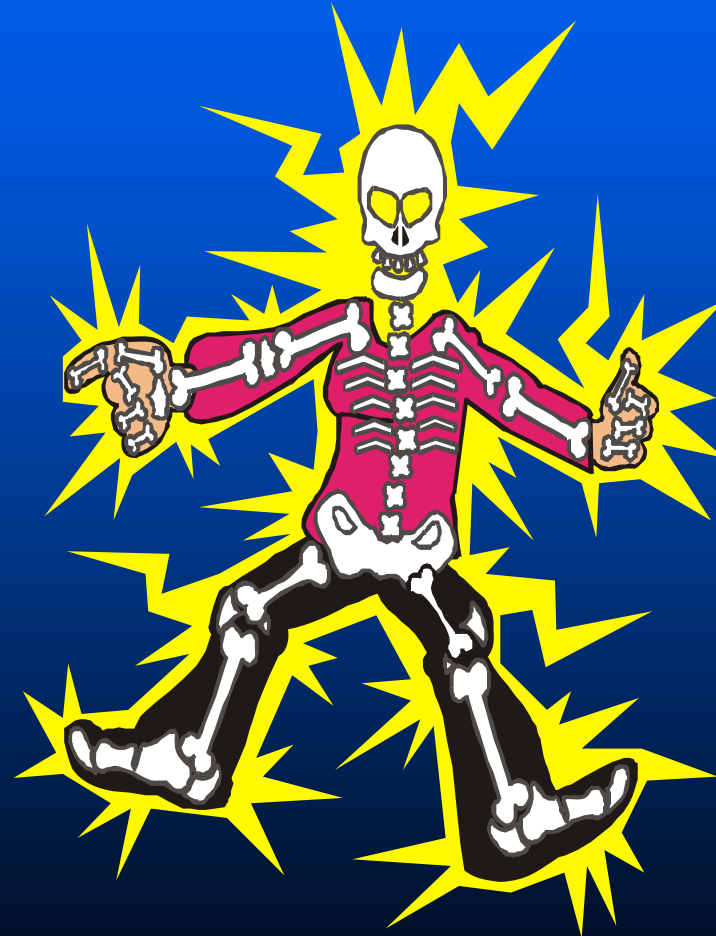


# MEDIUM VOLTAGE SUBSTATION PRACTICES



DARIO CAMPETTI & ASSOCIATES

# MEDIUM VOLTAGE SUBSTATION PRACTICES



**Medium Voltage (MV) is defined as:  
 $1000V < MV \leq 44kV$**

# **MEDIUM VOLTAGE SUBSTATION PRACTICES**

**This presentation covers some safety aspects and recommended MV substation practices such as phasing, voltage detection, switching and permit to work**

# INTRODUCTION

**Over the past decade or more, it has become evident that the skills and competencies of personnel in the electrical field in the South African coal mining industry, such as artisans, supervisors and engineers, have diminished**

# PROBLEMS EXPERIENCED

- High turn over of electricians
- Lack of suitable experience
- Lack of understanding of the basics of electricity
- Inadequate suitable candidates to fill available positions
- Good and experienced personnel emigrating or moving to better jobs
- Little or no mentorship

# **SPECIALISED ELECTRICAL WORK**

**On the mines, especially coal,  
good electrical competencies are  
not only required for the day to  
day maintenance and construction  
work, they are also required for  
specialised electrical work such  
as:**

# SPECIALISED ELECTRICAL WORK

- Inspection and maintenance of explosion protected apparatus
- Reading electrical drawings and fault finding
- Testing, phasing and working with Medium Voltage electrical systems

# TYPICAL MINE RETICULATION

- Power supply from Eskom
- Small mines up to 5MVA
- Larger mines up to 40 MVA or more
- Primary reticulation; typically 22 kV or 33 kV
- Secondary reticulation; typically 6.6 kV or 11 kV
- Radial feeders very common
- Larger mines have dual, parallel and ring feeds
- Extensive MV reticulation networks on mines
- Skilled and competent persons required to work on, test, fault find and maintain such networks

