

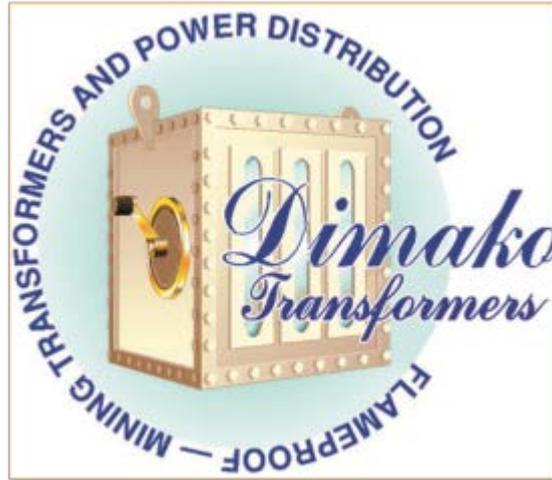


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# **Installation, Inspection and Maintenance of Flameproof Transformers**

**Flameproof TX**

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# **Installation, Inspection and Maintenance of Flameproof Transformers**



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## 1. General

As per SANS 10086-2, mines should have Code of Practices (COP) in place to ensure correct selection, installation and maintenance of equipment used in mines. This document is an extension of the mine's COP and should be incorporated within the mine's COP.

This document covers the following:

- Installation of the transformer assemblies
- Scheduled inspection, which shall be carried out regularly
- Scheduled maintenance and overhaul program, which shall be carried out periodically
- Operating procedure

## SWITCHGEAR

### INSTALLATION , INSPECTION AND MAINTENANCE OF FLAMEPROOF SWITCHGEAR

Each mine should have a code of practise for the following:

- Installation of switchgear
- Scheduled inspection which shall be carried out regularly
- Scheduled maintenance and overhaul programme which shall be carried out periodically
- Operation procedures

## INSTALLATION

Switchgear applications in mines are exposed to severe conditions. It is therefore essential to ensure equipment ratings and protection settings are observed and that maintenance is strictly carried out to safeguard mine personnel, operating staff and equipment.

The following points must be taken into consideration:

1. Equipment ratings - Equipment used in the switchgear is properly rated to withstand the full fault current and transient surge voltages.
2. Clearances - Bus-bars, circuit breakers, contactors, cable connections etc. Have adequate clearance and insulation as per the specific recommendations.
3. Interlocks - Both mechanical and electrical interlocking is provided on all panel doors and where possible on all inspection covers.
4. Sharp protrusions - Sharp metal protrusions shall be avoided where any insulation can sustain damage.
5. Cable securing devices - Any cable securing device or method that damages insulation in any way should be strictly avoided.
6. Ionisation - During power switching devices such as circuit breakers and contactors, air is ionised and therefore adequate clearances are provided and should be strictly adhered to and not compromised in any way.
7. Protection settings - Protection settings shall be configured and set for the specific installation.



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8. Drawings - Electrical and mechanical layout drawings for switchgear are available to allow for easy identification of components and their connection details.
9. Switchgear enclosures - The enclosure complies with the required standards.
10. Cable connections / terminations - All cable couplings, connections and terminations shall be properly secured and the earth continuity maintained with the switchgear enclosure.
11. Approval certification - Ensure that all inspection authority approval certificates and test reports are available and filed and that the correct explosion protected approval has been given for the hazardous area in which the equipment is to be used.
12. Internal components - Once the switchgear has been positioned open all panel doors and inspection covers to ensure the internal components, cable and connections are in place secure and free from damage.
13. Busbar connections - Ensure that all bus bar cable box connections are secure.
14. Insulation tests - Before energisation the following insulation tests shall be conducted. The incoming and outgoing phase leads, between phases and each phase to earth. (Ensure any electronic instrumentation is disconnected if necessary to prevent any damage during testing.)

Note: Insulation tests should be carried out with an approved insulation tester and testing should be done as per the mines specific standards.

15. Critical safety inspections prior to energisation - The following critical safety inspections shall be carried out prior to energisation of the switchgear.

Ensure the switchgear is located in a clean and dry location where the roof and sidewalls are in good condition and which is clear of moving traffic. The location should be such that the accumulation of dust and water is minimised.

