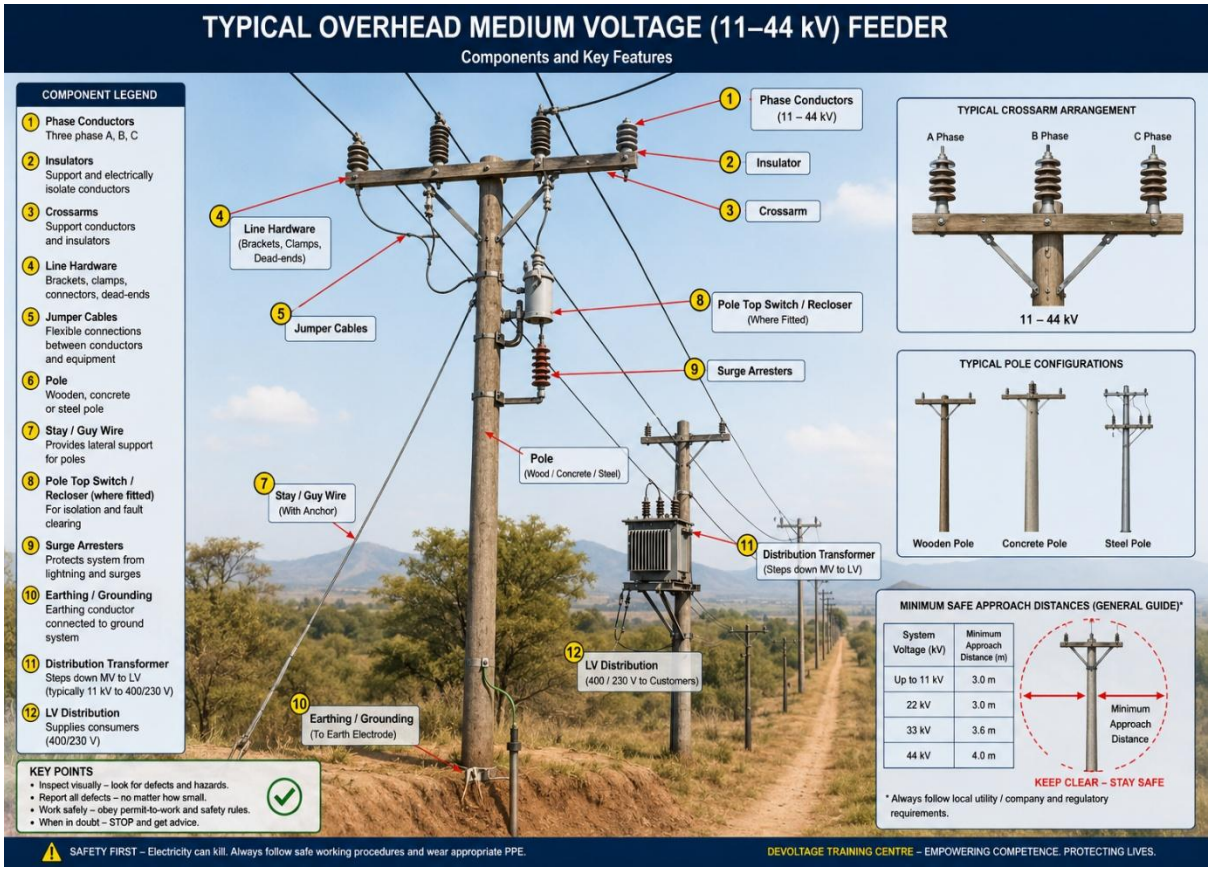

Electricity travels through several stages before reaching a customer's home or business.

## 1.1 Construction Worker's Responsibility

The construction team is mainly responsible for work on:

- MV overhead feeders
- Pole mounted transformers
- LV overhead reticulation
- ABC networks
- Bare conductor systems

Service connections




## 1.2 Voltage Levels

Understanding voltage levels is essential before entering any worksite.

| Voltage | Typical Application |
|---|---|
| 400 kV | National Transmission |
| 220 kV | Transmission |
| 132 kV | Transmission |
| 66 kV | Distribution |
| 33 kV | Municipal Distribution |
| 22 kV | MV Distribution |
| 11 kV | MV Distribution |
| 400/230 V | Low Voltage Supply |

## Important Rule

Construction workers must always assume every conductor is LIVE until proven otherwise by an authorised person.

## 1.3 Difference Between MV and LV Networks

| Medium Voltage | Low Voltage |
|---|---|
| 11 kV or 22 kV | 400/230 V |
| Supplies transformers | Supplies customers |
| Larger insulators | Smaller insulators |
| Greater conductor clearances | Lower clearances |
| Higher electrical hazard | Lower voltage but still dangerous |
| Operated only by authorised personnel | Construction workers perform installation under supervision |

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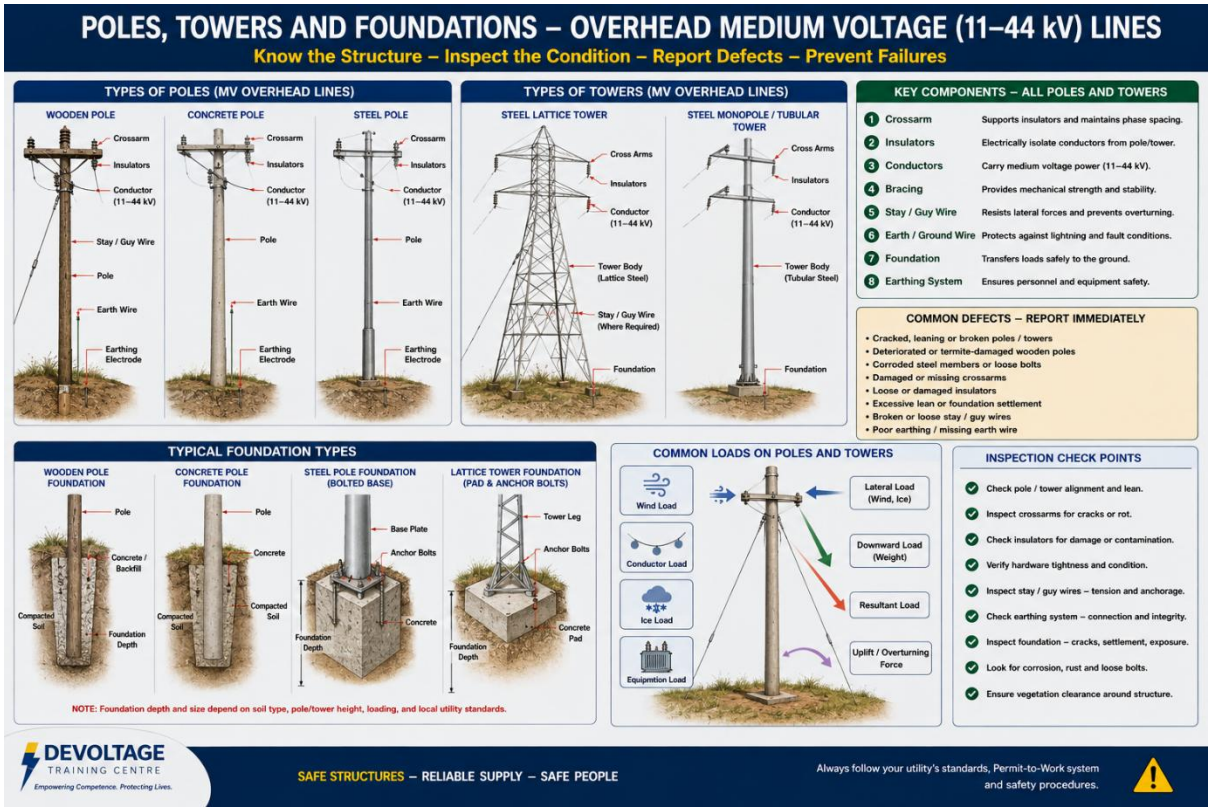
## 1.4 Components Found on Overhead Networks

During patrols, construction workers must identify every component correctly.