# HAZARDS ASSOCIATED WITH RETICULATION NETWORKS

- Back feeds from dual, parallel or ring feeds
- Old oil filled switchgear
- Inadequately maintained switchgear
- Manual switching
- Old switchgear that is not arc vented or arc contained
- Incorrect or out of date reticulation drawings
- Reticulation components not to standard or of adequate specification
- Electrical protection is not adequate, i.e. settings, relay operation, ratings

# FURTHER HAZARDS

- The 'assumption' that the power is OFF
- The use of incorrect test equipment
- Inadequate test procedures
- Inadequate isolation and locking out procedures
- Lack of skills
- Inadequate PPE
- Inadequate safety procedures

# RISKS AND CONESQUENCES

- Electrocution
- Explosion
- Fire
- Loss of life or limb
- Loss of equipment
- Loss of production



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# **SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES**

**In order to reduce the risk associated with the hazards posed by MV reticulation equipment and networks, a few basic improvements should be implemented. These can be summarised as follows:**

# SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES

- The use of correct and approved **TESTING APPARATUS**



# SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES

- For voltages greater than 1000 volt, testing to prove the circuit is dead or alive should be by means of a **VOLTAGE DETECTOR** which has been certified for the correct application
- For phasing, **PHASE COMPARATORS** should be used that have been certified for the correct application
- Training on the correct use of voltage detectors and phase comparators should be implemented
- The electrician doing the testing should be a competent and authorised electrician

# SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES

- The implementation of correct **PROCEDURES**

# SUBSTATION PROCEDURES

## MEDIUM VOLTAGE CHECKLIST

		YES	NO
1	Has the Permit to Work been obtained?		
2	Has the PPE been checked?		
3	Has the High Voltage Megger been tested?		
4	Has the Low Voltage Megger been tested?		
5	Has the Voltage Detector been tested?		
6	Has the Voltage Detector been cleaned correctly?		
7	Has the Phase Comparator been tested?		
8	Has the Phase Comparator been cleaned correctly?		
9	Have the Earthing Straps been checked and tested?		
10	Has the Fire Extinguisher been checked?		
11	Has the First Aid Box and Stretcher been checked?		
12	Have you check the Reticulation Drawing for this Substation?		
13	Have you identified the correct cables, circuit breakers and isolators?		
14	Have you recorded all information and Permit to Work number into the Logbook?		
15	Has the Time Setting been set to minimum on the CDG before Voltage Detection or Phasing is done? (Only in a no-load situation).		
16	Has the Lockout Procedure been adhered to?		
17	Has the Switching Procedure been adhered to?		
18	Was the cable tested?		
19	Was Earth tested for continuity between cubicle earth bar and main earth reference point?		
20	Has the Permit to Work been completed correctly and signed off?		

# SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES

- No work should be done on systems operating at voltages greater than 1000 volt until the apparatus has been isolated and made safe by a **COMPETENT AND AUTHORISED ELECTRICIAN** to do MV switching in accordance with the mine's code of practice and procedures for locking-out and for MV switching

# SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES

- Doing a **RISK ASSESSMENT** before any work takes place. Work such as switching, testing, isolation and locking out, etc.
- **PLANNING THE TASK** ahead before any work takes place

# SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES

- Implementing a **PERMIT TO WORK** system

# PERMIT TO WORK – MV ELECTRICAL EQUIPMENT

Permit No \_\_\_\_\_

Risk Assessment No: \_\_\_\_\_

## SECTION A : TO BE COMPLETED BY PERON REQUIRING PERMIT / ISOLATING / SWITCHING

REQUIRED BY: \_\_\_\_\_ DATE REQUIRED: \_\_\_\_\_

APPARATUS TO BE ISOLATED: \_\_\_\_\_

APPARATUS TO BE SWITCHED: \_\_\_\_\_

REASON FOR ISOLATION: \_\_\_\_\_

ESTIMATED TIME OF WORK: \_\_\_\_\_

SIGNED: \_\_\_\_\_ POSITION: \_\_\_\_\_ DATE: \_\_\_\_\_ TIME: \_\_\_\_\_

## SECTION B : TO BE COMPLETED BY AUTHORISED PERSON PERFORMING ISOLATION OR SWITCHING

I \_\_\_\_\_ certify that the following has been isolated as stated and that it can be worked on in safety for the above required purpose, all other equipment must be considered "Live"

