Eskom	Standard	Asset Management

Title: **Generation Air-Insulated Withdrawable AC Metal-Enclosed Switchgear and Controlgear for Rated Voltages above 1kV up to and including 52kV**

Unique Identifier:	**240-56227573**
Alternative Reference Number:	**N/A**
Area of Applicability:	**Generation**
Documentation Type:	**Standard**
Revision:	**2**
Total Pages:	**60**
Next Review Date:	**July 2025**
Disclosure Classification:	**CONTROLLED DISCLOSURE**

APPROVED FOR AUTHORISATION
☑ 6x ASSET MANAGEMENT
DOCUMENT CENTRE ☎ x4962

Compiled by

……..

Dyke Monyane

Chief Technologist

Elec Eng. Gx Asset Management

Date: 01 July 2020

Approved by

……..

Dyke Monyane

CG Convener

Metal Enclosed Switchgear CG

Date: 01 July 2020

Authorised by

……..

Machiel Viljoen

Senior Manager

Elec Eng. Gx Asset Management

Date: 2020-07-02

Supported by SCOT SC

……Khumalo.

Queeneth Khumalo

CSMES SC Chairperson

Date: 02 July 2020

PCM Reference : **240-53459028**

SCOT Study Committee Name : **Cable Systems and Metal Enclosed Switchgear**

CONTENTS

Page

FIGURES

TABLES

1. INTRODUCTION

This document contains the standard requirements of new air-insulated withdrawable AC metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV for indoor installations in accordance with SANS 62271-200.

The basic requirements for design, operations and maintenance shall be defined in this standard as applicable in the power generation plants belonging to Eskom Generation Group.

The requirements for withdrawable AC metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV for indoor installations in special environmental conditions such as nuclear applications are not included in this standard. Those requirements for switchgear for installation and use in special environmental conditions (i.e. exposure to high temperature, exposure to high pressure, earthquakes etc.), shall be subject to additional requirements.

This standard excludes requirements for metal-enclosed switchgear used in secondary distribution in the form of Ring Main Units (RMU). The requirements for RMUs are outlined in the Eskom Distribution Standard 240-56030406.

This standard includes requirements for 10 to 100MVA generator circuit-breakers and it excludes requirements for generator circuit-breakers that are rated 100 MVA and above. The requirements for generator circuit-breakers rated above 100MVA are outlined in the Eskom Generation Standard 240-56227522. This standard also excludes generator circuit-breakers intended for use in applications for pumped storage installations.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

The standard describes requirements for new air-insulated withdrawable AC metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV for indoor installation.

In order to ensure standardisation, the withdrawable AC metal-enclosed switchgear and controlgear covered by this standard shall be type tested, of modular design with air-insulated busbars for use on three phase systems at a rated frequency of 50Hz.

The standard also describes requirements for generator circuit-breakers for generators rated 10 MVA to 100MVA. These generator circuit-breakers are traditionally housed in an AC metal-enclosed switchgear and controlgear.

Components contained within the withdrawable metal-enclosed switchgear and controlgear functional unit shall be designed, manufactured and tested in accordance with their respective relevant standards.

The manufacturer shall design and supply the necessary connections, interconnecting wiring, supporting steelwork, holding-down bolts, guards, labels, other interfaces to structural foundations, accepted documentation, accessories etc. required to make a complete functional assembly that comply with this standard.

2.1.2 Applicability

This document shall apply to the Eskom Generation Group.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

The following documents (all parts including any amendments) contain provisions for this standard. For referenced standards, the latest revision of the document shall apply.

[1] 240-114967625 Operating Regulations for High-Voltage Systems.

[2] 240-75655504 Corrosion protection standard for new indoor and outdoor Eskom equipment, components, materials and structures manufactured from steel Standard.

[3] 240-143485806 Generation Auxiliary Plant MV Protection Standard.

[4] 240-56357424 MV and LV Switchgear Protection Standard.

[5] 240-56227589 List of Approved Electronic Devices to be used on Eskom Power Stations.

[6] 240-64685228 Generic Specific for Protection Intelligent Electronic Devices (IEDs)

[7] 240-150642762 Generation Plant Safety Regulations.

[8] 240-71432150 Plant Labelling Standard.

[9] 240-86973501 Engineering Drawing Standard - common requirements

[10] 240-56065202 Switchgear training requirements from original equipment manufacturers standard.

[11] TBA Engineering Drawing Symbol Standard.

[12] 0.00-002839 MV and LV Switchgear Outdoor Isolator Padlock.

[13] 0.00-10341-01 MV and LV Switchgear Lugs and Terminals.

[14] 0.00-10341-02 MV and LV Switchgear Pre-Insulated Lugs and Sleeves.

[15] 0.00-10341-03 MV and LV Switchgear Wiring and Termination.

[16] 0.00-10341-04 MV and LV Switchgear Circuit Function Letters.

[17] 0.00-10343-01 MV, LV and DC Switchgear Labels and Nameplate Details English Designation Only Arrangement Diagram.

[18] 0.00-10343-02 General Labels & Nameplate Details Arrangement Diagram.

[19] OHS Act Occupational Health and Safety Act (Act 85 of 1993) and Regulations.

[20] SANS 1091 National Colour Standards.

[21] SANS 1574 Electric Cables- Flexible Cords and Flexible Cables.

[22] SANS 10142-2 The Wiring of Premises Part 2: MV Installations above 1kV a.c. not exceeding 22kV a.c. and upto and including 3 MVA installed capacity.

[23] SANS 876 Cable terminations and live conductors within air-filled enclosures (insulation co-ordination) for rated a.c. voltages from 7.2 kV up to and including 36 kV.

[24] SANS 60529 Degrees of Protection Provided by Enclosures (IP Code)

[25] SANS 61000 Electromagnetic Compatibility (all relevant parts).

[26] SANS 61243-5 Live working – Voltage Detectors – Part 5: Voltage Detecting Systems (VDS).

[27] SANS 62271-1 High-Voltage Switchgear and Controlgear – Part 1: Common Standards.

[28] SANS 62271-100 High-Voltage Switchgear and Controlgear – Part 100: High-Voltage Alternating-Current Circuit-Breakers.

[28] SANS 62271–102 High-Voltage Switchgear and Controlgear – Part 102: Alternating Current Disconnectors and Earthing Switches.

[29] SANS 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.

[30] SANS 62271-307 High-Voltage Switchgear and Controlgear – Part 200: Guidance for the extension of validity of type tests of AC metal and Solid Insulation Enclosed Switchgear and Controlgear for rated voltages above 1kV and up to and including 52kV.

[31] SANS 61869-1 Instrument transformers Part 1: General requirements.

[32] SANS 61869-2 Instrument transformers Part 2: Additional requirements for current transformers.

[33] SANS 61869-3 Instrument transformers Part 3: Additional requirements for inductive voltage transformers.

[34] SANS 1019 Standard Voltages, Currents and Insulation Levels for Electricity Supply.

[35] SANS 61508 Functional Safety of Electrical/electronic/programmable Electronic Safety-related Systems. All Parts

[36] SANS 61511 Functional Safety - Safety Instrumented Systems for the Process Industry Sector. All Parts.

[37] SANS 1195 Busbars.

[38] SANS 1411-1 Materials of Insulated Electric Cables and Flexible Cords: Part 1: Conductors.

[39] SANS 61213 Mechanical Cable Glands.

[40] SANS 60060 High-Voltage Test Techniques.

[41] SANS 60269 Low-Voltage Fuses.

[42] SANS 60947 Low Voltage Switchgear and Controlgear. All parts

[43] SANS 61238-1 Compression and Mechanical Connections for Power Cables for Rated Voltages up to 30 kV(Um=36kV) Part 1: Test methods and requirements.

[44] IEC 60051 Direct-Acting Analogue Electrical Measuring Instruments and their Accessories.

[45] IEC 60688 Electrical Measuring Transducers for Converting AC and DC Electrical Quantities to Analogue or Digital Signals.

[46] IEC/IEEE 62271-37-013 High-Voltage Switchgear and Controlgear – Part 37-013: Alternative – current generator circuit-breakers.

[47] IEEE Std C37.013a Standard for AC High Voltage Generator Circuit-breakers Rated on a Symmetrical Current Basis – Amendment 1: Supplement for Use with Generator Rated 10-100 MVA.

[48] ISO 17025 General Requirements for the Competence of Testing and Calibration Laboratories

[49] ISO 9001 Quality Management Systems.

[50] CDA Publication 22 Copper Development Association (CDA), Publication 22, Copper for busbars.

[51] IEC 60038 Standard Voltages.

[52] IEC 60518 Dimensional standardisation of terminals for high-voltage switchgear and controlgear.

[53] EPRI 10003471 Electrical Connector Guideline.

2.2.2 Informative

Not applicable.

2.3 DEFINITIONS

The definitions contained in SANS 62271 shall apply. The following are the definitions of specific uncommon terms used in the document

Definition	Description
Abnormal Power Supply System Conditions	Conditions whereby switchgear is operated within the design and testing requirements but outside the normal system voltage and frequency but within the fault current specified.
Behind-Closed-Door Operation	This refer to the design of switchgear where the circuit-breaker compartment is such that the circuit-breaker is withdrawable and can be moved from the service position to the disconnected or test position and vice versa with the front door of the circuit-breaker compartment closed and locked.
Busbar Extension Dummy Panel	A panel which is only contain the busbar functional compartment, and is designed and installed between two adjacent panels to provide spacing for cable termination alignment. (See definition of Panel below)
Earth bar	Metallic bar forming part of the switchboard and used as a conductor for grounding and or earth path circuits as may be connected with it.
Electrical Life of Components	The electrical and mechanical designed operational life of equipment and components, in terms of the number of electrical operations, mechanical operations, age, etc.
Exhaust Duct	Mechanism used to evacuate gasses generated during an internal arc to the outside of the room. This shall be installed at the top of the switchboard and it shall be connected to the explosion vent and shall have a type tested sealed lid.
Explosion vent	Mechanism used to discharge gasses from functional unit enclosure into an exhaust duct to relieve the pressure generated during an internal arc. This shall normally be installed at the top of the enclosure and shall form part of the functional unit.

Definition	Description
IAC AFLR	Internal arc classification for type A (operator safety) accessibility for the front side, lateral side and rear side of the panel
Joggle Chamber	Custom designed metal enclosed panel used to align the busbars of different types of metal-enclosed switchgear
Mechanical Life	The life expectancy of the component which shall be determined by the mechanical operations of the component. The mechanical operational life expectancy shall be determined irrespective of the electrical operational load.
Panel	General term referring to a functional unit of metal-enclosed switchgear in accordance with SANS 62271-200.
Specialised tools	Any purpose-built tools that are necessary to carry out major (or specialised) maintenance on a circuit-breaker and its components
Switchboard	A complete switchgear assembly consisting of number of switchgear panels (switchgear panels include incomer panels, feeder panels, bus-section panels where cables are used to connect two bus-section breakers, VT panels, etc.).

2.3.1 Disclosure Classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

AC	Alternating Current
AFLR	A-(operator safety), Front, Lateral, Rear
CoE	Centre of Excellence
CSMES SC	Cable Systems and Metal Enclosed Switchgear Study Committee
CT	Current Transformer
DC	Direct Current
EPRI	Electric Power Research Institute
HMI	Human Machine Interface
HRC	High Rupturing Current/Capacity
IAC	Internal Arc Classified
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	International Protection code
ISO	International Organization for Standardization

LSC	Loss of Service Continuity
LV	Low Voltage
MCB	Miniature Circuit-Breaker
MES CG	Metal Enclosed Switchgear Care Group
MV	Medium Voltage
NPS	Negative Phase Sequence
ORHVS	Operating Regulations of High Voltage Systems
PILC	Paper Insulated Lead Covered
PM	Partitions Metallic
PPS	Positive Phase Sequence
RMU	Ring Main Unit
SANS	South African National Standards
VDS	Voltage Detection System
VT	Voltage Transformer
XLPE	Cross-linked Polyethylene

2.5 ROLES AND RESPONSIBILITIES

- Generation Asset Management is the custodian of the standard.
- Generation power stations should ensure that acquisition of all new MV switchgear is done in accordance to the provisions of this document.
- This document shall be used in conjunction with the technical specification.