The supplied Devoltage construction manual introduces these components during LV construction and ABC installation.




## Structures

- Wooden poles
- Concrete poles

- Steel poles
- Stay poles
- Terminal poles
- Intermediate poles
- Angle poles

**Conductors**

- Bare Aluminium
- ABC conductors
- Copper conductors

**Insulators**

- Pin insulators
- Shackle insulators
- Suspension clamps
- Strain clamps

**Hardware**

- Crossarms
- Brackets
- Bolts
- Stay rods
- Stay wires
- Pole steps

**Equipment**

- Pole mounted transformers
- Pole-top distribution boxes
- Drop-out fuses
- Streetlight brackets
- Service connection boxes

### 1.5 Bare LV Networks

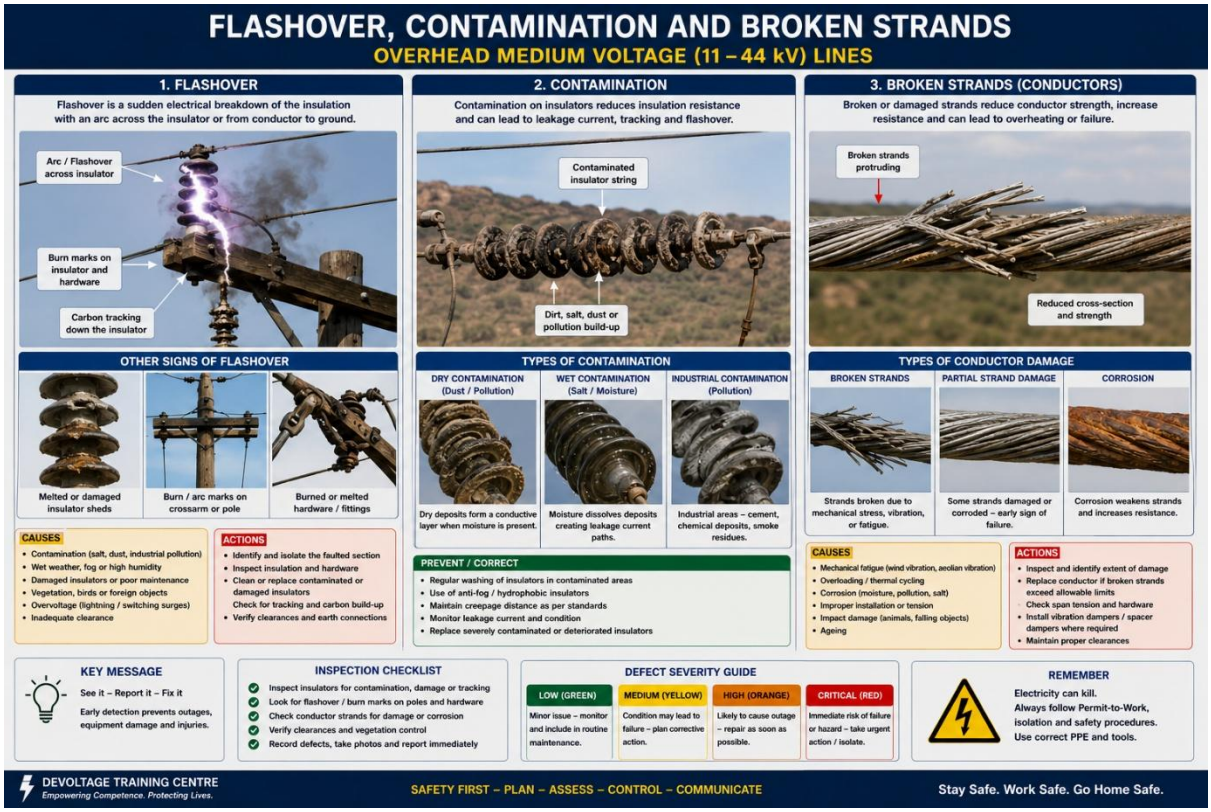
Bare conductor systems are still installed in parts of the City of Cape Town.

The supplied Devoltage manual explains:

- Bare conductors
- Jumpers
- Connections
- Line configurations
- Installation methods
- Required conductor clearances

Typical defects include:

- Loose jumpers
- Burnt connections
- Broken conductors
- Excessive sag
- Damaged insulators
- Missing ties




## 1.6 ABC Networks (Aerial Bundled Conductors)

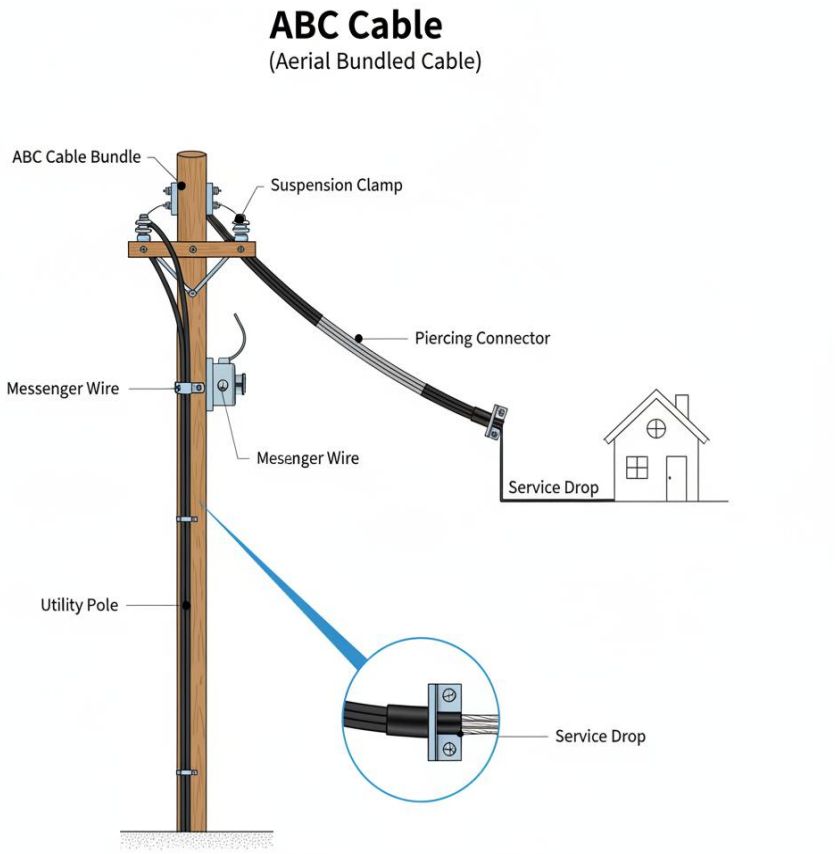
Modern City of Cape Town reticulation generally uses ABC systems.