The basic requirements are:-

- Unobstructed ventilation around the switchgear
  - Easy installation and removal of incoming and outgoing cables
  - Uninhibited access to the assembly in particular operating handles, push buttons, emergency stops, inspection covers and doors.
  - Free visual access to inspection windows, indication lamps and switchgear assembly labelling.
- Confirm the integrity of all back tripping circuits ie: door, cover and short circuit back trip provisions and electrical interlocking
  - Ensure that all incoming and outgoing adaptors and sockets are clean and free from damage and secure.
  - Ensure all blanking plugs and plates are in place secure
  - Ensure that any instrument glasses and inspection windows are intact.
- 
- Ensure that all panel doors, inspection and access covers are in place and correctly secured by the correct specified bolts, which are of a proper and uniform size, type and are tight.
  - Ensure that all the covers over reset / set buttons etc are fitted securely.
  - Carry out flameproof gap tests using the correct type of feeler gauge to ensure they are within the correct limits.
  - Ensure that the earth bonding of equipment complies with the mine specific standards.
  - Ensure that the fire fighting and statutory notices are legible and in position.
  - Ensure that the inspection authority approval mark is displayed for the hazardous area in which the equipment is to be used.
  - Carry out any other checks required by the mine standards.



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Once the above inspections have been carried out satisfactorily, the incoming and outgoing cables can be connected. Ensure that the cables are suitably anchored or positioned so as to prevent undue tension and twisting of the cable under operating conditions. All explosion protection requirements shall be observed. Once this is done the electrical supply can be energised.

16. Critical safety inspections after energisation - The following critical safety inspections will be carried out after energisation.

### **SCHEDULED INSPECTIONS**

- The frequency of regular inspections shall be in accordance with mine specific procedures
- Ensure that the switchgear is free from obstruction and accumulation of dust and water and that the surface temperatures are not excessive.
- Ensure that all enclosures, inspection covers, doors plug and socket fastening bolts are in position and tight and that all the flameproof gaps are clean, free from rust and comply with requirements.
- Check the conditioning of the incoming and outgoing cables. Ensure that there is no twisting, undue tension, or sharp bends and that the cable is secure.
- Inspect the condition of the surge arrestors at the beginning of every operational shift before energisation.
- Ensure that the ammeter readings correspond in relation to duty.
- Ensure any reset of setting covers are secure.
- Ensure that statutory notices and fire fighting appliances are provided and in position.
- Ensure that all earth bonding is in place.
- Check instruments and indicator glasses have no defect.
- Ensure correct earth leakage, earth leakage lockout protection and any other interlocks necessary for the safe operation of the switchgear are operational.
- Ensure that the logbook is available and correctly utilised.
- Perform any other inspections advised by the mines specific standards.



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## MAINTENANCE

Two types of maintenance programs should be in place:

### SCHEDULED MAINTENANCE

Note: Ensure the correct isolation earthing and making safe of equipment as per mine specific lockout procedures before attempting to open any covers or remove any incoming or outgoing cables.

1. Maintenance intervals should be according to approved mine specific procedure.
2. Perform all checks under scheduled inspection.
3. Ensure that all internal parts are secure on their mountings and all cable and bus bar connections are secure.
4. Inspect all cable connections for signs of overheating.
5. Inspect bus chamber, main enclosure, cable boxes and bus bar interconnections for signs of overheating.
6. Ensure all contacts are making good electrical contact and show no signs of overheating.
7. Ensure that all arc shields etc are in position and in good condition.
8. Ensure that all overload, short circuit trips and earth leakage trips are set correctly for duty.
9. Ensure that all indication is in order and operating correctly.
10. Clean the interior.  
Use only approved cleaning agents and ensure that the area around the cleaning operation is well ventilated. (Some oil based water displacement sprays attack certain plastic materials and the oil residue allows coal dust to accumulate, which could compromise design creep age distances).
11. Ensure that all mechanical operations and interlocks are operative.
12. Ensure all fuses are to the correct size and type and are intact and secure in their holders.
13. Ensure that the voltage tap settings of control transformer are in accordance with the supply voltage and required control voltage.
14. Ensure all cable insulation is clean and in good order and perform insulation tests on phase cables.
15. Ensure the isolator compartment is clean, all connections are secure and that there are no signs of overheating.
16. Ensure all back tripping and electrical interlocking is operative.
17. Ensure all push buttons are operative and not sticking.
18. Ensure that the vacuum circuit breakers are not damaged and there is no loss of vacuum. Inspect circuit breakers in accordance with the manufactures recommendations to ensure that the service life and duty has not been exceeded.
19. Check that all incoming and outgoing sockets are free from damage , dust or moisture.