2.6 PROCESS FOR MONITORING

None

2.7 RELATED/SUPPORTING DOCUMENTS

[54] 240-93576770 Technical A&B Schedule Template

[55] 240-93576642 Compliance Schedule Template

[56] 240-77300784 MV Switchgear Schedules Template

3. STANDARD OF AIR-INSULATED WITHDRAWABLE MEDIUM VOLTAGE METAL-ENCLOSED SWITCHGEAR AND CONTROLGEAR

3.1 RATINGS AND OPERATING CONDITIONS

3.1.1 Panel Ratings

a) The ratings selected for the switchgear and controlgear, their operating devices and the auxiliary equipment shall be in accordance with SANS 62271-200, and shall be provided in each project specific Switchgear Schedules (240-77300784) and Technical Schedule A&B (240-93576770).
b) The associated temperature rise for the rated normal current specified in each Technical Schedule A&B and Switchgear Schedule shall be in accordance with SANS 62271-200. The panel types shall be fully type tested at the specified current ratings.
c) For motor starters, the temperature rise current ratings shall take into account the impact of the motor starting current and the number of starts per hour specified.

3.1.2 Ratings for Switching Devices

a) The circuit-breaker shall be capable of continuously carrying the circuit-breaker current rating as specified and at the specified altitude for an ambient temperature of 40ºC.
b) All assigned current ratings relate to the circuit-breaker in the in-service position within the fully assembled and functional unit.
c) The circuit-breaker shall be capable of interrupting, making, latching against and able to withstand the specified fault duties at the maximum specified voltage.
d) The electrical endurance for the circuit-breaker shall be classified as Class E2 in accordance with SANS 62271-100 without reclosing, unless otherwise specified for special applications.
e) The mechanical endurance for the circuit-breaker shall be classified as Class M2 in accordance with SANS 62271-100.
f) The electrical endurance for Earthing devices shall be Class E2 in accordance with SANS 62271-102, as a minimum.
g) The mechanical endurance for Earthing devices shall be Class M1 in accordance with SANS 62271-102
h) The short-circuit withstand current rating and insulation level of an earthing device shall match that of the panel. This excludes the special installations such as small generating plant (less than 100MVA) where power evacuation system consists of metal enclosed switchgear.
i) The connection between the earthing device and the panel earth bar shall be designed to withstand the panel short-circuit withstand rating for same duration.

3.1.3 System Characteristics and Operating Conditions

The following system characteristics and operating conditions may be experienced on Eskom Generation Plants where medium voltage withdrawable metal enclosed switchgear and controlgear will be installed. It is therefore required that during tender submissions, suppliers need to indicate and submit where applicable, the relevant SANS/IEC type test reports that can be used to validate equipment ratings against these system characteristics and operating conditions.

a) Main power system normal power supply conditions may occur simultaneously as follows:
   - Voltage: ± 5%

- Negative Phase Sequence (NPS) voltage up to 0.02 of nominal Positive Phase Sequence (PPS) voltage
- The Zero Phase Sequence Voltage component can be up to 1% of the PPS component.

b) Circuit-breaker auxiliary coils shall be functional under the following conditions for both AC and DC applications:
- Shunt closing release – between 85% and 110% of the rated supply voltage.
- Shunt opening release – between 85% and 110% of the rated supply voltage.
- Under-voltage release - below 35% of the rated supply voltage.

c) The harmonic distortion of the supply voltage under normal operation shall be as follows:
- The Total Harmonic Distortion (THD) of the voltage can be up to 5% of the fundamental component.
- The voltage waveform can contain harmonic components up to the 100th harmonic.
- The amplitude of any individual component can be up to 1% of the fundamental component.

d) The amplitude and duration of temporary abnormal voltage operating characteristics which can occur on the power supply shall be as follows:
- Short Duration Abnormal Conditions: Short duration under voltage conditions arise either due to a loss of supply or the supply voltage being depressed due to a short circuit on the network.
- Loss of Power Supply:
    i. When the supply is disconnected, the supply voltage either drops rapidly to 0% of nominal value or it is sustained at low amplitude at a reduced frequency because of back generation of electrical drives.
    ii. The initial voltage amplitude during these conditions is less than 80% of nominal value and decays with a time constant of up to 1.5 seconds.
    iii. The time duration from loss of supply until supply restoration is between 1 second and 2.5 seconds.

3.1.4 Switchgear Operating Conditions

a) The switchgear shall comply with the power station operating conditions and with the operating requirements of 240-114967625: Operating Regulations for High-voltage Systems.

b) Under normal and abnormal conditions, in the events the following may occur during which all the safety requirements of the switchgear and controlgear shall be met;

- A fault can occur when moving a withdrawable component (e.g. a circuit-breaker) from the disconnected, earthed or test position to the service position and vice versa
- An earth switch can be applied onto a live power circuit
- A low voltage compartment investigation can be performed while the functional unit is live
- VTs' can be racked in/out with the switchboard energised
- A cable can be terminated in an isolated cable compartment whilst the busbars of the isolated compartment panel and adjacent cable compartments are live
- Busbar VT panel can be racked out and accessed whilst the busbars and adjacent circuit-breaker compartments are alive.

3.2 PANEL DESIGN AND CONSTRUCTION

3.2.1 Service Conditions

The normal service conditions for indoor switchgear and controlgear specified in SANS 62271-1 shall apply. The following additional specific requirements shall be taken into account:

a) A minimum ambient air temperature of -5 ^{0}C;

Note: A maximum ambient air temperature of 40 ^{0}C is applicable, in accordance with the 'normal' service conditions for indoor switchgear as specified in SANS 62271-1.

b) The switchgear shall be installed up to altitudes of 1800 m;

Note: Due (in part) to the fact that the switchgear and controlgear shall be used up to altitudes of 1800 m AMSL (Above Mean Sea Level), higher insulation withstand levels shall be specified in project specific Switchgear Schedules (240-77300784). No further altitude correction factors are therefore required for altitudes above 1000 m AMSL in accordance with SANS 62271-1.

3.2.2 General Requirements

a) The switchgear and controlgear shall be of indoor use, air-insulated, metal-enclosed and internal arc classified in accordance with SANS 62271-200.

b) The switchgear and controlgear shall be internal arc classified AFLR for 1 second in accordance with SANS 62271-200.

c) The switchgear and controlgear shall be of behind-closed-door operation i.e circuit-breaker compartment door shall not be part of the circuit-breaker.

d) The switchboards shall be of modular designs that allow for the subsequent addition of identical panels.

e) The switchgear and controlgear shall be clearly marked with the ratings to which the equipment has been type tested. This rating shall be in the nameplate.

f) Design information relating to the type tested and routine tested components and moulded components (i.e. spouts, bushings, insulators) shall be made available i.e. during tendering to clarify the materials, manufacturing method, design and manufacturing location for these components.

3.2.3 Panel Architecture

Single busbar design is required for withdrawable indoor metal enclosed switchgear and shall include the following defined panels (functional units):

a) "Incomer" panels incorporating a withdrawable three-pole operated circuit-breaker, cable earthing switch and cable compartment fitted with CTs, VTs and VDS;

b) "feeder" panels incorporating a withdrawable three-pole operated circuit-breaker, cable earthing switch and cable compartment fitted with CTs and VDS;

c) "bus-section" and "interconnector) panels incorporating a withdrawable three-pole operated circuit-breaker, CTs, VTs and VDS on both busbar sections; and

d) "VT" panels incorporating a withdrawable VT and busbar earthing switch.

Note: Switchgear schedule (240-77300784) shall indicate the required panels for a specific project.

3.2.4 Segregation of Compartments

3.2.4.1 General

As a minimum, separate compartments shall be provided for the different panels forming a switchboard as follows:

- Circuit-breaker compartment
- Main busbar compartment
- Low voltage compartment
- Power cable compartment
- Busbar earthing device compartment
- VT compartment

3.2.4.2 Low Voltage Compartment

a) The low voltage compartment shall be located at the front and top position of the functional unit.

b) The compartment shall be designed to house all equipment required for the protection, control and monitoring functionalities specified.

c) The Human Machine Interface (HMI) shall be located on the compartment door and all control facilities shall be accessible from the front of the panel.

d) The compartment door shall be of swing frame design.

e) The low voltage compartment design shall allow for control cables to be added either from the top or the bottom.

f) Slots or holes used to channel control cables into the low voltage compartment shall be sealed off to prevent debris from adjacent compartments during an arc flash incident.

3.2.4.3 Power Cable Compartment

a) The power cable terminations and current transformers shall be accessible from the power cable compartment.

b) The panel shall be designed such that it allows for disconnection of power cables, removal and replacement of current transformers with the main busbars energised. In other words, the panel shall be designed such that arc flash occurring in one compartment does not propagate to other compartments.

c) The power cable compartment shall comply with the SANS 876 and shall provide for both single core or three core cables type 2 (shrouded) terminations, unless otherwise specified.

d) Special procedures shall be required to access the power cable compartment in accordance with ORHVS in 240-114967625.

3.2.4.4 Main Busbar Compartment

a) The main busbar compartment shall house the busbars and the busbar support structures.

b) Special procedures shall be required to access the main busbar compartment in accordance with ORHVS in 240-114967625.

3.2.4.5 Circuit-breaker Compartment

a) A dedicated compartment shall be provided to house the circuit-breaker.

b) The compartment of the withdrawable device shall be an operator-accessible compartment as per interlocking requirements.

c) The switchgear panels design shall be the mid-mount/ floor-mount withdrawable type, that shall ensure to provide:

1) Integral Motorised Racking of the circuit-breakers on panel mounted rails/ guided panel floor plates within the switchgear panel, and

2) Withdrawing or inserting of the withdrawable mounted circuit-breakers in and out of the switchgear panels shall be achieved by ensuring the correct floor level alignment for trolleys or circuit-breaker floor level wheel movement during the switch room design. This floor level alignment requires the switchgear room floor design to consider where applicable:

- cable trench mounted base frame alignment to the onsite casted switchgear room floor level,
- concrete floor levels where switchgear panels are mounted directly on top of the floor, and
- steel base raised floor levels.

3) Positive circuit-breaker position indication and catch-like mechanisms shall be provided to confirm the status and physical correct position of the cassette mounted circuit-breaker on the panel mounted rails inside the switchgear panels for; the ready to withdrawal position, the inserted and ready to rack in position and the in-service position.

d) A hole shall be provided on the circuit-breaker door aligning with the OFF pushbutton of the circuit-breaker. This is to allow circuit-breaker to be tripped directly during an emergency. The special tool shall be provided to trip the circuit-breaker or an attached mechanism on the door shall be provided for the tripping function of the circuit-breaker.

e) The ON pushbutton of the circuit-breaker shall be blanked off to prevent the circuit-breaker from being closed directly. The circuit-breaker shall be closed via the IED at bay level or via the SCADA/DCS.

3.2.4.6 Busbar Earthing Device Compartment

a) The busbar earthing device compartment shall be a special-accessible compartment and requires that the switchboard and all incoming and outgoing supplies to be isolated and tools shall be required to open this compartment. The isolations shall comply with requirements of ORHVS in 240-114967625 and Generation Plant Safety Regulations 240-150642762.

b) The busbar earthing device compartment shall be on the same panel as the VT compartment.

c) The busbar earthing device shall be operated from the front and the outside of the panel.

d) The busbar earthing device shall be of the fixed type. The use of a withdrawable device shall be subject to Eskom acceptance.

3.2.4.7 VT Compartment

a) The compartment of the VT device shall be a separate panel with an operator-accessible compartment as per interlocking requirements to prevent access to the VT while racked in.

b) The VT shall be of the withdrawable type.

3.2.5 Service Continuity Classification

The loss of service continuity category shall be LSC2B in accordance with SANS 62271-200.