The supplied manual explains:

- Neutral messenger
- Insulated phase conductors
- Suspension brackets
- Strain clamps
- IPC connectors
- Pulling socks
- Swivels
- Tensioning methods
- Cable ties
- End caps

Advantages include:

- Reduced faults
- Improved safety
- Reduced vegetation interference
- Lower maintenance
- Reduced theft




## 1.7 Service Connections

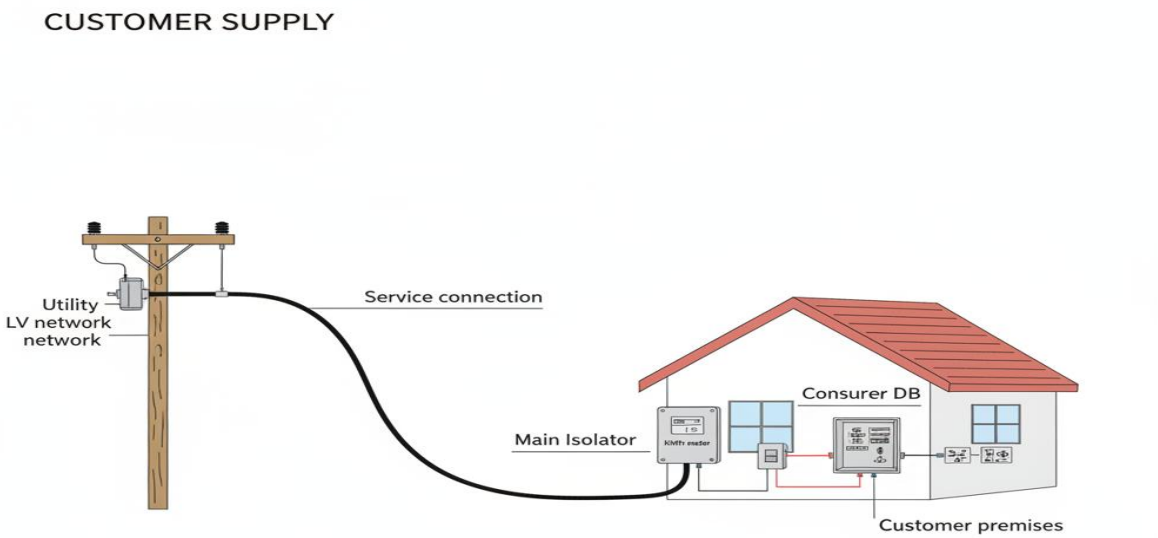
Electricity reaches the customer through a service connection.

The supplied Devoltage manual explains:

- Pole-top distribution boxes
- Concentric cable
- Meter connections
- Underground services
- Overhead services
- Span lengths
- Service poles
- Clearances

Construction workers must inspect:

- Pole box condition
- Service cable
- Cable clamps
- Entry point
- Customer connection
- Meter box
- Earth connection




## 1.8 Responsibilities of Construction Level Workers

Construction workers are expected to:

- Carry out work safely.
- Inspect overhead lines.
- Identify defects.
- Report hazards.
- Install poles.
- Install conductors.
- Install ABC.
- Install service connections.
- Replace damaged hardware.

- Maintain statutory clearances.
- Protect the public.
- Follow Devoltage work procedures.
- Work only within the limits of their authorisation.

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**Module Summary**

After completing this module you should now understand:

✓ The structure of the City of Cape Town electrical distribution system.

✓ The difference between Medium Voltage and Low Voltage networks.

✓ The purpose of transformers.

✓ Components found on overhead lines.

✓ Bare conductor systems.

✓ ABC systems.

✓ Service connections.

✓ The role of Construction Level Workers.

✓ The importance of safe working practices before commencing any overhead line construction or patrol activities.

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**Knowledge Check (Before Module Assessment)**

1. What is the primary function of a pole-mounted transformer?
2. What is the nominal voltage of a low-voltage distribution network?
3. Name three types of pole structures used in overhead line construction.
4. What is the difference between bare conductor and ABC systems?
5. List five components you would expect to inspect during a line patrol.
6. Why must every conductor be treated as live?
7. What is the purpose of a service connection?
8. Identify three hazards commonly found on overhead distribution lines.
9. Why are statutory clearances important?
10. What are the main responsibilities of a Construction Level Worker on the City of Cape Town network?

This module forms a solid foundation for the next section, **Module 2 – Electrical Safety, Risk Assessment and Safe Working Practices**, where learners will study hazard identification, PPE, work permits, minimum approach distances, emergency procedures, and Devoltage safety philosophy in greater depth.

**MODULE 2**

**ELECTRICAL SAFETY, RISK ASSESSMENT AND SAFE WORKING PRACTICES**

**Course:** Line Patrol and Maintenance of Low Voltage (LV) and Medium Voltage (MV) Overhead Lines

**Target Group:** Construction Level Workers – City of Cape Town Networks

**Duration:** 3 Hours

**Module Assessment:** 10 Knowledge Questions

**Module Aim**

The purpose of this module is to provide every Construction Level Worker with the knowledge required to identify electrical hazards, perform risk assessments, use Personal Protective Equipment (PPE) correctly, and work safely on or near Low Voltage and Medium Voltage overhead line construction sites.

**This module is not an authorisation to work on live electrical equipment.**

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**Learning Outcomes**

On completion of this module the learner will be able to:

- Understand the legal responsibilities of employers and employees.
- Identify electrical hazards on overhead line construction sites.
- Apply Devoltage's "Safety First" philosophy.
- Select the correct PPE.
- Carry out a basic risk assessment.
- Establish a safe work area.
- Identify Minimum Approach Distances (MAD).
- Respond correctly to electrical emergencies.
- Protect members of the public.
- Report unsafe conditions immediately.

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**2.1 Safety Philosophy**

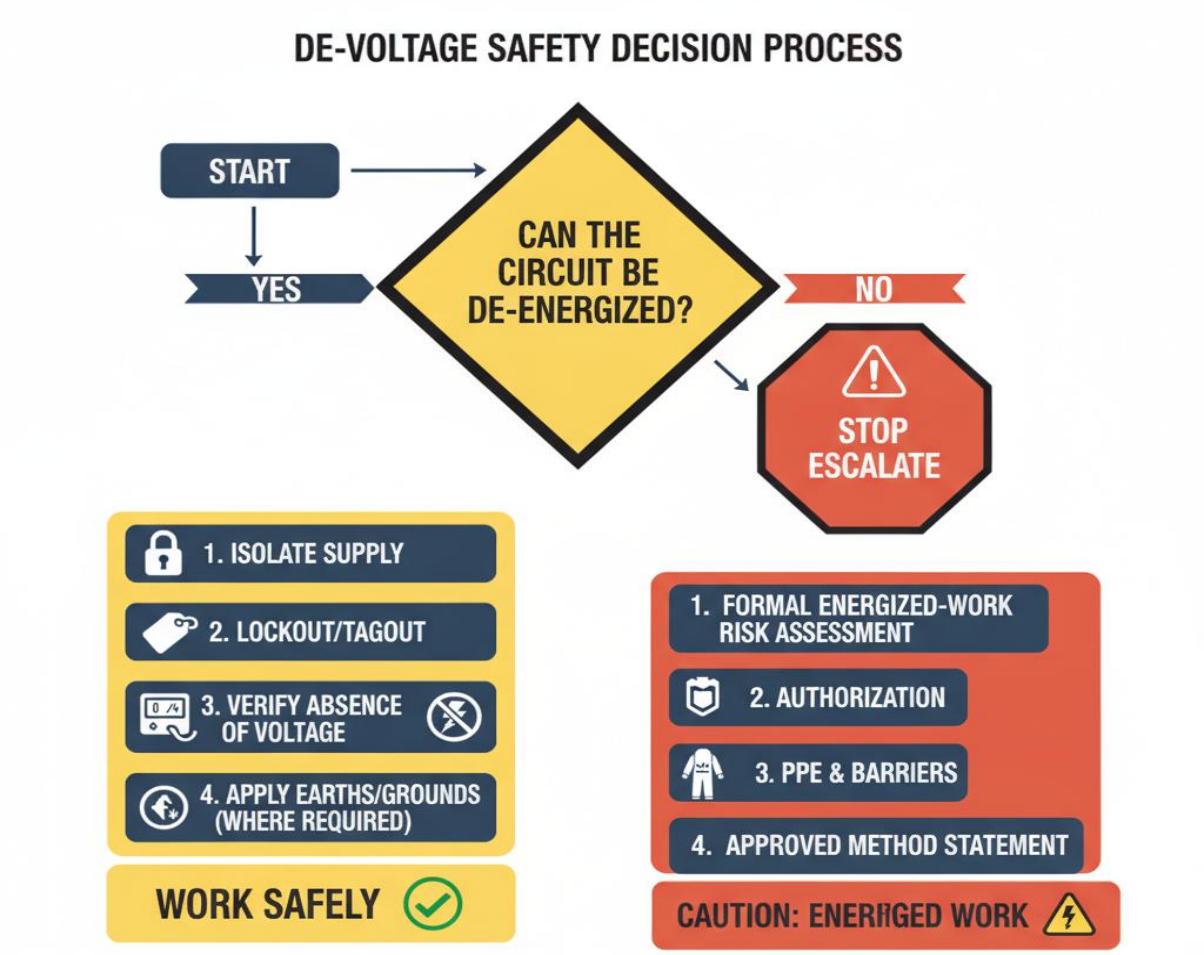
**"No Job is So Urgent That We Cannot Perform It Safely"**