APPARATUS TO BE SWITCHED: \_\_\_\_\_

APPARATUS TO ISOLATED: \_\_\_\_\_

METHOD OF ISOLATION: \_\_\_\_\_

TESTS CARRIED OUT: \_\_\_\_\_

DANGER / CAUTION NOTICES POSTED AT: \_\_\_\_\_

LOCKS FIT AT: \_\_\_\_\_ PAD LOCK & KEY NO. \_\_\_\_\_

SIGNED: \_\_\_\_\_ POSITION: \_\_\_\_\_ DATE: \_\_\_\_\_ TIME: \_\_\_\_\_

## SECTION C : MUST BE COMPLETED BY ALL PERSONS WORKING ON ISOLATED EQUIPMENT

I / We accept the above isolation & are fully aware that other equipment may be live & Dangerous

SIGNED: 1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_ 4. \_\_\_\_\_

5. \_\_\_\_\_ 6. \_\_\_\_\_ DATE: \_\_\_\_\_ TIME: \_\_\_\_\_

## SECTION D : MUST BE COMPLETED BY ALL PERSONS IN SECTION C ON COMPLETION OF WORK

I / We declare the above work has been completed. All personnel, tools etc., have been withdrawn and the equipment is in a serviceable condition

SIGNED: 1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_ 4. \_\_\_\_\_

5. \_\_\_\_\_ 6. \_\_\_\_\_ DATE: \_\_\_\_\_ TIME: \_\_\_\_\_

## SECTION E : MUST BE COMPLETED BY AUTHORISED PERSONS IN SECTION B

This permit id now cancelled. All notices, earths & locks have been removed and the supply may now be restored:

SIGNED: \_\_\_\_\_ POSITION: \_\_\_\_\_ DATE: \_\_\_\_\_ TIME: \_\_\_\_\_

# PERMIT TO WORK

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# SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES

- The use of the correct **PPE**, such as an approved and tested flash suit

# PERSONAL PROTECTIVE EQUIPMENT



Face mask or shield

Full flash suit

Gloves

# SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES

- **COMPETENCY TRAINING** of electricians or supervisors required to do any MV work
- The **APPOINTMENT OR AUTHORISATION** of persons required to any MV work subject to them been found competent as a result of specialised training received

# APPOINTMENT OR AUTHORISATION

## 1.1 KV – 44 KV SWITCHING AUTHORISATION

To: Whom it May Concern

From: \_\_\_\_\_

Date of issue: \_\_\_\_\_

Expiry Date : \_\_\_\_\_

I, hereby authorize \_\_\_\_\_ to perform switching operations on switchgear, I.e. Circuit breakers, isolators and links at voltage of 1.1 kV – 44 kV on \_\_\_\_\_ Mine.

Area of responsibility: \_\_\_\_\_  
\_\_\_\_\_

I have cautioned him on all the associated safety aspects and I have found him competent by actual practical tests done, to perform these duties. He is also aware of the MV switching code of practice and lockout procedure.