3.2.6 Partition Class and Shutters

a) Partition class PM classification as defined in SANS 62271-200 shall be required for shutters to the breaker compartment when breaker is withdrawn to the disconnected, test, earthed or removed position.

b) Automatically-operated shutters shall be provided so that on racking out of the circuit-breaker, these shutters cover the busbar and cable connection points inside the spouts automatically to prevent inadvertent contact with live busbars and cables.

c) Orifice shutter operation shall be positively driven in both directions. Solely gravity operated shutters shall not be accepted.

d) Orifice shutters shall be automatically operated by the movement of the withdrawable part.

e) Spout shutters shall be arranged to operate independently for the busbar spout shutters and cable connection spout shutters. These shutters shall be capable of being padlocked in the open and closed position. Shutters shall operate without lubrication and shall be constructed in such a manner as to ensure fail-safe operation.

f) Shutter endurance and reliability shall be proven by type testing to the number of operations as specified.

g) Busbar spout shutters shall be coloured red and labelled with the word “BUSBAR” in black letters at least 50 mm high.

h) Cable spout shutters shall be coloured yellow and labelled with the word “CABLE” in black letters at least 50 mm high.

i) In case of bus-section circuit-breakers of switchboards joined by busbars both shutters shall be labelled “BUSBAR”.

3.2.7 Cooling

a) The use of natural cooling on functional units is preferred over forced cooling.

b) Where forced cooling forms part of the standard design and type testing, the design shall be in compliance with the following requirements:

c) No tripping of the circuit-breaker shall be allowed if the fan fails.

d) Monitoring of the fans shall be done using fan failure indications and alarms.

e) The cooling fan motor assembly shall be readily available in South Africa.

f) Low speed high volume fans shall be used.

3.2.8 Degree of Protection

a) The required minimum degree of protection shall be in accordance with SANS 60529:
   1) IPXXB for live parts (inside LV compartment), and
   2) IP3X for cable boxes.

b) The degrees of protection of the switchboard offered shall be IP4X.

3.2.9 Panel Fasteners, Doors and Covers

a) Fasteners used in the construction of the functional unit shall not deviate from those used in the type tested panels.

b) If the panel fastener is also the locking mechanism, provision shall be made for a padlock with dimensions as specified in Figure 1.

c) Where the design allows for lift-off covers for the cable compartment, the cover shall be mechanically interlocked with the cable earthing device. The cover shall only be removed if the cable earth switch is applied.

d) All compartment doors housing a circuit-breaker or Busbar VT shall be fitted with a front window, for the purpose of indicating the mechanical status of the component within, that was part of the type testing for internal arc compliance.

e) Cable compartments shall be fitted with a bolted cover or doors. Interlocks are mandatory when accessing the cable VT.

f) Cable compartment doors shall be tool-based accessible and lockable.

g) Where doors are provided for empty compartments, the doors shall be pad-lockable with a padlock as shown in Figure 1.

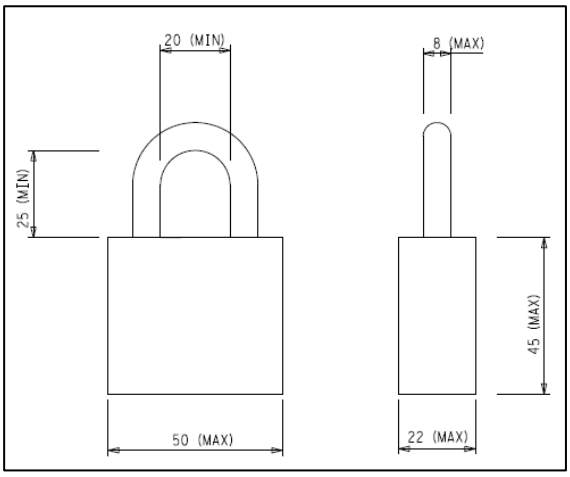

Figure 1: Eskom standard padlock.

3.2.9.1 Padlocking facilities

a) Facilities shall be provided to padlock the following:
   1) all orifice shutters individually in the closed position;
   2) the circuit-breaker in each of the service and test/disconnected positions;
   3) the integral earthing switches in both the open and earthing positions; and

4) the circuit-breaker where applicable when it is supplied with the mechanical closing device button.

b) All padlock facility positions shall be labelled.

c) All padlocking facilities shall be suitable for padlocks that have a shackle diameter of 8 mm, as shown in Figure 1.

3.2.10 Corrosion Protection

a) Steelwork shall be corrosion protected in accordance with the standard 240-75655504. Where corrosion protection is not in accordance with the Eskom standard, the tenderer shall provide proof that the method of corrosion protection applied is equal or better than the stipulated requirements in 240-75655504.

b) The colour of the final coating shall be in accordance with SANS 1091.

3.2.11 Labels and Colour Coding

3.2.11.1 General

a) All local paint colours shall be standard colours in accordance with SANS 1091. Imported colours (RAL) shall match local colours.

b) All labels shall be in accordance with labelling standards found in 240-71432150 and 0.00-10343 Sheets 1 and 2.

c) Labels shall be inscribed in English. The content of the label shall be provided by Eskom following the relevant plant codification standard.

3.2.11.2 Colour Coding of Switchboards

All switchgear panels need to be painted as per the system voltage categories in Table 1 below. For voltage categories not covered in Table 1, special instructions will be provided for each project by Eskom. The painting of panels shall include all front covers, side covers and back covers.

Table 1: Colour Coding of Switchboards.

Voltage (kV)	Colour
15	Local H09 Imported RAL 6028
11	Local H09 Imported RAL 6028
6.6	Local B32 Imported RAL 2000
3.3	Local B32 Imported RAL 2000

3.2.11.3 Warning Labels for Internal Arc Classified Board

a) In cases where the design of the functional unit is such that the blow out is to the top of the functional units in order as to fulfil the IAC requirements, the switchboard shall be labelled to provide warning messages to people working on the panels.

b) The following is the prescription for the warning labels required:

c) DO NOT CLIMB ON TOP OF THE SWITCHGEAR WHEN ENERGISED. The labels shall be installed at the rear and the sides of the switchboard. The number of labels on the rear shall depend on the length of the board.

d) DO NOT STEP ON THE PRESSURE RELIEF FLAPS. The labels shall be installed at locations clearly visible and in close vicinity to the flaps.

e) The warning labels shall be of red lettering on a white background.

3.2.12 Busbars and Connections

a) The main busbars compartment and connections inside the busbar compartment shall be air insulated and the clearances shall not compromise the specified voltage withstand levels. The busbars shall be supplied as per the type tested arrangement, including any additional insulation shrouding or tubes that were used.

b) Cables are not allowed to be used for busbars or busbar connections inside the circuit-breaker, busbar voltage transformer and busbar compartments.

c) All busbars shall be marked per panel in such a manner that they shall be easily identifiable as to the phase or pole they are connected to when covers are removed. It is recommended to use heat shrink tube for marking however, the material used for marking the busbars is subject to Eskom acceptance.

d) Busbar connections shall be made with at least two bolts and the overlap is sufficient to ensure ample mechanical strength and joint conductivity. The busbar connections shall match those of a type tested panel. Silver tinted or tinted copper joint interfaces are preferred.

3.2.13 Spouts, Bushings and Insulators

a) Moulded type bushings and spouts shall be used as the connection between circuit-breakers and busbars.

b) All bushings and insulators shall have permissible levels of partial discharge in accordance with SANS 62271-200.

3.2.14 Insulating Materials

a) The insulation material shall be identical to the material used during voltage withstand and temperature rise type testing.

b) Insulating materials may be used in areas where the insulation level criteria cannot be met with air as an insulating medium.

c) Where insulation on busbars is required, it shall be of the heat shrink type with non-static characteristics.

d) Where insulating barriers are required, the material used shall be of a non-static type.

3.2.15 Auxiliary Circuit Wiring and Identification

a) The wiring, terminals, lugs, identification and installation shall be in accordance with Drawing 0.00/10341.

b) All control wiring shall be of a neat appearance and suitably braced, placed in wire trunks, clipped and/or laced to prevent vibration and not to be deformed under through fault conditions. Connections to equipment on swing doors shall be arranged so as to give a twisting motion and not a bending motion to the conductor.

c) For identification all leads shall be marked at both ends with an approved type of marking device in accordance with the schematic diagram. Interlocking type ferrules with permanent black letters impressed on a white or yellow background are preferred. The number ferrule shall not fall off when disconnecting the wire. Ferrules shall read in a consistent manner in both vertical and horizontal planes (see Drawing 0.00/10341 Sheets 3 and 4).

d) Control wire sheaths shall be coloured as follows:

1) AC circuits: Black

2) DC circuits: Grey

3) Earthing: Green and yellow

4) CT and VT wiring shall be coloured as per the phase - red, white, blue and black (neutral).

- CT wiring: Wiring between the current transformer and the low voltage compartment terminals shall be coloured as per the phases – red, white, blue and black (neutral) with wire numbers in accordance in Drawing 0.00/10341 Sheets 4.
- VT wiring: Wiring between the voltage transformer and the first fuse shall be coloured as per the phases. After the first fuse the AC wiring shall be all black with wire numbers in accordance in Drawing 0.00/10341 Sheets 4.

e) Control wiring shall be terminated with pre-insulated compression type lugs. Each terminal strip mounting rail shall be provided with not less than 10% spare length with a minimum of 50 mm. Not more than two conductors shall be connected to any side of a terminal, so that the size of all terminals is suitable for the termination of two cables/wires of 4 mm^2 each.

f) For top cable entry into the low voltage compartment, gland plates for control cables shall be provided . An arrangement of terminals in the low voltage compartment allow for easy termination of all cables brought in. The number of control terminals shall be in accordance with the control drawings for that specific panel. Allowance shall be made for any possible inter-panel or looped bus wiring, from one low voltage compartment to the next low voltage compartment.

g) All external control cables shall be brought into the low voltage compartment, within a separate channel from the power cable compartment.

3.2.16 Power Cable Entry and Termination

3.2.16.1 Power Cable Termination

a) The power cable compartment shall be adequately sized to allow for the termination in air. Allowance shall be made inside the cable compartment to install the termination kits for either PILC or XLPE MV cables of the same voltage rating as the panel, unless otherwise specified.

b) The distance between cable termination points and adjacent structures within the compartment shall be in accordance with SANS 876.

c) Provision shall be made to allow for the termination of multiple cables per phase. It is required to always provide one termination flag per cable to be terminated. The number of cables shall be provided in the MV Switchgear Schedule 240-77300784.

3.2.16.2 Gland Plates

a) Gland plates shall be of pre-galvanised or aluminium sheets and the switchgear manufacturer shall provide a means to ensure good metallic contact between the gland plate and the body of the panel. The number of cables shall be provided in the MV Switchgear Schedule 240-77300784

b) There shall be an earth path continuity for the armouring through gland, gland plate to panel and earth bar.

c) For single-core cables, a non-ferrous or split-stainless steel gland plate shall be used to eliminate eddy currents.

3.2.16.3 Cable Entry Arrangements

The minimum requirements shall be as per the SANS 876: Distance from terminal centre line to gland plate or cable clamp. Any through wall plates or gland plates mounted between the bushing centre line and cable clamps shall be a minimum distance of 800 mm from the bushing centre line to the through wall plate or gland plate to allow for standard Eskom three core cable terminations, unless otherwise specified. For single-core cables the minimum distance shall be 600mm from terminal centre line to gland plate or cable clamp.

3.2.16.4 Vermin and Fire Proofing of Cable Compartment and LV Compartment

a) All cable compartments shall be designed to be sealed off with a 2 hour fire retardant material of at least 50 mm thick at floor level, after the cables have been installed, to ensure that fire cannot propagate from the basement/trench into the switchgear cable compartment.

b) For top entry of control cables into the LV compartment, all unused gland holes shall be sealed.

c) The space provided beneath the switchgear panel in the trench shall allow for the installation of fire retardant material, to the extent that during an internal arc in the cable compartment there shall be no pressure release or any smoke or heat to the front of the panel, the rear of the panel, into the cable trench or tunnel or any adjacent compartments and functional units.