Every employee has both a legal and moral responsibility to stop unsafe work.

Before any work starts, ask yourself:

- Is the work properly planned?
- Have all hazards been identified?
- Do I understand the task?
- Do I have the correct tools?
- Am I competent?
- Is the work area safe?
- Have I been authorised?

If the answer to **any** of these questions is **NO**, work must not proceed.



## 2.2 Legal Responsibilities

Construction workers must comply with:

- Occupational Health and Safety Act 85 of 1993
- Electrical Machinery Regulations
- Construction Regulations
- General Safety Regulations
- City of Cape Town Safety Procedures
- Employer Safe Working Procedures

### Employee Responsibilities

Every employee must:

- Work safely.
- Wear PPE.
- Report hazards.
- Protect fellow workers.
- Protect the public.
- Use approved tools.
- Follow work instructions.
- Never remove safety devices.

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## 2.3 Electrical Hazards

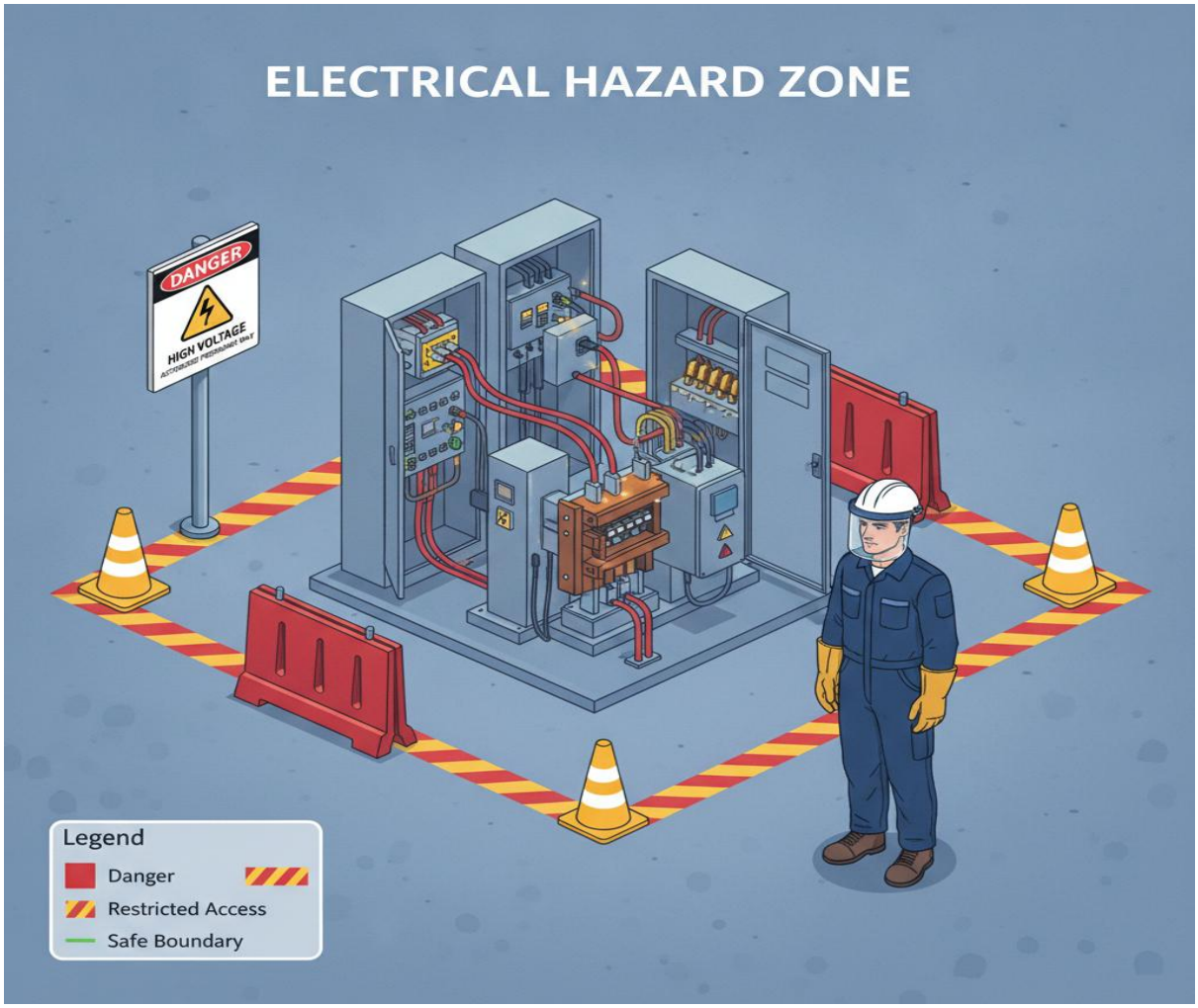
Electricity cannot be seen.

Many electrical accidents occur because workers assume equipment is dead.

### Typical Hazards

- Contact with overhead conductors
- Damaged conductors
- Broken neutral conductors
- Induced voltages
- Damaged transformers
- Broken insulators
- Fallen conductors
- Backfeed from generators
- Exposed live parts
- Damaged service cables

**Illustration 2.2**




## 2.4 Hazards During Line Patrol

Construction workers should never touch equipment during patrol unless specifically instructed.

Observe for:

- Leaning poles
- Broken stays
- Damaged crossarms
- Burn marks
- Bird nests
- Vegetation
- Broken insulators
- Loose conductors
- Excessive sag
- Missing danger notices

Any defect must be reported.

### 2.5 Personal Protective Equipment (PPE)

The supplied Devoltage construction manual identifies PPE as a basic requirement before commencing line construction activities.