Accepted by: \_\_\_\_\_

Date: \_\_\_\_\_

Approved by: \_\_\_\_\_

Date: \_\_\_\_\_

**Responsible Engineer**

**Note:** Equipment is to be treated as “live” at all times. The four steps to safety are to be applied at all times.

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# SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES

- On job evaluation or planned task observation (**PTO**)

# SAFETY IMPROVEMENTS WITH RESPECT TO MV SUBSTATION PRACTICES

- The approach for implementing the above improvements should be on a holistic basis since all the above will be beneficial together and not as isolated interventions

# TYPICAL MV LOCK-OUT PROCEDURE

- Complete **PERMIT TO WORK**
- **PLANNING** and **RISK ASSESSMENT**
- Correct and approved safety **PPE**
- Sign the **LOGBOOK** (Permit to Work number in logbook)
- Check the reticulation drawing to identify the circuit breaker, physical **IDENTIFICATION** of circuit breaker, check for ring feeds
- Trip, **ISOLATE**, rack out
- **LOCK-OUT**, attach Danger Sign and Tag
- **CHECK** if equipment is switched off
- **TEST** (with approved Voltage Detector) for supply check busbar first then load side
- Apply **EARTHING**

# FURTHER SUGGESTIONS

- No oil filled MV switchgear
- Motorised MV switchgear with remote switching
- Up to date and proper reticulation drawings
- Switchgear, transformers, cables, etc. properly identified wrt to reticulation drawing
- Logbooks
- Planned maintenance

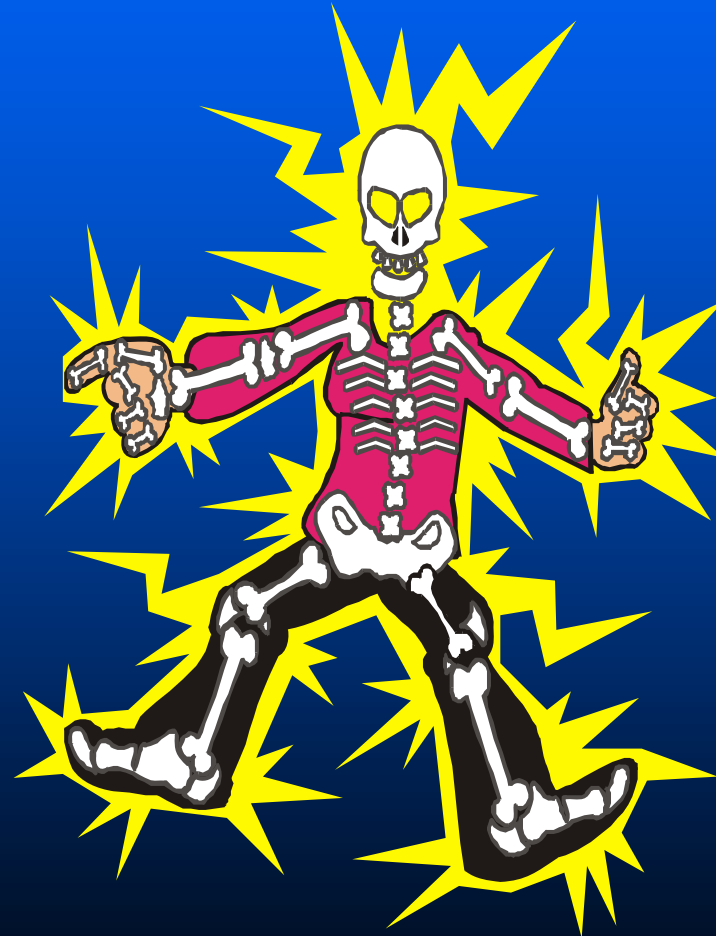
# FURTHER SUGGESTIONS

- MV switchgear to comply with IEC 62271-200 (High-voltage switchgear and controlgear, Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV)
- Type Test: Affects of arcing due to an internal arc
- Example: Internal Arc Classification (IAC) AFLR 21.5kA for 0.5s

# BENEFITS OF SUGGESTED SAFETY IMPROVEMENTS

- Electrical safety is enhanced
- Can demonstrate competence in terms of the Mines Health and Safety Act or the Occupational and Safety Act
- Reduce the likelihood of electrical risk
- Persons are appointed or authorised and can be held accountable for their actions or the lack of

**THANK YOU FOR YOUR TIME  
ANY QUESTIONS?**



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