3.2.17 Earthing

a) Holes shall be provided for connecting the station earth to the switchboard earthing bar inside the switchgear panels. The earthing bar shall not extend outside the last panel.

b) Provision shall be made for the earthing bar to be connected to the station earth mat at least at both ends of the board and for boards exceeding 15 m in length shall be connected to the station earth in at least three places.

c) For any earth bar, it is required to provide 25 mm wide earth bar with a suitable thickness calculated to provide an equivalent fault current carrying capacity of at least 200 A/mm^2. The impact of holes in the earth bars shall also be considered to ensure the fault current rating equivalent cross section required.

d) All doors and covers shall be earthed to ensure that the touch potential does not exceed the safe values as specified in the OHS Act.

3.2.18 Busbar Extension Dummy Panels

a) The busbar extension dummy panel shall be designed and constructed to ensure compliance to the type tested switchgear panel design and arrangement.

b) Where Busbar extension dummy panels are installed the main busbars shall not be accessible.

3.3 SPECIAL CONSIDERATION FOR INTERNAL ARC PROOF DESIGN

a) Pressure relief flaps in a power compartment shall be designed such that the gasses are not directed to any other compartment during an internal arc fault.

b) Each power compartment shall have dedicated exhaust channel inside the panel to the pressure relief flaps.

c) Each compartment shall contain the arc without spreading it to other compartments.

d) Each functional unit (panel) shall contain the arc without spreading it to any other functional unit/s.

e) Due to the internal arc classification and for maintenance purposes, no VTs or earthing device shall be installed within the pressure relief area on top of any functional unit.

f) On fault levels equal and above 25kA, all switchboards shall be equipped and type tested with exhausting ducts to channel the hot gasses generated by internal arc fault to the outside of the substation. All applicable type test reports and type test videos shall be provided during tender evaluations.

g) On fault levels below 25kA, the design of switchboard may allow for venting to the inside of the substation switchgear room subject to Eskom's acceptance. In such a case, proof of type test reports and type test videos shall be submitted for Eskom tender evaluations. During design phase simulation reports, by calculation or other means, shall be submitted to declare that it is safe to vent inside the substation(s).

h) Switchboard fitted with the exhaust duct shall not have common duct with the next switchboard. (i.e. Switchboard A shall not have common ducts with Switchboard B even if they are connected by bisection circuit-breakers.

i) For substations with soft ceilings and/or windows (glass), venting shall be directed to the outside of the substation via the exhausting duct.

j) IAC requirements shall be upheld while working in the low voltage compartment. Hence, the channels or conduits between the power compartments and the low voltage compartments should be sealed accordingly and type tested with the LV compartment door removed.

3.4 CIRCUIT-BREAKERS

3.4.1 General

a) Circuit-breakers shall be in accordance with SANS 62271–100

b) Circuit-breakers are of the triple-pole withdrawal type with visible indication which is mechanically interlocked with the circuit-breaker.

c) The arc-quenching medium and/or insulation are of the type tested as specified.

d) Withdrawable circuit-breakers are housed in a circuit-breaker compartment of the "behind close door" design.

e) The circuit-breaker operation under emergency operating conditions shall comply with the “behind close door” design.

f) Total current interruption (break) time as defined in SANS 62271-100 shall not be greater than the time duration specified, under all operating conditions.

g) Where circuit-breakers are used, the power connecting arms are fully insulated. Bare copper as connecting arms are not acceptable.

h) Where bus-zone protection is required, the bus-section circuit-breaker design shall allow for the installation of current transformers on each side of the bus-section circuit-breaker.

i) Where vacuum interrupters are used in the circuit-breaker design, only the type tested vacuum interrupter design or product specific code as per the type test report designation shall be offered during tender evaluation.

3.4.2 Inter-changeability

The circuit-breaker main and secondary circuit contacts shall be such that all circuit-breakers of the same type, current rating and auxiliary configuration are interchangeable. However, it shall not be possible to insert a circuit-breaker of lower rating into a circuit of a higher current rating.

3.4.3 Circuit-breaker mid-mount trolley/floor-mount connections

a) Where the control connections between the circuit-breaker mid-mount/floor-mount trolley and the circuit-breaker compartment are made by means of flexible connections these shall be contained in a flexible conduit.

b) If metallic conduit (between the control plug and circuit-breaker) is provided, this shall be covered by an approved insulating material. A means shall be provided to retain the flexible connection out of the path of the circuit-breaker when the mid-mount trolley/floor-mount is inserted into or removed from the circuit-breaker compartment.

c) Where control connectors are of the multi-pin design the connecting pins and female studs shall be of the removable design and secured into position.

3.4.4 Mechanisms and Closing Devices

a) Mechanisms as per SANS 62271-1, SANS 62271-100, SANS 62271-102 and SANS 62271-200 shall be provided.

b) All conventional circuit-breakers and actuator circuit-breakers electrically-operated closing devices including mechanism charging motors shall be suitable for operation at any voltage between 85% and 110% of nominal control voltage measured at the terminals of the device.

c) The circuit-breaker shall close correctly when an electrical closing pulse of 100 ms duration is applied to the closing coil.

d) The total power drawn by the closing coil, excluding closing solenoids, shall not exceed 1200 VA per circuit-breaker.

3.4.5 Tripping Devices

a) All conventional circuit-breakers and actuator circuit-breakers electric tripping devices shall be of the shunt type, suitable for operating at any voltage between 85% and 110% of the rated control voltage measured at the device terminals.

b) Two normally-open auxiliary contacts in parallel shall be included per tripping circuit in series with the trip coil.

c) Circuit-breakers design shall make provision for the installation of a second tripping coil as per the voltage specified. This second trip coil shall form an integral part of the design of the circuit-breaker complete with interlocking.

d) Circuit-breakers design shall make provision for the installation of an under voltage release coil as per the voltage specified in MV Switchgear Schedule 240-77300784.

e) This under voltage release coil shall form an integral part of the design of the circuit-breaker complete with interlocking.

f) Where a circuit-breaker is used for safety application, such as Boiler Protection Systems, it shall meet the specified safety integrity level (SIL) requirements as a minimum. A confirmation that safety requirement is met must be provided with tender submissions in the form of certification to SANS 61508 or SANS 61511 whichever applicable, datasheet of under voltage release coil, safety application notes, etc.

3.4.6 Indicating Devices

a) A positive driven mechanical indicating device to show whether the circuit-breaker is open or closed shall be provided. The devices are labelled as follows:

   1) Circuit-breaker close: ON or I – white lettering on a red background

   2) Circuit-breaker open (Trip): OFF or O – white lettering on green background

Note: The Eskom colour coding convention for trip/close actuators is opposite to that specified in IEC 60073 (i.e. IEC requires trip red and close green).

b) Lettering size shall not be less than 10 mm. The method of securing the labels shall be as per the requirements of this standard.

c) Where the circuit-breaker position is not visible from the front of the panel, a positive driven mechanical indicator shall be provided to indicate whether the circuit-breaker is in the service or disconnected position, or state the position of the integral-connected disconnector, whichever is applicable.

d) All mechanical indicators shall be clearly visible from the front of the panel and are type tested for the number of operations of the operating device to prove the reliability of the indicating mechanism.

3.4.7 Auxiliary Contacts

a) Auxiliary contacts shall be readily accessible and the preference shall be for contacts with a pronounced wiping action.

b) Sufficient auxiliary contacts shall be provided as per the schematic drawings and the requirements for spare contacts.

c) The spare contacts shall be easily replaceable with normally open or normally closed contacts and shall be wired to the outgoing control terminals. Auxiliary contacts positively follow the action of the main contacts.

d) Suitable arrangements shall be made to ensure that circuit-breaker auxiliary contacts only signal the change of state when the circuit-breaker is in the service and disconnected position.

e) Where insufficient contacts are available, a continuously rated slave relay shall be provided but is used for indication circuits only.

3.4.8 Control Connector

a) Control connectors shall be of the multi-pin design with removable pins for male and female connectors.

b) Connectors shall be of on load design.

c) Control connectors shall have the facility to be coded to differentiate between different circuit-breaker types, ratings and functions or protection schemes for the same rated circuit-breakers.

3.4.9 Insulation Level

a) Internal insulation and clearances in air shall comply with the requirements for live conductors in accordance with SANS 876; unless otherwise proven by dielectric and partial discharge type testing to the required insulation levels.

Note: In general, this type of air-insulated switchgear is designed for either type 1 (bare) or type 2 (shrouded/covered) live conductor arrangements in accordance with SANS 876.

b) The insulation level of all circuit-breakers, busbars, busbar connections and any other related components shall be in accordance with the values specified in MV Switchgear Schedule 240-77300784.

c) The use of insulation material barriers for phase segregation to increase the insulation level shall be not acceptable if not type tested.

d) No insulation material shall be used that may lead to material ageing and degradation for the insulation levels specified over time, or may lead to partial discharge of the panel due to ageing or possible dust collection.

e) Where insulating materials are part of the integral design of the switchgear, the life expectancy shall be guaranteed by means of testing where applicable and material data sheets for the prescribed installation conditions.

3.5 DISCONNECTORS

a) Disconnector shall be in accordance with SANS 62271–102.

b) All disconnectors shall be of the air-break, triple-pole, gang-operated type.

c) Use of fully functional circuit-breaker switchgear panel in the racked out (disconnected) position to fulfil the on-load isolation purpose is allowed.

d) The disconnector position indicator shall be visible from the front of the panel. A positive driven mechanical indicating device to show whether the disconnector is open or closed shall be provided. The requirements in Clause **3.4.6** also apply to disconnector.

e) All disconnectors shall be operated by means of a handle and from the front with the panel door closed.

f) Provision shall be made for a mechanism that enables padlocking in both the “ON” and “OFF” positions to inhibit operation of the disconnector.

g) The closing operation of the disconnector shall require minimal application of speed and force on the operating handle.

3.6 EARTHING DEVICES

3.6.1 General

a) Earthing devices shall be in accordance with SANS 62271–102.

b) The switchgear design shall include busbar and cable earthing devices as an integral part of the associated functional unit.

c) All earthing devices shall be operated from the front and outside of the panel.

d) Earthing switches shall be fitted with motorising mechanism to allow for applying of earth remotely.

e) Provision shall be made for a mechanism that enables padlocking in both the “ON” and “OFF” positions to inhibit operation of the earthing devices.

f) Interlocks shall be provided in accordance with SANS 62271-200.

g) Earthing of cables or busbars via the enclosure and supporting structures shall not be acceptable.

h) The earthing device position indicator shall be visible from the front of the panel. A positive driven mechanical indicating device to show whether the earthing device is open or closed shall be provided. The requirements in Clause 3.4.6 also apply to earthing devices.

3.6.2 Busbar Earthing Devices

a) Busbar earthing devices shall be provided for the main busbars.

b) Busbar earthing devices shall be used to provide connection between all three phases of the main busbars and main earth bar through isolating bushings where applicable.

c) The busbar earthing device may only be mounted in the busbar compartment.

3.6.3 Cable Earthing Device

a) Cable earthing switches shall be provided for all incoming and feeder circuit panels.

b) Interlocking shall be required for the cable earthing device to be applied before the cable compartment door or cover can be opened.

c) Interlocking shall also be provided for utilizing the cable live indication system (VDS) to prevent closing of the earthing switch onto live cables.

d) Cable earthing devices shall be connected between all three phases of the cable terminals and main earth bar.

3.7 SPECIAL REQUIREMENTS FOR GENERATOR CIRCUIT-BREAKER

3.7.1 General

a) This standard includes requirements for 10 to 100MVA generator circuit-breakers and it excludes requirements for generator circuit-breakers that are rated 100 MVA and above. These generator circuit-breakers are housed in an AC metal enclosed switchgear and controlgear.

b) Metal enclosed switchgear and controlgear used for power generation and export system shall comply with all the requirements of this Eskom MV Switchgear standard with the following exceptions;

1) The earthing switches' short-circuit making capability (electrical endurance class) shall be rated above the anticipated earth fault level.