**Mandatory PPE**

- Hard hat
- Arc-rated long-sleeve clothing
- Safety boots
- Safety glasses
- Leather gloves
- High-visibility vest
- Hearing protection (where required)

**Additional PPE**

Depending on the task:

- Full body harness
- Fall arrest lanyard
- Rubber insulating gloves (authorised live work only)
- Face shield
- Arc flash visor
- Respiratory protection
- Rainwear

**Illustration 2.3 – PPE and PPC**

**2.6 Working at Heights**
Many overhead line accidents involve falls.
Before climbing:
Inspect:

- Pole condition
- Pole stability
- Stay wires
- Pole steps
- Weather conditions

Never climb:

- Rotten poles
- Leaning poles
- Fire damaged poles
- Damaged concrete poles
- Poles struck by vehicles

**2.7 Risk Assessment**
Every task begins with a Risk Assessment.
Identify:

**Hazards**

Examples:

- Live conductors
- Traffic
- Weather
- Slippery ground
- Manual handling
- Falling objects

Assess

- Likelihood
- Severity

Control

- PPE
- Barriers
- Isolation
- Permit
- Additional workers
- Traffic control

Monitor
Continue monitoring throughout the work.

**Illustration 2.4**


## 2.8 Establishing a Safe Work Area

Before starting work:

- Place warning signs.
- Establish barriers.
- Position vehicles safely.
- Wear PPE.
- Prevent public access.
- Position observers if required.
- Protect traffic.

**Traffic Control**

Where work is carried out adjacent to roads:

Use:

- Cones
- Signs
- Flag personnel
- Flashing lights
- Barriers

Never rely on passing motorists to avoid workers.

## 2.9 Minimum Approach Distances

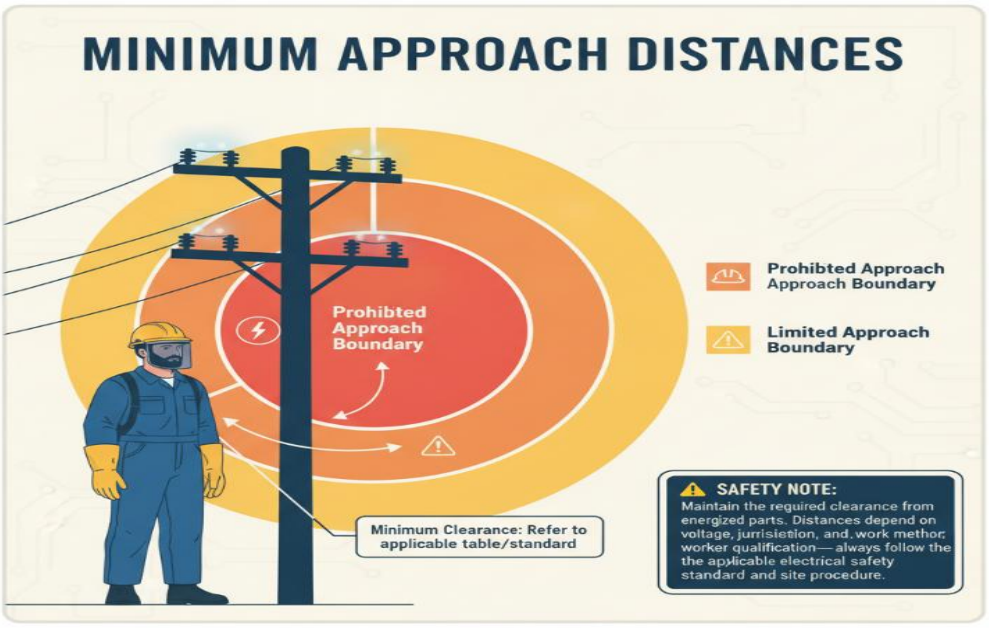
Construction workers must never approach live electrical equipment closer than the approved minimum distance specified by the employer's operating procedures.

Only authorised personnel may enter the electrical danger zone.

If work requires entering this zone:

- Stop work.
- Notify supervision.
- Obtain the correct authorisation.

**Illustration 2.5 – Safe Working Distance**




## 2.10 Public Safety

Construction workers are responsible for protecting:

- Pedestrians
- Children
- Motorists
- Property owners
- Livestock
- Cyclists

Examples include:

- Barricading excavations
- Covering holes
- Securing materials
- Removing trip hazards
- Preventing unauthorised access

## 2.11 Environmental Hazards

Do not work during:

- Lightning storms
- High winds
- Heavy rain
- Dense fog

- Unsafe visibility

Watch for:

- Bees
- Snakes
- Dogs
- Wet ground
- Falling branches

### 2.12 Emergency Procedures


If an accident occurs:

**DO NOT PANIC**

1. Stop work.
2. Protect yourself.
3. Protect others.
4. Raise the alarm.
5. Contact emergency services.
6. Report to supervisor.
7. Preserve the scene.
8. Complete incident report.

**If a Conductor Falls**

- Treat it as LIVE.
- Keep everyone away.
- Establish a safety perimeter.
- Notify the control centre.
- Wait for authorised personnel.

Never attempt to move a conductor.

**If Someone Receives an Electric Shock**

Do NOT touch the casualty until the electrical hazard has been made safe.

Once safe:

- Call emergency services.
- Commence CPR only if trained and it is safe to do so.
- Continue until relieved by medical personnel.
- Record all incident details.

**2.13 Safety During Construction**

Before commencing construction:
✓ Job briefing completed
✓ PPE inspected
✓ Tools inspected
✓ Risk assessment completed
✓ Public protected
✓ Materials inspected
✓ Traffic controlled
✓ Weather suitable
✓ Communication established
✓ Emergency plan discussed

**Daily Safety Checklist**

Every worker should ask:

- Am I fit for work?
- Do I understand today's task?
- Is my PPE in good condition?
- Are my tools serviceable?
- Have hazards been identified?
- Is the work area safe?
- Do I know the emergency procedures?

If the answer to any question is **No**, stop and notify your supervisor.

**Module Summary**

After completing this module, you should be able to:

- Explain the Devoltage safety philosophy.
- Understand your legal duties under the OHS Act.
- Identify common electrical hazards.
- Select and wear the correct PPE.
- Conduct a basic risk assessment.
- Establish a safe work area.
- Protect the public.
- Respond correctly to electrical emergencies.
- Understand the importance of safe approach distances and authorisation.
- Recognise when work must be stopped because conditions are unsafe.

**Module 2 Knowledge Check**

1. What is the first action if you identify an unsafe condition on site?
2. List five mandatory PPE items for overhead line construction.
3. Why must all overhead conductors be treated as live?
4. What are the four basic steps of a risk assessment?
5. Name four hazards commonly encountered during a line patrol.
6. What should you do if a conductor is found on the ground?
7. Why is traffic control important during overhead line work?
8. Who is responsible for protecting members of the public on a construction site?
9. Under what weather conditions should overhead line work be suspended?
10. Explain why only authorised personnel may enter the electrical danger zone.

**Reference to supplied training material:** This module builds on the safety requirements identified in the Devoltage **LV Line Construction** manual, including the requirements for PPE, approved tools, stable pole structures, hazard awareness, and adherence to health and safety procedures before commencing work.

**MODULE 3**

**LINE PATROL PRINCIPLES AND OVERHEAD LINE INSPECTION**

**Course:** Line Patrol and Maintenance of Low Voltage (LV) and Medium Voltage (MV) Overhead Lines

**Target Group:** Construction Level Workers – City of Cape Town Electricity Distribution Networks

**Duration:** 3 Hours

**Assessment:** 10 Knowledge Questions

## Module Aim

The purpose of this module is to equip Construction Level Workers with the knowledge and practical skills required to carry out safe and effective line patrols on Low Voltage and Medium Voltage overhead distribution networks.