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20. Inspect any densely packed cable trucking and take specific notice around the vicinity of any tight strapping together of cables such as run lock's for signs of overheating or damage.
21. Inspect any bushings to ensure they are clean and free from damage.
22. Perform any other maintenance and tests advised by equipment manufacturers or mine specific requirements.
23. All periodic inspection and results of tests performed shall be recorded and filed for future reference

## 2. Installation

Due to the arduous operating conditions experienced in a mine, equipment must be rated for the specific application it will be exposed to.

The following points must be taken into consideration.

- a. Transformer primary fault current, cable insulation and conductor size, connections, bushings, MV switchgear and protection shall be rated to withstand full fault conditions.
- b. Transformer core heat dissipation.  
To avoid possible de-rating of design specifications it is essential to ensure adequate heat dissipation is allowed. Adequate space must be allowed around the transformer for this purpose. It is also essential to ensure that equipment such as cables, mining utensils, boxes etc. are not stored on top of the transformer and that the top area is kept clean from accumulated dirt. This is where most of the transformer heat is dissipated and if inhibited in any way will result in higher transformer temperatures, reduced life time of the transformer and possibly even derating of the transformer capacity.
- c. Inspect the core and windings to ensure the bracing and securing of the transformer core has not moved during transportation.
- d. Tap change links  
The tap change links shall be suitably positioned to ensure ease of access. Connection drawings of the link positions shall be clearly displayed.  
Ensure clearances between the tap link board and earth is adequate.
- e. Check earth straps  
To ensure a good bond to earth.
- f. Transformer secondary fault current.  
Ensure cable insulation and conductor size, connections, bushings, MV switchgear, protection equipment is rated to withstand full calculated fault conditions and voltage rating.
- g. Cable connections / Terminations  
All MV and LV cable couplings, connections and terminations shall be properly secured and earth continuity maintained with the transformer enclosure.
- h. Drawings  
Electrical and mechanical lay out drawings for the transformer assembly shall be available to allow easy identification of components and their connection details.
- i. Approval certification  
Ensure that all inspection Authority approval certificates and test reports are available and filed, and that the correct explosion protected approval has been given for the hazardous area in which the equipment is to be used.
- j. Internal components



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Once the transformer assembly has been positioned open all the panel doors and inspection covers to ensure that internal components, cables and connections are in place, secure and free from damage.

k. Busbar connections

Where possible ensure that all bus bar and cable box connections are secure.

l. Protection settings

Protection settings shall be correctly configured and set for the specific installation.

m. Insulation tests

Before any energisation the following insulation tests shall be conducted :

- The transformer windings, MV to earth, LV to earth (neutral to be disconnected if applicable) and between the LV and MV windings.
- The incoming MV phase leads, between phases and each phase to earth, the outgoing LV phase leads between phases and to earth. (Ensure any electronic instrumentation is disconnected if necessary to prevent inadvertent damage).

**NOTE: INSULATION TESTING SHOULD BE CARRIED OUT WITH AN APPROVED TESTER AND TESTING SHOULD BE DONE AS PER A SPECIFIC MINE STANDARD**



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## 3. Safety Inspections

Critical safety inspections prior to the energisation of the transformer assembly.

- a. Ensure that the transformer assembly is located in a clean, dry location where the roof and sidewalls are in good condition and which is clear of moving traffic. The location should be such that the accumulation of dust or water is minimized.
- b. Ensure that adequate space is allowed around the transformer assembly to provide the following:
  - b.1. Unobstructed ventilation around the assembly.
  - b.2. Easy installation and removal of incoming and outgoing cables.
  - b.3. Uninhibited access to the assembly and in particular operating handles, push buttons, emergency stops, inspection covers, access covers and doors.
  - b.4. Free visual access to inspection windows, inspection lamps and transformer assembly labelling.
  - b.5.
    - Confirm the integrity of the neutral earth resistor (if applicable)
    - Confirm the integrity of all back tripping circuits, ie doors, cover, short circuit back trip provisions and any further electrical interlocks.
- c. Ensure that all incoming and outgoing adaptors and sockets are clean, free from damage and are secure.
- d. Ensure that any drain or blanking plugs fitted are in place and are secure.
- e. Ensure that any instrument glassed and inspection windows are intact.
- f. Ensure that all panel doors, inspection and access covers are in place and correctly secured by the specific bolts, which are proper and uniform size, type and are tight.
- g. Ensure that all covers over set/reset buttons etc, are fitted and secure.
- h. Carry out flameproof gap tests using the correct type of feeler gauge to ensure they are within the acceptable limits.
- i. Ensure that the earth bonding of equipment complies with specific mine requirements
- j. Ensure that the firefighting and statutory notices are available, legible and in place that the correct explosion protected approval mark is displayed for the hazardous area in which the equipment is used.
- k. Carry out any other checks or test required by the mines standards.