2) The rated short-time withstand current and duration of the earthing switch may not match that of the functional unit/panel and shall be rated above the anticipated fault level.

c) The circuit-breaker duty cycle of "CO – 30 minutes – CO" is applicable only in the case of the rated short-circuit current interruption duty. For non-fault interruption, the duty of "CO - 3 minutes – CO" is applicable.

3.8 ACCESSORIES

3.8.1 Current Transformers

a) Current transformers shall comply with SANS 61869 part 1 and 2.

b) Current transformers shall be installed inside the associated functional unit such that they are easily accessible and removable.

c) The short-time withstand current rating of current transformers shall not be less than that of the associated circuit-breaker.

d) Secondary windings of current transformers shall be earthed at one point only. Each group of current transformers (i.e. protection, metering etc.) shall be earthed to the earth bar using solid wire.

e) All current transformers shall be of air-cooled design and the cooling shall be through natural flow of air.

f) Additional rating plates made of a durable material shall be provided with markings as per SANS 61869-2. The information on the additional rating plates shall be duplicated from that appearing on each current transformer and shall be located within the low voltage compartment in a position giving easy visibility.

g) The phase colour with which each current transformer is associated shall appear on the CT name plate that is mounted inside the LV compartment door.

3.8.2 Voltage Transformer

a) VTs shall comply with SANS 61869 part 1 and 3.

b) VTs shall be of the resin encapsulated type and air-cooled design. The cooling shall be through natural flow of air.

c) VTs shall be of the single-phase design, where applicable for motor starter panels.

d) VTs s shall be of the withdrawable type.

e) The primary side of busbar connected VT panels shall be connected to the busbars via adequately rated HRC fuses. It shall not be possible to gain access to these HRC fuses with the VT in the service position.

f) The busbar connected VT shall be of the plug-in type and arranged such that it can be isolated and removed without affecting the associated circuits.

g) When VTs are withdrawn, the spouts shall be closable by means of automatic shutters. The shutters shall have padlocking facilities.

h) Provision shall be made to enable locking of the busbar connected VT in the “service” position.

i) All VTs shall be star primary and star secondary connected. The VT shall be earthed at both the primary and secondary star points.

j) The circuit on the secondary side of the VT shall be protected with the use of either fuses or mcb’s. The protection devices shall be mounted on the VT in order to include the wiring from the VT to the LV compartment in the protected circuit.

k) The secondary fuses of the cable VT shall be easily accessible without any danger of having to work in a live chamber. No fuses or mcb’s shall be fitted in a phase-circuit that is connected to earth.

l) The VT shall be connected to the earth bar by means of solid wires.

3.8.3 Indicating and Measurement Instruments

a) All instruments shall be of the flush-mounting industrial type in accordance with IEC 60051 for indicating instruments of Class 1.5 category.

b) Transducers shall conform to IEC 60688.

3.8.4 Cable and Busbar Live Indicators

An “integrated” voltage detection system (VDS) with fixed voltage indicators and test points in accordance with SANS 61243-5 shall be provided for cable live indication on each incomer and feeder panels, and busbar live indication on each bus section and/or bus coupler panel.

3.8.5 Wiring and Cable Lugs

a) Control wiring lugs and their application with different types of terminals shall be in accordance with Drawing 0.00-10341 Sheets 1 to 4.

b) Crimping on of power lugs shall be in accordance with SANS 61238-1. Crimping tools shall be re-calibrated according to their manufacturer’s standards.

3.8.6 Nameplates and Labels

a) Each switchgear panel shall be labelled in accordance with the nameplate requirement of SANS 62271-200. In addition to the requirements of SANS 62271-200.

b) Each circuit-breaker shall be separately labelled in accordance with the nameplate requirement of SANS 62271-100. The following additional information shall be provided for the circuit-breaker operating mechanism:

1) Type designation,

2) Manufacturer OEM name,
3) The relevant SANS reference number,
4) Trip-coil voltage, current, d.c. resistance (at 20 ^{0}C),
5) Close-coil voltage, current, d.c. resistance (at 20 ^{0}C), and
6) Motor voltage and current (starting peak current and nominal running current).

c) Each switchboard labels shall be provided with a labels which complies with the standards found in 240-71432150 and 0.00-10343 Sheets 1 and 2.

d) Main, circuit description, components and operating labels shall be in accordance with 240-71432150.

3.9 SWITCHGEAR INTERLOCKING SYSTEMS

a) All interlocks shall be in accordance with SANS 62271(relevant parts).

b) Mandatory mechanical interlocks shall be provided for the withdrawable circuit-breakers to ensure that:

1) The circuit-breaker can only be engaged and disengaged to/from the service position when the circuit-breaker main contacts are fully open.
2) The circuit-breaker can only be operated when it is in the service, or disconnected or test position.
3) The circuit-breaker compartment front cover or door is trapped in the close position and cannot be removed/opened when the circuit-breaker is in the service position and during racking of the circuit-breaker.
4) Integral earth switches, if fitted, cannot be closed unless the circuit-breaker is in the disconnected position and cable VDS indication is dead.
5) For flexible auxiliary connections, the multi-pin connector must be engaged and the control supply switched on to enable the circuit-breaker to be placed in the service position.
6) Circuit-breakers cannot be closed unless the cable earth switch is in the open position.
7) Busbar earthing is only possible when all busbar supply circuit-breakers and circuit-breakers of feeder panels are in the disconnected position.
8) With the circuit-breaker in the disconnected position and the circuit-breaker compartment door open, the circuit-breaker cannot be moved from the disconnected position to the service position.
9) The cable compartment door can only be open if the earth switch is in the earthed position (i.e. earth switch applied).

c) The requirements for non-mechanical interlocks shall conform to required operating philosophy presented by Eskom, defined schematic drawings and SANS 62271-200.

d) Where blocking magnets are used as part of the system interlocking, the rating of the blocking magnets shall be continuously rated and shall comply with the control voltage rating and variations.

e) Where electrical system interlocking is preferred, the details shall be specified by Eskom.

3.10 TESTING

3.10.1 Type Test

a) The type tests shall be carried out on all types of functional units in accordance with SANS 62271-200.

b) Where extension of validity of type tests is performed, SANS 62271-307 guide shall be used to perform interpolation of characteristics covering various designs and rating aspects.

c) The electrical components affecting the performance of the functional unit shall be type tested in accordance with the relevant parts of SANS 62271 and other applicable standards.

d) CTs shall be type tested in accordance with SANS 61869 part 1 and 2.

e) VTs shall be type tested in accordance with SANS 61869 part 1 and 3.

f) Cable live indicators shall be type tested in accordance with SANS 61243-5.

g) The indoor switchgear panels (functional units) shall be type tested in accordance with SANS 62271-200, under the authority of a laboratory accredited by a full member (MRA signatory) of ILAC (International Laboratory Accreditation Cooperation). Type test authorities for switchgear and controlgear shall be accredited in accordance with ISO 17025.

h) All type tests and extension of validity of type tests shall be verified and accepted by Eskom before manufacturing can start.

3.10.2 Routine Tests

a) Routine tests shall be performed on each of the functional units and associated components.

b) Switchgear and controlgear shall be routine tested in accordance with the relevant parts of SANS 62271.

c) CTs shall be tested in accordance with SANS 61869-2.

d) VTs shall be tested in accordance with SANS 61869-3.

e) All the other components forming part of the functional unit shall be tested in accordance with the applicable standards to prove functionality.

f) For prototype panels, full range of the required routine tests shall be conducted in accordance with SANS 62271 (all relevant parts) and witnessed by Eskom.

3.10.3 Special Test – Open door LV compartment

a) The LV compartment design shall ensure that no internal arc flashover or debris within the circuit breaker, busbar or cable compartments shall vent into the LV compartment i.e. the internal arc classification achieved for the switchgear panels shall be of such a nature that opening the LV compartment door does not compromise the type tested IAC. Sufficient proof shall be submitted from the already performed IAC type tests performed to proof that. If no proof can be submitted during tendering, the re-type testing of the complete switchgear panel with LV compartment door open for internal arc classification shall be required prior to contract conclusion.

   If no proof can be submitted during tendering, the re-type testing of the complete switchgear panel with LV compartment door open for internal arc classification. The following are the requirements;

1) The internal arc test shall be carried out in accordance with SANS 62271-200 with the LV compartment door open or removed. The duration of the test shall be 1 second.

2) The test shall be carried out on compartments that are adjacent to the LV compartment.

b) Type test laboratory used to perform special test shall be accredited as a full member (MRA signatory) of ILAC (International Laboratory Accreditation Cooperation). Type test authorities for switchgear and controlgear shall be accredited in accordance with ISO 17025.

c) Special test compliance shall be verified and accepted by Eskom.

3.11 MAINTENANCE AND OPERATION

3.11.1 Maintenance and Operating Tools

a) Any special tools or keys that may be required for maintenance, operating or for adjustments shall be provided.

b) These special tools or keys shall be provided with a wall mounted lockable enclosure. The number tools or keys shall be indicated in the Technical A and B Schedule (240-93576770)

c) Where circuit-breaker emergency tripping tool does not form part of the panel, it shall be mounted at nearest accessible location inside the substation room.

d) Handling equipment or trolleys shall be provided to facilitate the removal of the mid-mount withdrawable devices from the panel. The number of handling equipment or trolleys shall be indicated in the Technical A and B Schedule (240-93576770).

3.11.2 Maintenance and Operating Instructions

a) The works instructions or procedures shall be provided by the original equipment manufacturer detailing descriptions of the maintenance and operating work in accordance with SANS 62271-1.

b) The procedures shall cover the requirements for maintenance and operating of the equipment over the design life.

c) It is required during tenders to develop and submit to Eskom a failure mode effect and criticality analysis (FMECA) to identify all maintenance requirements and end of life criteria for the panel types offered.

3.12 TRAINING

The supplier shall provide first hand training of an international standard on the supplied equipment by OEM accredited instructors.

Refer to 240-56065202 for the switchgear training requirements from original equipment manufacturers.

3.13 DOCUMENTATION

3.13.1 Language

a) All documentation, including reports, manuals, etc. shall be in the English language.

3.13.2 Type Test Reports

a) Type test documentation shall represent the design of the functional unit with respect to the configuration, type and rating.

b) The information to be included in type test reports shall be in accordance with SANS 62271-200.

c) The report of the type tested functional unit and associated components shall reflect the equipment under consideration.

d) The type test report shall be provided in full, containing all records of the tests conducted as well as the drawings.

e) Softcopies shall be provided for all type test documentation.

3.13.3 Manuals and Drawings

a) The technical, training, maintenance and operating manuals shall be provided for each type (e.g. for different ratings, voltage levels etc.) of a functional unit.

b) Technical manuals shall include all technical data, information on the switchgear construction as well as the technical data and leaflets of each individual component used in the switchgear provided.

c) Where generic manuals are provided, an addendum shall be provided indicating the applicable project specific components.

d) Drawings shall comply with 240-86973501: Eskom Engineering Drawing Standard and 240-54690969: Engineering Drawing Symbol Standard.

e) Manuals shall be of a good quality and shall cover the following as a minimum:

1) Technical descriptions of the equipment and component parts
2) General arrangement drawings
3) Installation instructions with drawings or pictures
4) Operating and maintenance instructions for all components
5) Detailed parts lists (accompanied by exploded view type drawings clearly detailing the part and uniquely identifying it)
6) Spare part ordering instructions

f) Any special instructions pertaining to storage as spare parts or as shelf life shall be included in the maintenance manual.

g) All drawings requested for component location, dismantling and re-assembly for maintenance shall be included in the maintenance manual.

h) All special tools required for operating and maintenance of the equipment shall be presented in a form of a schedule in the operating and maintenance manual, respectively.

i) The content of the training manual shall be based on the content of the technical, operating and maintenance manuals.

3.14 PACKAGING, TRANSPORTATION AND HANDLING

a) The functional unit shall be suitable for handling and removal by providing mechanisms for crane hooks.

b) The functional unit shall be suitable for handling and removal by providing mechanisms to avoid damage to the functional unit.

c) During transportation the electrical components shall be packaged in such a way that damage is prevented.

d) Components of the functional unit that are transported separately shall be marked accordingly and shall be easily identifiable.