Line patrols are one of the most important preventative maintenance activities undertaken by electricity utilities. A well-trained patrol team can identify defects before they become failures, reducing outages, improving public safety and extending the life of the electrical network.

## Learning Outcomes

After completing this module the learner will be able to:

- Explain the purpose of a line patrol.
- Understand different types of patrols.
- Prepare for a patrol safely.
- Conduct systematic visual inspections.
- Identify defects on LV and MV overhead lines.
- Assess defect severity.
- Complete inspection reports.
- Use photographic evidence correctly.
- Prioritise maintenance activities.
- Report emergency defects immediately.

## 3.1 What is a Line Patrol?

A line patrol is a planned visual inspection of an overhead electrical network to determine its condition and identify defects before they result in equipment failure, electrical accidents or power interruptions.

Line patrols form part of the City's preventative maintenance programme and help ensure the electricity network remains safe, reliable and compliant with operational standards.
The patrol should be systematic, thorough and properly documented.

**Objectives of a Line Patrol**

The objectives are to:

- Improve network reliability.
- Prevent equipment failure.
- Identify safety hazards.
- Protect the public.
- Detect vandalism and theft.
- Monitor vegetation growth.
- Identify damaged poles and structures.
- Schedule maintenance work.
- Reduce emergency outages.
- Improve customer service.

**Illustration 3.1**

## 3.2 Types of Line Patrols

Different patrols are carried out depending on operational requirements.

### Routine Patrol

Conducted according to a planned maintenance schedule.

Purpose:

- General inspection
- Defect identification
- Vegetation inspection
- Public safety

### Storm Patrol

Conducted after:

- Strong winds
- Heavy rain
- Lightning
- Floods
- Fires

Purpose:

Identify emergency defects.

### Emergency Patrol

Conducted after reports of:

- Power failures
- Broken conductors
- Fallen poles
- Vehicle accidents
- Public complaints

Immediate response is required.

### Construction Patrol

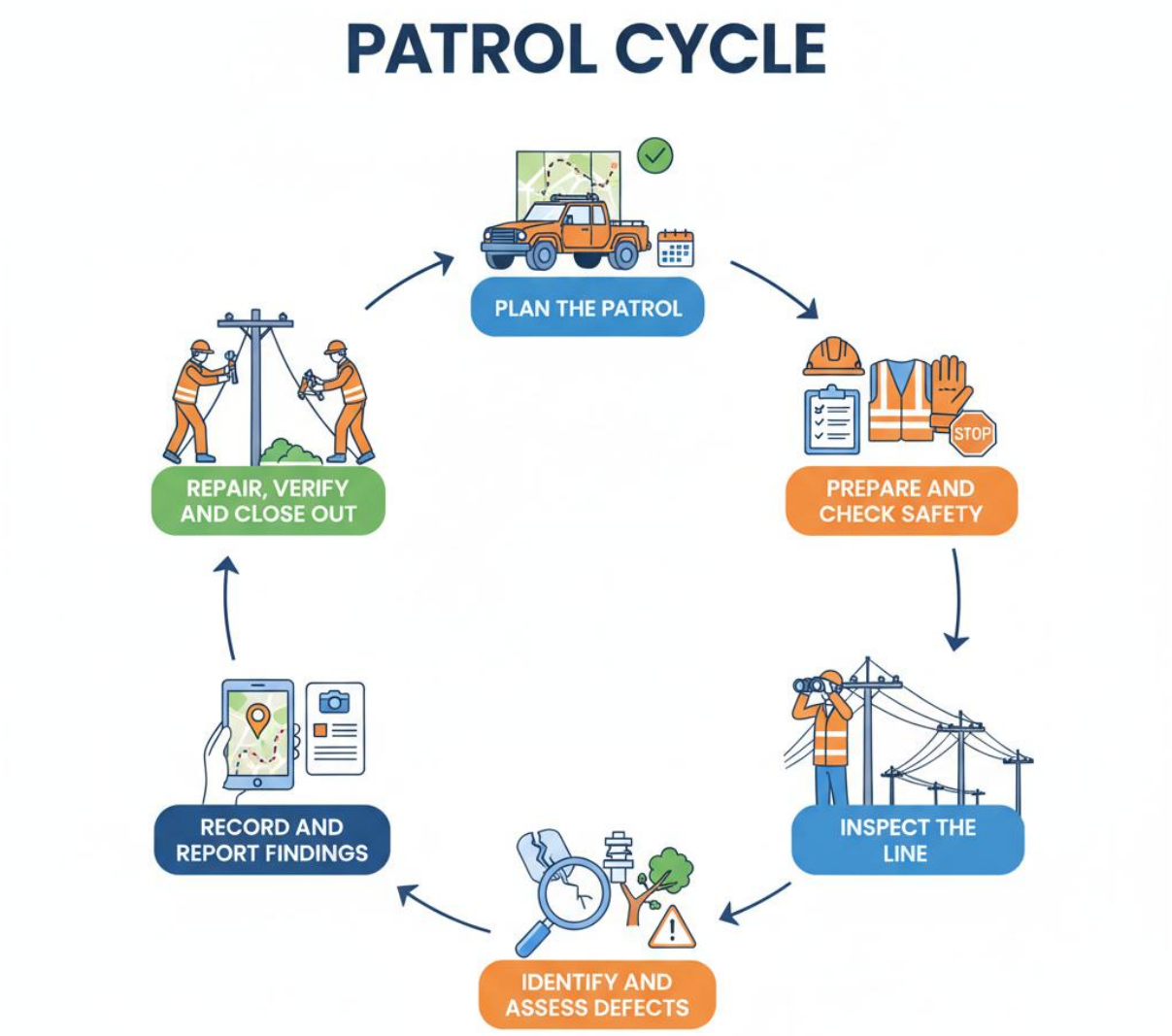
Performed:

- Before construction begins
- During construction
- After project completion

Purpose:

Ensure construction complies with design specifications and safety requirements.

**Illustration 3.2 –**




### 3.3 Preparing for a Patrol

Before leaving the depot:

✓ Receive work instructions
✓ Study the patrol route
✓ Check weather conditions
✓ Inspect the patrol vehicle
✓ Ensure communication equipment is operational
✓ Wear PPE

✓ Carry inspection forms
✓ Carry maps or GPS
✓ Carry camera or tablet
✓ Attend toolbox talk

**Equipment Required**

- Hard hat
- Safety boots
- High visibility vest
- Safety glasses
- Gloves
- Clipboard or tablet
- Camera
- Binoculars
- GPS
- Torch
- Two-way radio
- First aid kit
-


**Illustration 3.3**

## 3.4 Patrol Methods

There are several methods used during inspections.

### Vehicle Patrol

Suitable for:

- Main roads
- Rural feeders
- Long distribution routes

Advantages

- Fast
- Covers large distances
- Suitable for routine inspections

**Walking Patrol**

Used where:

- Access is difficult
- Dense vegetation exists
- Detailed inspections are required

Provides better inspection quality. **Pole-by-Pole Inspection**
Each structure is inspected individually.
This is the preferred method during maintenance planning.

**3.5 Inspection Sequence**

Every pole should be inspected using the same systematic method.
Start at ground level and work upwards.