Once the above operations have been carried out satisfactorily the incoming and outgoing cables can be connected. Ensure that the cables are suitably anchored and positioned so as to prevent undue tension or twisting of the cable under operating conditions. Once this is done the electrical supply can be energized.



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### **4. Safety Inspections after Equipment Energized**

The following critical safety inspections will be carried out after energisation.

- a. Ensure the correct operation of the earth leakage trip and earth fault lockout protection
- b. Ensure the correct pilot operation (if applicable)
- c. Ensure all live line indicators are operational
- d. Check the correct operation of the assembly
- e. Ensure adequate lighting is available to allow for the reading of labels and location of operating handles and push buttons.
- f. Installation of inspection records  
All installation and inspection results of tests performed shall be recorded and filed for future reference and inspection.
- g. Log book  
A log book should be provided to record all switching operations, isolations and trip occurrences.



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### **5. Scheduled Inspections**

The frequency of regular inspections shall be in accordance with mine specific procedures.

- a. Ensure that the transformer assembly is free from obstruction and accumulation of dust, dirt or water and the surface temperature is not unduly hot.
- b. Ensure the tap change cover is secure
- c. Ensure that all inspection covers, access, doors, plug and socket fastening bolts are in position and tight.
- d. Check the conditioning of incoming and outgoing cables. Ensure that there is no twisting, undue tension or sharp bends that the cable is secure in the glands.
- e. Ensure that all statutory notices and firefighting appliances are provided and in position.
- f. Ensure that all earth bonding is fitted and securely attached.
- g. Ensure that the logbook is available and correctly utilized.
- h. Perform any other inspections advised by the mines specific requirements.



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## 6. Maintenance

Two types of maintenance programs should be in place.

### 6.1. Scheduled Maintenance

**Note:** Ensure correct isolation of equipment as per the mines specific lockout procedures before attempting to open any covers or remove any incoming and outgoing cables.

- a. Ensure that the transformer assembly is free from obstruction and accumulation of dust, dirt or water and the surface temperature is not unduly hot.
- b. Ensure the tap change cover is secure
- c. Ensure that all inspection covers, access, doors, plug and socket fastening bolts are in position and tight. All flameproof paths must be clean, free of rust and comply to the specific requirements.
- d. Check the conditioning of incoming and outgoing cables. Ensure that there is no twisting, undue tension or sharp bends that the cable is secure in the glands.
- e. Ensure that all statutory notices and firefighting appliances are provided and in position.
- f. Ensure that all earth bonding is fitted and securely attached.
- g. Ensure that the logbook is available and correctly utilized.
- h. Perform any other inspections advised by the mines specific requirements.

### 6.2. Scheduled Major Overhaul

In order to facilitate major overhaul, the transformer assembly should be removed from service and taken to a workshop environment.

- a. All transformer covers shall be removed.
- b. Remove the transformer core from its enclosure:
  - Remove any rust & dust from the core and windings.
  - Remove any rust, dust or moisture from the enclosure. Special attention should be given to the inside corners which can be susceptible to a buildup of powder and rust which can impair the integrity of the enclosure.
- c. Ensure all bracings; connections are secure after reassembly into the enclosure.
- d. All bushings should be cleaned, inspected for damage and insulation tested.
- e. Switchgear associated with the transformer should be maintained as described under the section on switchgear.
- f. Perform any other necessary tests specified by the mine standards.
- g. Perform all other inspections and test described under periodic underground inspections.
- h. All maintenance and test results should be recovered and filed for future reference and inspection.