3.15 SPARES

3.15.1 Availability of spares

a) The supplier (who may represents the OEM), shall be responsible for ensuring the continued availability of spare parts required for maintenance for a period of not less than 25 years from the date of discontinuation of the switchgear and control-gear.

b) Spares required under emergency breakdown conditions shall be readily available with a maximum lead time of 96 hours from date of purchase order. The supplier shall state the lead time offered in schedule B. This excludes spares required for scheduled maintenance.

c) The following spares shall be readily available locally (in South Africa) within 96 hours:

1) Trip coils;
2) Close coils;
3) Under voltage release coils;
4) Spring charging motors; and
5) Racking motors;

d) The supplier shall undertake to supply to Eskom all the necessary replacement parts for the circuit-breaker throughout its expected service life. If the manufacture of the specific make and type of circuit-breaker (or any of its replacement parts) is discontinued; Eskom shall be advised in writing.

e) Written advice (relating to discontinuation) shall also be provided for parts of the equipment that the supplier obtains from a third party (sub-supplier). In this situation; the supplier shall supply the following information to Eskom:

1) All design data,
2) All material characteristics and parameters,
3) All testing information (parameters, equipment, methods, criteria, etc.),
4) All manufacturing information, and
5) All relevant working drawings and information.

f) This information shall be supplied to Eskom in a legible and acceptable format in English when notice of discontinuation of the circuit-breaker or any of its replacement parts is given. In this case, Eskom will be able to make alternative arrangements to obtain the necessary replacement parts. Another option is to pool spare parts: the supplier shall state his/her spares availability philosophy with the tender documentation.

3.15.2 Identification of spares

a) Spares shall be identified by a unique number and cross-referenced in the instruction manual. Large spares such as poles and operating shafts shall be packed in separate cases, clearly labelled and consigned to Eskom. Such large spare items shall be provided with a durable label bearing the appropriate identification.

b) A list of parts shall be provided with each consignment of spares, clearly identifying each item by description, identification number and quantity supplied. The contract number shall appear on the packaging containing spares.

4. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
Machiel Viljoen	Senior Manager: Gx Asset Management, Electrical Engineering
Vonani Mathebula	Chief Engineer: Gx Asset Management, Electrical Engineering
Fred Claassens	Senior Consultant: Gx Asset Management, Electrical Engineering
Gert Brink	Electrical Engineering Manager - Arnot Power Station
Steyn Drotsky	Electrical Engineering Manager - Camden Power Station
Andile Nqayane	Electrical Engineering Manager - Duvha Power Station
Mantombi Mkemezulu	Electrical Engineering Manager - Grootvlei Power Station
Aluwani Mutsilanwana	Electrical Engineering Manager - Hendrina Power Station
Remember Sigawuke	Electrical Engineering Manager - Kendal Power Station
Zieyaad Isaacs	Electrical Engineering Manager - Koeberg Power Station
Tsumza Tsumane	Electrical Engineering Manager - Kriel Power Station
Samuel Chembe	Electrical Engineering Manager - Komati Power Station
Mohapi Mphirime	Electrical Engineering Manager - Kusile Power Station
Theko Shete	Electrical Engineering Manager - Lethabo Power Station
Thabile Modungwa	Electrical Engineering Manager - Tutuka Power Station
Kefuoe Sejosing	Electrical Engineering Manager - Majuba Power Station
Louisa Bamuza	Electrical Engineering Manager - Matimba Power Station
Nkosinathi Maseko	Electrical Engineering Manager - Matla Power Station
Derrick Chauke	Electrical Engineering Manager - Medupi Power Station
Ian Kuiler	Electrical Engineering Manager - Peaking Power Stations

5. REVISIONS

Date	Rev.	Compiler	Remarks
August 2013	0.1	JS Moroaswi D Monyane	GGSS1201 rev 1 was revised and given a new number: 36-852 but it was never published. During TDAC process, GGSS1201 rev 1 was formatted into 240-56227573 but never published as well. 36-852 standard number was then changed to 240-56227573, First Draft for comments Review
June 2015	1	JS Moroaswi D Monyane	Final Document for Authorisation and Publication
December 2019	1.1	D Monyane	The standard is revised and the following items are included; • Safety integrity level (SIL) requirements for Boiler/Turbine Protection. • Motorised circuit-breaker racking and earthing devices. • Generator circuit-breaker requirements for generator rated 10 - 100MVA.
June 2020	1.2	D Monyane	Final Draft Document for Business Review Process.
June 2020	1.3	D Monyane	Updated Final Draft after Review Process completed.
July 2020	2	D Monyane	Final Rev 2 Document Authorised for Publication.

6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Alex Feldmann
- Brian Mokoena
- Dyke Monyane
- Euveshen Govender
- Francois Dragner
- Henk Nieuwenhuis
- Makgatle Lentsoane
- Manie Van Staden
- Martin Visser
- Queeneth Khumalo
- Sashan Marion
- Vusi Cele

7. ACKNOWLEDGEMENTS

None

ANNEX 1: TECHNICAL SCHEDULE C- TYPE TESTING REQUIREMENTS

Schedule C1: Switchgear and Controlgear (Switchboards) - Functional Units SANS 62271-1 and SANS 62271-200

Applicable Clauses for SANS 62271-1 and SANS 62271-200	Type Test	Equipment to which Applicable	Panel type and Rating	Report/Certificate Number	Testing Authority

Schedule C2: Switchgear and Controlgear (Switchboards) - Circuit-breakers SANS 62271-100

Applicable Clause for SANS 62271-1 and SANS 62271-100	Type Test	Equipment to which Applicable	Panel type and Rating	Report/Certificate Number	Testing Authority

Schedule C3: Switchgear and Controlgear (Switchboards) - Earthing Switches SANS 62271-102

Applicable Clause for SANS 62271-1 and SANS 62271-102	Type Test	Equipment to which Applicable	Panel type and Rating	Report/Certificate Number	Testing Authority

Schedule C4: Switchgear associated Components - Current Transformers and Voltage Transformers

Applicable Clause for SANS 61869-1, SANS 61869-2 and SANS 61869-3	Type Test	Equipment to which Applicable	Panel type and Rating	Report/Certificate Number	Testing Authority

ANNEX 2: TECHNICAL A & B SCHEDULE FOR GENERATION AIR-INSULATED WITHDRAWABLE AC METAL-ENCLOSED SWITCHGEAR AND CONTROLGEAR FOR RATED VOLTAGES ABOVE 1KV UP TO AND INCLUDING 52KV

Note: Technical A&B Schedule is available in Microsoft Excel Format, and shall be submitted in the completed Microsoft Excel format and pdf.

Technical A&B Schedule Unique Identifier number: 240-93576770

Link to Compliance schedule on Hyperwave is 240-93576770

NOTES for completing Technical A & B Schedules

SCHEDULE A: PARTICULARS OF EMPLOYER'S REQUIREMENTS

SCHEDULE B: GUARANTEES AND TECHNICAL PARTICULARS OF PLANT AND MATERIAL OFFERED

1. Values and parameters entered in Schedule A are considered to be the minimum requirements. Where the Contractor does not fully comply with the Employer's requirement, any deviations must be clearly indicated in Schedule B and listed in the Deviation Schedule.

2. Where there is a need to substantiate or further describe an item in Schedule B, especially in instances of non-compliance with Schedule A, particulars are furnished on a separate sheet clearly marked with the notation of the Schedule A item referred to.

3. If a blank space is left in Schedule B next to certain requirement specified in Schedule A, this constitutes a confirmation that the tenderer does not comply with that specific requirement.

4. Where 'xxx' is indicated for an item in Schedule A, the Contractor is required to fill in the appropriate information in Schedule B, for the equipment offered.

5. Where '***' is indicated in the Schedule A column, Eskom engineering practitioner shall provide information before enquiry is issued to the market.

6. Separate schedules are completed for each rating of switchgear as per the requirements of the switchgear schedules. The same applied for the circuit breakers. Further, separate schedules should be provided for the equipment of different types, if offered for the same ratings.

TECHNICAL A&B SCHEDULE FOR GENERATION AIR-INSULATED WITHDRAWABLE METAL-ENCLOSED SWITCHGEAR AND CONTROLGEAR FOR RATED VOLTAGES ABOVE 1KV UPTO AND INCLUDING 52KV	Template Unique Identifier:	240-93576770 (Rev 2)
	Switchgear Standard number:	240-56227573
	Document Unique Identifier:	xxx-xxxxxxxx
	Revision No:	<x.x>
	Effective Date	01-Jul-20
	GENERATION ASSET MANAGEMENT	

Item no.	Clause of 240-56227573	Item Description	Units	Schedule A	Schedule B
1	**3.1**	**RATNGS AND OPERATING CONDITIONS**			
1.1	**3.1.1**	**Panel Ratings**			
1.2		System nominal voltage	kV	per switchgear schedule	
1.3		System voltage range	%	per switchgear schedule	
1.4		Rated voltage	kV	per switchgear schedule	
1.5		Number of phases		3	
1.6		System neutral earthing		***	
1.7		Rated Short-Duration Power Frequency Withstand Voltage	kV rms	per switchgear schedule	
1.8		Rated Lightning Impulse Withstand Voltage	kV peak	per switchgear schedule	
1.9		Rated Frequency	Hz	50	
1.10		Rated Normal Current at 40 degrees Celsius	A	per switchgear schedule	
1.11			kA	per switchgear schedule	

		Rated Short-Time Withstand Current			
1.12		Rated Peak Withstand Current	kA	per switchgear schedule	
1.13		Rated Duration of Short Circuit	s	per switchgear schedule	
1.14		Rated Supply Voltage of Closing and Opening Devices and of Auxiliary and Control Circuits		***	
2	**3.1.2**	**Ratings for Switching Devices** **Note:** Individual ratings of circuit breakers shall be stipulated on Switchgear Schedule Template			
2.1	d)	Circuit-breakers' Electrical endurance classification		E2	
2.2	e)	Circuit-breakers' Mechanical endurance classification		M2	
2.3	f)	Earthng Devices Electrical endurance classification		E2	
2.4		Fault making curent rating		kA	
2.5		Fault withstand current rating		kA	
2.6		Durantion of short circuit withsatnd current		s	
2.7		Current rating of connection between device abd earth bar		kA	
2.8	g)	Earthing Devices Mechanical endurance classification		M1	
3	**3.1.3**	**System Characteristics and Operating Conditions**			
3.1	a)	Main power system normal power supply		± 5%	
3.2	b)	Circuit-breaker auxiliary coils:			
3.3		Shunt closing release		85% - 110%	
3.4		Shunt opening release		85% - 110%	
3.5		Under-voltage release		below 35%	
3.6	c)	Total Harmonic Distortion (THD)		up to 5%	

4	**3.2**	**PANEL DESIGN AND CONTRUCTION**			
4.1	**3.2.1**	**Service Conditions**			
4.2		Installation	Indoor/Outdoor	Indoor	
4.3	a)	Ambient temperature	^{O}C	-5 to 40	
4.4	b)	Altitude	metres	xxx	
5	**3.2.2**	**General Requirements**			
5.1		Manufacturer		xxx	
5.2		Technology type		xxx	
5.3		Model/Type		xxx	
5.4		Power cable access	Rear/Front	yyy	
5.5		Control cable entry	Top/Bottom	yyy	
5.6		**Switchboards physical dimesions**			
5.7		Minimum overall length	mm	xxx	
5.8		Maximum overall height	mm	xxx	
5.9		Maximum overall depth	mm	xxx	
5.10		Circuit breaker compartment depth	mm	xxx	
5.11		Low voltage compartment depth	mm	xxx	
5.12		Base frame height	mm	xxx	
5.13		Power cable opening/slot (Length x Width)	mm x mm	xxx	
5.14		Overall mass of complete switchboard	kg	xxx	
5.15	b)	Internal Arc Classification		AFLR for 1 sec	
5.16		Fault current rating	kA	xxx	
5.17	c)	The switchgear and controlgear shall be of behind-closed-door operation i.e circuit-breaker compartment door shall not be part of the circuit-breaker		Yes	
5.18	d)	The switchboards shall be of modular designs that allow for the subsequent addition of identical panels		Yes	
6	**3.2.4**	**Segregation of Compartments**			