**Step 1**

Inspect surrounding area.
Look for:

- Erosion
- Flood damage
- Fire damage
- Vehicle damage

**Step 2**

Inspect pole.
Look for:

- Rot
- Cracks
- Leaning
- Termite damage
- Missing identification numbers

**Step 3**

Inspect stays.
Look for:

- Broken strands
- Corrosion
- Loose anchors
- Damaged insulators

**Step 4**

Inspect crossarms.
Check for:

- Rot
- Cracks
- Loose bolts
- Corrosion

**Step 5**

Inspect insulators.
Check for:

- Cracks
- Flashover marks
- Pollution

- Missing components

**Step 6**

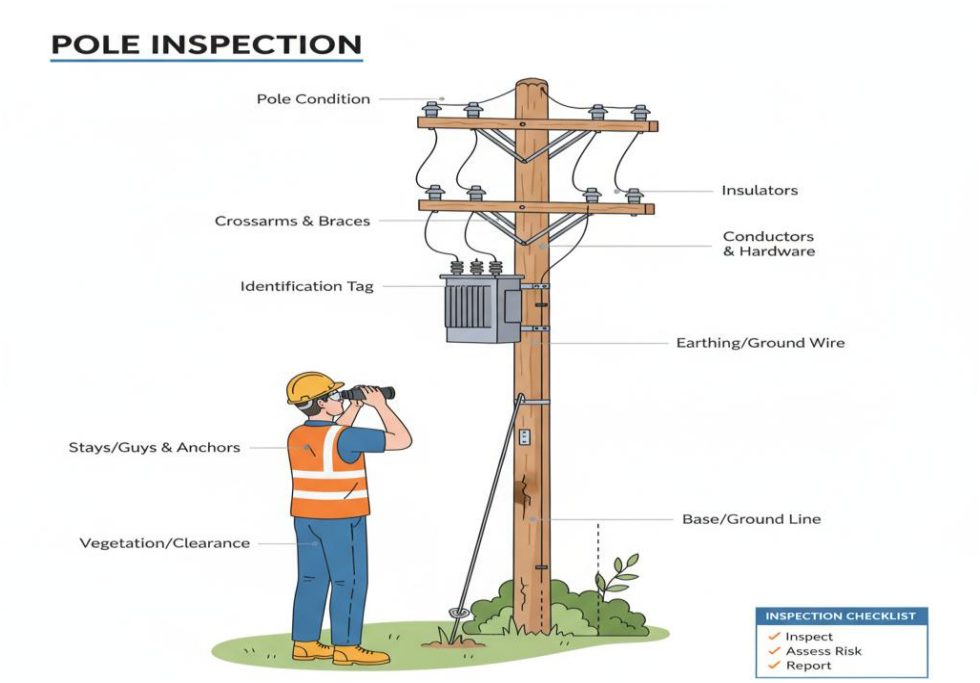
Inspect conductors.

Look for:

- Broken strands
- Excessive sag
- Loose jumpers
- Burn marks
- Corrosion

The supplied Devoltage LV Line Construction manual highlights the importance of maintaining correct clearances, inspecting jumpers and connections, and ensuring conductors are installed and maintained correctly.

**Illustration 3.4 –**




### 3.6 Inspecting Bare LV Networks

When inspecting bare conductor systems check for:

- Correct conductor spacing
- Damaged jumpers
- Loose connectors
- Broken ties
- Incorrect clearances
- Damaged insulators
- Burnt connections

The supplied manual explains bare LV line configurations, conductor clearances and jumper installations that should be verified during inspections.

### 3.7 Inspecting ABC Networks

The Devoltage manual provides detailed guidance on ABC construction and installation. During patrols, inspect the following:

- Suspension clamps
- Strain clamps
- IPC connectors
- Cable ties
- End caps
- Neutral messenger
- Cable insulation
- Cable tension
- Cable sag
- Pole brackets

Also look for:

- Bird damage
- Abrasion
- UV deterioration
- Broken clamps

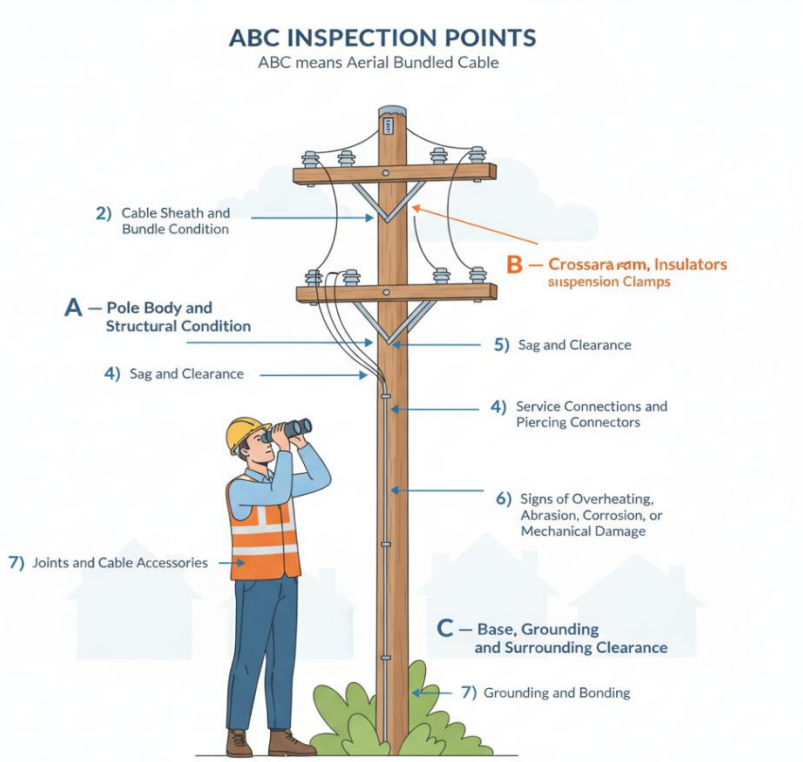



**Illustration 3.5**

### 3.8 Medium Voltage Patrol

Construction workers must visually inspect MV equipment only and must not operate or interfere with live MV equipment unless specifically authorised.

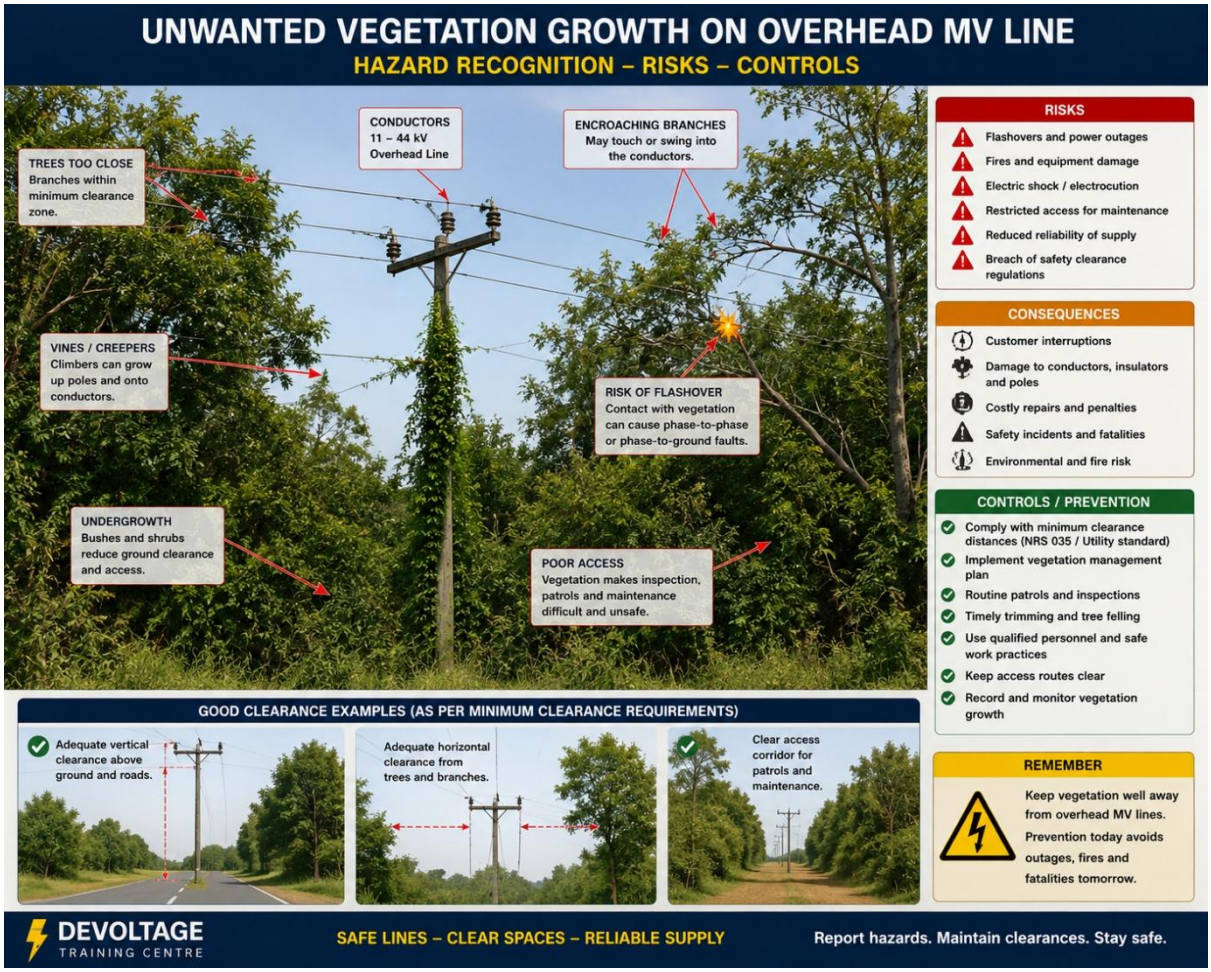
Inspect:

- Pin insulators
- Post insulators
- Crossarms
- Stay wires
- Lightning arresters
- Drop-out fuses
- Pole-mounted transformers
- Earthing conductors

**Ilustration 3.6 – MV Pole**

### 3.9 Vegetation Inspection

Vegetation is a major cause of electrical faults.




Inspect for:

- Tree branches near conductors
- Falling trees
- Dead branches
- Bush encroachment
- Vines growing on poles

Report any vegetation requiring trimming.

Do not cut vegetation unless authorised.

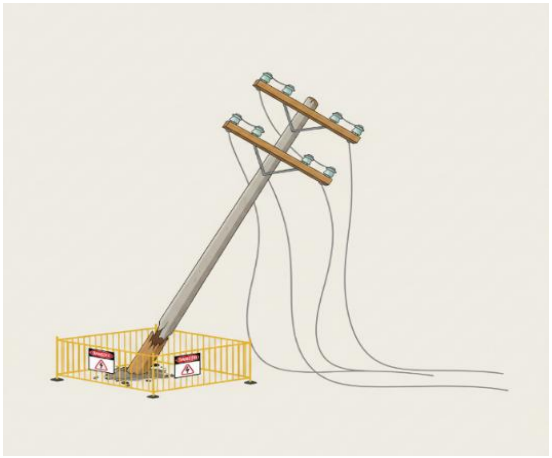
### 3.10 Defect Classification

**Category A – Emergency**

Immediate danger to life or network.

Examples:

- Fallen conductor
- Pole collapse
- Broken transformer
- Vehicle collision
- Fire



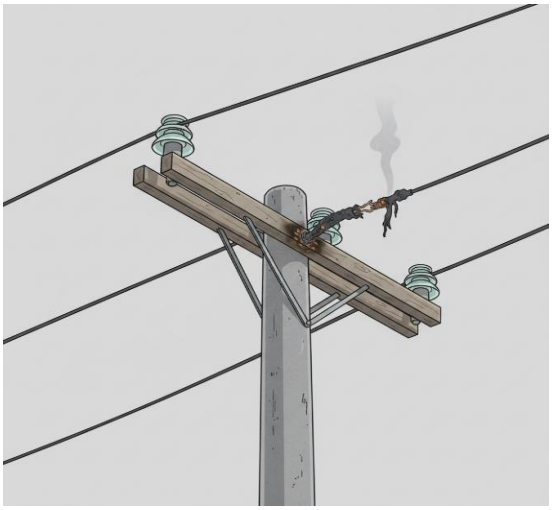
Immediate reporting required.

**Category B – Urgent**

Requires repair within 24 hours.

Examples:

- Leaning pole
- Broken insulator
- Loose conductor
- Burnt jumper



**Category C – Planned Maintenance**

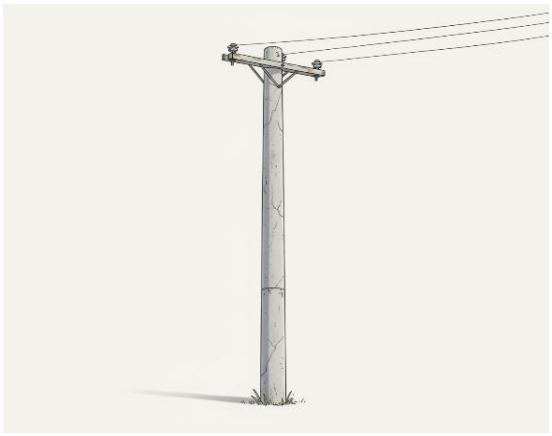
Examples:

- Surface corrosion
- Faded pole numbers
- Loose labels

**Category D – Monitor**

Examples:

- Slight corrosion
- Early weathering
- Minor leaning
- Cosmetic defects



Never rely on memory.

**3.12 Reporting Emergencies**

Immediately report:

- Fallen conductors
- Fire
- Pole collapse
- Vehicle accidents
- Public danger
- Broken MV equipment

- Exposed live conductors

Remain at a safe distance until authorised personnel arrive.

**Module Summary**

After completing this module, you should be able to:

✓ Explain the purpose of a line patrol.

✓ Prepare for a safe inspection.

✓ Conduct a systematic pole-by-pole inspection.

✓ Identify defects on LV and MV overhead lines.

✓ Inspect bare conductor and ABC systems using the principles contained in the Devoltage construction manual.

✓ Classify defects according to urgency.

✓ Record findings accurately.

✓ Report emergency conditions immediately.

**Knowledge Check**

1. What is the primary purpose of a line patrol?
2. Name four different types of line patrols.
3. List six items of equipment required before starting a patrol.
4. Why should poles always be inspected from the ground upward?
5. Name five defects that may be found on a wooden pole.
6. What should you inspect on an ABC network during a patrol?
7. Give three examples of Category A (Emergency) defects.
8. Why is vegetation management important for overhead lines?
9. What information must be recorded when reporting a defect?
10. What action should you take if you discover a fallen conductor during a patrol?

**Source basis:** This module incorporates and expands on the inspection concepts found in the supplied **Devoltage LV Line Construction** manual, particularly the sections covering bare LV lines, ABC installations, connectors, clearances, and service connections