6.1	**3.2.4.1**	**General**			
6.2		Separate circuit breaker compartment		Yes	
6.3		Separate busbar compartment		Yes	
6.4		Separate control and protection cable termination compartment		Yes	
6.5		Separate power cable termination compartment (including cable earth switch)		Yes	
6.6		Separate busbar earthing device compartment		Yes	
6.7		Separate busbar VT compartment		Yes	
6.8	**3.2.4.3**	**Power Cable Compartment**			
6.9	c)	Power cable compartment shall comply with SANS 876		Yes	
6.10		Power cable terminations type for single core and three core		Type 2 (shrouded/covered)	
6.11	**3.2.4.5**	**Circuit-breaker Compartment**			
6.12	1)	Integral motorised racking mechanism		Yes	
6.13	**3.2.4.6**	**Busbar Earthing Device Compartment**			
6.14	b)	The busbar earthing device compartment shall be on the same panel as the VT compartment		Yes	
6.15	d)	Fixed type busbar earthing device		Yes	
6.16	**3.2.4.7**	**VT Compartment**			
6.17	d)	Withdrwable type VT		Yes	
7	**3.2.5**	**Service Continuity Classification**			
7.1		Loss of service continuity category		LSC2B	
8	**3.2.6**	**Partition Class and Shutters**			
8.1	a)	Partiton class		PM	

8.2		Number of mechanical operating cycles		1000	
9	**3.2.8**	**Degree of Protection**			
9.1	a) 1)	Protection againsnt live part inside LV compartment		IPXXB	
9.2	2)	Cable boxes		IP3X	
9.3	b)	Switchboards		IP4X	
9.4	**3.2.9.1**	**Padlocking Facilities**			
9.5	c)	Diameter for all padlocking facilities		Min 10 mm	
9.6		Dimensions of padlock		Figure 1 of 240-56227574	
10	**3.2.10**	**Corrosion Protection**			
10.1	a)	Corrosion protection		Yes	
10.2	**3.2.11.2**	**Colour Coding of Switchboards**			
10.3		Panel exterior colour coding		xxx	
11	**3.2.12**	**Busbars and Connections**			
11.1		Main busbars current rating	A	xxx	
11.2		Number of busbars	number per phase	xxx	
11.3		Busbar insulating medium		Air	
11.4		Busbar connections		Bolt, nut and washer	
11.5		Busbar material		HD copper	
11.6		Method of busbar identification		Colour coding	
12	**3.2.14**	**Insulating Materials**			
12.1	a)	Insulating material name		xxx	
12.2		Type and manufacturer of phase to phase barriers		xxx	
12.3		Type and manufacturer of phase to earth barriers		xxx	

12.4		Type and manufacturer of connection joints insulation		xxx	
13	**3.2.15**	**Auxiliary Circuit Wiring and Identification**			
13.1		Control cable type		PVC, PVC, SWA	
13.2		Insulation voltage rating	V	600/1000	
13.3		VT and CT circuits conductor sizes	mm^2	2.5	
13.4		Control circuits conductor sizes	mm^2	1.5	
13.5		Alarm circuits	mm^2	1.5	
13.6	d)	Control wire sheath colour:			
13.7	1)	AC circuits		Black	
13.8	2)	DC circuits		Grey	
13.9	3)	Earthing		Green and yellow	
13.10	4)	CT and VT wiring as per the phase		red,white, blue and black(neutral)	
13.11	**3.2.16.1**	**Power Cable Termination**			
13.12	b)	Clearance between cable termination points and and adjacent structures (SANS 876)	mm	xxx	
13.13		Power cable entry		Bottom	
13.14		Power cable type		per switchgear schedule	
13.15		Conductor size		per switchgear schedule	
13.16		Number of cables		per switchgear schedule	
13.17	**3.2.16.3**	**Cable Entry Arrangements**			
13.18		Distance from terminal(bushing) centre line to the gland plate or cable clamp (SANS 876)	mm	Min 800 mm	
13.19	**3.2.16.4**	**Vermin and Fire Proofing of Cable**			

		Compartment and LV Compartment			
13.20	a)	Minimum fire rating	hrs	2	
13.21		Type of material used		xxx	
14	**3.2.17**	**Earthing**			
14.1	c)	Earth bar cross sectional area (25 mm wide)	mm^2	xxx	
14.2		Earth conductor position		Rear of the panel	
14.3		Earth conductor material		Copper	
14.4		Earth conductor type		Earth bar	
14.5		Earth conductor size (calculated as per switchboard specification)	mm^2	200 minimum	
14.6		Short-time current withstand for earth conductor between earth switch and earth bar (for three seconds)	kA	xxx (equal to board rating)	
14.7		Earth conductor screened earth bar required	Yes/No	No	
15	**3.3**	**Special Consideration for Internal Arc proof design**			
15.1	c)	Each compartment shall contain the arc without spreading it to other compartments		Yes	
15.2	d)	Each functional unit (panel) shall contain the arc without spreading it to any other functional unit/s.		Yes	
15.3	h)	Switchboard fitted with the exhaust duct shall not have common duct with the next switchboard		Yes	
15.4	j)	IAC requirements shall be upheld while working in the low voltage compartment. Hence, the channels or conduits between the power compartments and the low voltage compartments should be sealed accordingly and type tested with the LV compartment door removed.		Yes	
16	**3.4**	**CIRCUIT-BREAKERS**			
16.1	**3.4.1**	**General**			

16.2		Manufacturer		xxx	
16.3		Model		xxx	
16.4		Number of poles		3	
16.5		Total auxiliaries contacts		xxx	
16.6		Type of circuit-breaker operation		Trip-free	
16.7	a)	Circuit-breakers in accorance with SANS 62271-100		Yes	
16.8	b)	Triple pole withdrawable type		Yes	
16.9	d)	Withdrawable circuit-breakers are housed in a circuit-breaker compartment of the “behind close door” design		Yes	
16.10	i)	Arc-interrupting medium		Vacuum	
16.11		Vacuum interupter name		xxx	
17	**3.4.4**	**Mechanisms and Closing Devices**			
17.1		**Spring Mechanism**			
17.2		Manual recharge	Yes/No	Yes	
17.3		Motor recharge	Yes/No	Yes	
17.4		Motor voltage rating	V DC	220	
17.5		Motor power rating	W	xxx	
17.6		Motor starting current	A	xxx	
17.7		Motor steady-state current rating	A	xxx	
17.8		Mechanism recharging time at 80% control voltage	s	xxx	
17.9		Mechanism recharging time at 100% control voltage	s	xxx	
17.10		Number of spare spring-device limit switch contacts per mechanism provided - Normally open (when closing spring is discharged)		1	
17.11		Number of spare spring-device limit switch contacts per mechanism provided - Normally closed (when closing spring is discharged)		1	
17.12		Number of open/close operations before recharge		xxx	
17.13	b)	Electrically-operated devices including charging motors operating voltage tolerance		85% - 110%	

17.14		**Closing Coils**			
17.15		Nominal voltage	V DC	220	
17.16		Maximum operating voltage	%	10	
17.17		Minimum operating voltage	%	-15	
17.18		Maximum power drawn by closing coil at nominal voltage	W	xxx	
17.19		Maximum operating current at nominal voltage	A	xxx	
17.20		Nominal operating current at nominal voltage	A	xxx	
17.21		Number of open/close operations stored		xxx	
17.22	d)	closing coil power per circuit-breaker		Max 1200VA	
18	**3.4.5**	**Tripping Devices**			
18.1		**Main Tripping Coil**			
18.2		Nominal voltage	V DC	220	
18.3	a)	Maximum operating voltage	%	110	
18.4		Minimum operating voltage	%	85	
18.5		Maximum power drawn by tripping coil at nominal voltage	W	xxx	
18.6		Maximum operating current at nominal voltage	A	xxx	
18.7		Steady-state operating current at nominal voltage	A	xxx	
18.8		**Second Tripping Coil**			
18.9	c)	Provision fo the intallation of second tripping coil		Yes	
18.10		Nominal voltage	V DC	220	
18.11		Maximum operating voltage	%	110	
18.12		Minimum operating voltage	%	85	
18.13		Maximum power drawn by tripping coil at nominal voltage	W	xxx	
18.14		Maximum operating current at nominal voltage	A	xxx	
18.15		Steady-state operating current at nominal voltage	A	xxx	
18.16		**Under Voltage Release Coil**			

18.17		Nominal voltage	V AC or DC	***	
18.18	e)	Release voltage	%	xxx	
18.19		Maximum power drawn by closing coil at nominal voltage	W	xxx	
18.20		Maximum operating current at nominal voltage	A	xxx	
18.21		Steady-state operating current at nominal voltage	A	xxx	
19	**3.4.6**	**Indicating Devices**			
19.1	a) 1)	Circuit-breaker close: ON or I – white lettering on a red background		Yes	
19.2	2)	Circuit-breaker open (Trip): OFF or O – white lettering on green background		Yes	
19.2	b)	Lettering size		Min 10 mm	
20	**3.4.7**	**Auxiliary Contacts**			
20.1		Manufacturer		xxx	
20.2		Type		xxx	
20.3	b)	Number of spare normally-open contacts		2	
20.4	b)	Number of spare normally-closed contacts		2	
20.5		Current rating at 220V DC (utilizing category AC14 or DC13 to IEC 60947-5-1)	A	xxx	
20.6		Current rating at 220V AC (utilizing category AC14 or DC13 to IEC 60947-5-1)	A	xxx	
20.7		Anti-pumping facilities provided		Yes	
21	**3.4.9**	**Insulation Level**			
21.1		Manufacturer		xxx	
21.2		Type of material used			
21.3		Thickness	mm	xxx	
21.4		Insulation withstand	V/mm	xxx	
21.5	a)	Internal insulation and clearances in air in accordance with SANS 876 unless proven by type testing to the required insulation levels		xxx	

22	**3.5**	**DISCONNECTORS**			
22.1	a)	Disconnectors shall be in accordance with SANS 62271-102		Yes	
22.2	b)	Air-break, triple-pole and gang-operated type		Yes	
23	**3.6**	**EARTHING DEVICES**			
23.1		Type		xxx	
23.2		Manufacturer		xxx	
23.3		Designation (e.g. busbar earth switch, cable earth switch)		***	
23.4		Number of operations		2000	
23.5	a)	Earthing devices shall be in accordance with SANS 62271–102		Yes	
23.6	d)	Motorising mechamism for earth switch		Yes	
23.7		**Auxiliary Contacts**			
23.8		Manufacturer		xxx	
23.9		Type		xxx	
23.10		Number of spare normally-open contacts		2	
23.11		Number of spare normally-closed contacts		2	
23.12		Current rating at 220V DC (utilizing category AC14 or DC13 to IEC 60947-5-1)	A	xxx	
23.13		Current rating at 220V AC (utilizing category AC14 or DC13 to IEC 60947-5-1)	A	xxx	
24	**3.8**	**ACCESSORIES**			
24.1	**3.8.1**	**Current Transformers**			
24.2	a)	CTs complies to SANS 61869 part 1 and 2		Yes	
24.3	c)	CTs short-time withstand current rating not less than associated Circuit-breaker rating		Yes	
24.4	e)	CTs shall be air-cooled design with natural flow of air		Yes	

24.5		**Circuit Protection and Measurement**			
24.6		Manufacturer		xxx	
24.7		Type	Ring/Bar	Bar	
24.8		Model		xxx	
24.9		Grouping		Block	
24.10		**Core Balance**			
24.11		Manufacturer		xxx	
24.12		Type		xxx	
24.13		Model		xxx	
24.14		**Current Sensing Device**			
24.15		Manufacturer		xxx	
24.16		Type		xxx	
24.17		Model		xxx	
25	**3.8.2**	**Voltage Transformers**			
25.1	a)	VTs complies to SANS 61869 part 1 and 3		Yes	
25.2	b)	VT s shall be resin encapsulated type and air cooled design. And cooling shall be through natural flow of air		Yes	
25.3	c)	VTs shall be single phase design		Yes	
25.4	d)	Withdrawable type		Yes	
25.5		**Busbar Connected Voltage Transformer**			
25.6		Manufacturer		xxx	
25.7		Type		xxx	
25.8		Model		xxx	
25.9		Nominal voltage	kV	***	
25.10		Insulation of primary winding		per switchgear schedule	
25.11		Primary connection		Star-unearthed	
25.12		Secondary connection		Star-earthed	
25.13		Rated primary voltage	kV	per switchgear schedule	

25.14		Rated secondary voltage	V	110	
25.15		Accuracy class		per switchgear schedule	
25.16		Voltage factor		1.9	
25.17		Rated time at maximum operating voltage		Continuous	
25.18		Magnetising current on secondary winding basis at 100% rated voltage	A	xxx	
25.19		Continuous power rating of the secondary winding	VA	50	
25.20		Primary protection		HRC fuse	
25.21		Secondary protection		mcb	
25.22		**Cable Voltage Transformer**			
25.23		Manufacturer		xxx	
25.24		Type		Single phase	
25.25		Model		xxx	
25.26		Nominal voltage	kV	per switchgear schedule	
25.27		Insulation of primary winding		xxx	
25.28		Primary connection		Star-unearthed	
25.29		Secondary connection		Star-earthed	
25.30		Rated primary voltage	kV	per switchgear schedule	
25.31		Rated secondary voltage	V	110	
25.32		Accuracy class		per switchgear schedule	
25.33		Voltage factor		1.9	
25.34		Rated time at maximum operating voltage		Continuous	
25.35		Magnetising current on secondary winding basis at 100% rated voltage	A	xxx	
25.36		Continuous power rating of the secondary winding	VA	50	
25.37		Primary protection		HRC fuse	
25.38		Secondary protection		mcb	
25.39		**Running Hour Meters**			
25.40		Functionality incorporated in IED	Yes/No	xxx	

25.41		Manufacturer		xxx	
25.42		Type		Flush electromechanical	
25.43		Model		xxx	
25.44		Number of display running hours (minimum)	hrs	100 000	
25.45		Number of operation counter display digits		6	
25.46		Supply voltage	V DC	220	
25.47		Reset		No	
26	**3.8.4**	**Cable and Busbar Live Indicators**			
26.1		Manufacturer		xxx	
26.2		Type		xxx	
26.3		Model		xxx	
27	**3.8.5**	**Wiring and Cable Lugs**			
27.1	a)	Control wiring lugs		0.00-10341	
27.2	b)	Crimping on of power lugs shall be in accordance with SANS 61238-1		Yes	
28	**3.8.6**	**Nameplates and Labels**			
28.1		Designation of equipment		***	
28.2		Main labels		Yes	
28.3		Circuit description labels		Yes	
28.4		Component labels		Yes	
28.5		Operating Labels		Yes	
29	**3.9**	**SWITCHGEAR AND INTERLOCKS SYSTEMS**			
29.1		All interlocks as stipulated in 240-56227573		Yes	
30	**3.10**	**TESTING**			
30.1	**3.10.1**	**Type Testing**			
30.2		Schedule C completed fully (on Appendix C		Yes	

		of 240-56227573)			
30.3		All relevant reports available		Yes	
30.4		Reports available in accordance with IEC standards		Yes	
30.5		Reports in English		Yes	
30.6	g)	Testing authority of a laboratory accredited by a full member (MRA signatory) of ILAC (International Laboratory Accreditation Cooperation)		Yes	
31	**3.10.2**	**Routine Testing**			
31.1		Provision made for Factory Acceptance Testing (FAT)		Yes	
31.2		Location where FAT will be performed		Yes	
31.3		Provision made for Site Acceptance Testing		Yes	
32	**3.10.3**	**Special Test – Open door LV compartment**			
32.1		Type tests performed with LV compartment door open or removed		Yes	
32.2		Duration of the test with LV compartment door open	s	1	
32.3	a) 1)	The internal arc test shall be carried out in accordance with SANS 62271-200			
32.4	2)	The test shall be carried out on compartments that are adjacent to the LV compartment			
32.5	b)	Type test laboratory used to perform special test shall be accredited as a full member (MRA signatory) of ILAC (International Laboratory Accreditation Cooperation)			
33	**3.11**	**OPERATING AND MAINTENANCE**			
33.1		Number of toolboxes for operating		2 sets per substation	

33.2		Number of toolboxes for maintenance		2 sets per substation	
33.3		Number of trolleys and associated lifting equipment required (cradle type switchgear)		2 per substation per breaker type	
33.4		Access Ladders		2 per substation	
34	**3.12**	**TRAINING**			
34.1		240-56065202 for the switchgear training requirements from original equipment manufacturers		Yes	
35	**3.13**	**DOCUMENTATION**			
36	**3.13.1**	**Language**			
36.1	a)	All documentation shall be in English Language		Yes	
37	**3.13.3**	**Manuals and Drawings**			
37.1	a)	The technical, training, maintenance and operating manuals shall be provided for each type (e.g. for different ratings, voltage levels etc.) of a functional unit		Yes	
37.2	d)	Drawings shall comply with 240-86973501 and 240-54690969		Yes	
37.3		**Drawings**			
37.4		Software format (Microstation)		Microstation	
37.5		Software copies	No. of drawings	***	
37.6		Hard copies	No. of drawings	***	
37.7		**Technical Manual**			
37.8		Equipment catalogue	Copies per type	***	
37.9		Equipment functional description manual	Copies per	***	

			type		
37.10		**Operating and Maintenance Manuals**			
37.11		Operating manual	Copies	***	
37.12		Maintenance manual	Copies	***	
37.13		Training manual	Copies	***	
37.14		Maintenance video/DVD	Copies	***	
37.15		Operating video/DVD	Copies	***	
38	**3.14**	**PACKAGE, TRANSPORTATION AND HANDLING**			
38.1		**Transportation**			
38.2		Dimensions of largest transport section:			
38.3		Width	mm	xxx	
38.4		Depth	mm	xxx	
38.5		Height	mm	xxx	
39	**3.15**	**SPARES**			
39.1	**3.15.1**	**Availability of Spares**			
39.2	a)	Availability of spare parts required for maintenance from the date of discontinuation of the switchgear and controlgear		More than 25 years	
39.3	b)	Spares required under emergency breakdown conditions shall be readily available with a maximum lead time of 96 hours from date of purchase order		xxx	
39.4	c)	The following spares shall be readily available locally (in South Africa) within 96 hours:			
39.5		Trip coils		xxx	
39.6		Closing coils		xxx	
39.7		Under voltage release coils		xxx	
39.8		Spring charging motors		xxx	

39.9		Racking motors		xxx	

DEVIATION SCHEDULES

EXCLUSIONS, ADDITIONS AND DEVIATIONS		
NOTES:		
1. Any deviations/modifications/alternatives offered to specification are listed below with reasons for the departure.		
2. No deviations/modifications/alternatives offered to the specification are recognised unless listed on this Schedule.		
3. If no deviations/modifications/alternatives are offered, this Schedule are marked N/A		
Schedule Item no.	**Item Description**	**Proposed deviation/ Modification/Alternative**

ANNEX 3: MV SWITCHGEAR SCHEDULE

Eskom	ELECTRICAL MEDIUM VOLTAGE SWITCHGEAR SCHEDULE	Template Unique Identifier	240-77300784 (Rev 2)
		Document Unique Identifier	xxx-xxxxxxxx
		Revision No:	<x.x>
		Effective Date:	2020/06/01
		GENERATION PLANT ENGINEERING	

			0 1BBA	11kV UNIT BOARD 1
LABEL INSCRIPTIONS	PLANT CODIFICATION	PROCESS (SOURCE/DESTINATION) CODE		
		POINT OF INSTALLATION CODE (NOTE 2)		
	PANEL NUMBER			
	CIRCUIT DESCRIPTION			
PROTECTION SCHEME NUMBER				
SWITCHGEAR RATINGS	FAULT CURRENT :	BUSBAR AMPS (A)		
		CIRCUIT AMPS (A)		
	kA rms for 3 seconds	CIRCUIT BREAKER AMPS (A) REQUIRED		
	kA peak	CIRCUIT BREAKER AMPS (A) OFFERED		
		PANEL RATING AT 40 DEGREE C (A)		
		NUMBER OF OPERATIONS REQUIRED		
		NUMBER OF OPERATIONS OFFERED		
	WITHSTAND VOLTAGE:	1st TRIP COIL VOLTAGE		
		2nd TRIP COIL VOLTAGE		
	kV Impulse Voltage	UNDER VOLTAGE - RELEASE VOLTAGE		
	kV Power Frequency	CABLE EARTH SWITCH		
	for 60 secc (N	BUSBAR EARTH SWITCH		
LOAD PARAMETERS		TRANSFORMER RATING kVA		
		MOTOR RATING kW		
		MOTOR STARTING CURRENT (A)		
		MOTOR STARTING TIME (sec)		
		NUMBER OF STARTS PER HOUR		
		MOTOR SPACE HEATER		
CURRENT TRANSFORMERS	DIFFERENTIAL PROTECTION	RATIO		
		ACCURACY CLASS		
		BURDEN (VA)		
		SATURATION FACTOR		
		ACCURACY LIMIT / KNEE POINT		
	CIRCUIT PROTECTION	RATIO		
		ACCURACY CLASS		
		BURDEN (VA)		
		SATURATION FACTOR		
		ACCURACY LIMIT / KNEE POINT		
	MEASUREMENTS	QUANTITY		
		RATIO		
		ACCURACY CLASS		
		BURDEN (VA)		
		SATURATION FACTOR		
	BUSZONE PROTECTION	RATIO		
		ACCURACY CLASS		
		BURDEN (VA)		
		SATURATION FACTOR		
		ACCURACY LIMIT / KNEE POINT		
	CORE BALANCE	RATIO		
		ACCURACY CLASS		
		BURDEN (VA)		
VOLTAGE TRANSFORMER		CABLE VT		
		BUSBAR VT		
		RATIO		
		ACCURACY CLASS		
		BURDEN (VA)		
		WITHDRAWABLE OR FIXED		
CONTROL SYSTEM INDICATION		CURRENT TRANSDUCER		
		VOLTAGE TRANSDUCER		
		POWER TRANSDUCER		
REFERENCE DOCUMENTS		I/O INTERFACE BLOCK		
		FUNCTIONAL & INTERFACE BLOCKDIAGRAM		
		PROTECTION AND CONTROL SCHEMATIC DIAGRAM		
POWER CABLES		QUANTITY		
		CORE PER CABLE		
		CORE AREA		
		TECHNOLOGY TYPE (NOTE 1)		
CONTROL CABLES		QUANTITY		
		CORE PER CABLE		
		CORE AREA		
		TECHNOLOGY TYPE (NOTE 1)		
		CABLE ENTRY		

NOTES

1. CABLE TYPE
P - PILCSWA(PAPER INSULATED LEAD COVER STEEL WIRE ARMOURED)
V - PVC, PVC, SWA, PVC
X - CROSS LINKED POLIUTHENE
2. CIRCUIT NUMBER TO BE PREFIXED BY THE SWITCHBOARD CODE LETTERS
3. SWITCHGEAR RATINGS
FAULT CURRENT - CONSIST OUT OF SHORT TIME WITHSTAND CURRENT AND PEAK WITHSTAND CURRENT
WITHSTAND VOLTAGE - CONSIST OUT OF SHORT DURATION POWER FREQUENCY WITHSTAND VOLTAGE AND LIGHTNING IMPULSE WITHSTAND VOLTAGE

REVISION DETAILS

REV NO.	REV DETAILS	DATE

Eskom

TITLE	11kV UNIT BOARD 1		
AKZ/KKS CODE	0 1BBA		
FUNCTION			
TYPE			
COMPILED BY		DATE	
CHECKED BY		DATE	
REVIEWED BY		DATE	
APPROVED BY		DATE	
DOCUMENT NUMBER		SHEET OF	
PRICE SCHEDULE NO		REVISION	