Eskom	Standard	Technology

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1. INTRODUCTION

1.1 This document contains the specification of Generation fixed pattern gas-insulated AC metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV for indoor installation in accordance with SANS 62271-200.

1.2 The basic requirements for design, manufacture, installation, operations and maintenance are defined in this specification as applicable in the power generation plants belonging to Eskom Generation Group.

1.3 The requirements for fixed pattern gas insulated metal-enclosed indoor primary 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 specification. 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.

1.4 This specification excludes requirements for generator circuit-breakers.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

2.1.1.1 The specification provides the Group Generation's specific and standardised requirements for Generation Fixed Pattern Gas Insulated Metal-Enclosed Indoor Primary Switchgear and Controlgear for Rated Voltages above 1kV up to and including 52kV.

2.1.1.2 A set of technical schedules A and B (240-109713946) accompanies this specification. Schedule A gives the relevant clause number of this specification unless otherwise indicated. Additional and special requirements may also be included in schedule A.

2.1.1.3 The specification covers the design, manufacture, testing, supply, delivery, storage, installation, pre-commissioning and guarantee of switchgear and controlgear specified herein.

2.1.2 Applicability

2.1.2.1 This document shall apply to the Eskom Holdings Limited; 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 specification. For referenced standards, the latest revision of the document shall apply.

2.2.1.1 Eskom Standards, Specifications, Regulations and Standard Drawings

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

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

[3] 240-56358929 Electronic Protection and Fault Monitoring Equipment for Power Systems Standard (Alt No. EST32-333)

[4] 240-56357424 MV and LV Protection Standard

[5] 240-54937450 Fire Protection & Life Safety Design Standard

[6] 240-86973501 Engineering Drawing Standard – Common Requirements

[7] 36-681 Plant Safety Regulations

[8] 0.00-10341-01 MV and LV Switchgear Lugs and Terminals

[9] 0.00-10341-02 MV and LV Switchgear Pre-Insulated Lugs and Sleeves.

[10] 0.00-10341-03 MV and LV Switchgear Wiring and Termination

[11] 0.00-10341-04 MV and LV Switchgear Circuit Function Letters

[12] 0.00-10341-05 MV and LV Switchgear Outdoor Isolator Padlock

[13] 0.00-10341-06 MV, LV and DC Switchgear Labels and Nameplate Details English Designation Only Arrangement Diagram.

[14] 0.00-10341-07 General Labels & Nameplate Details Arrangement Diagram

2.2.1.2 South African National Standard, Regulations, Codes of Practice and Specifications

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

[16] SANS 1091 National Colour Standards

[17] SANS 1574 Electric Cables- Flexible Cords and Flexible Cables

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

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

[20] SANS 61000 Electromagnetic Compatibility

[21] SANS 62271-206 High-voltage switchgear and controlgear Part 206: Voltage presence indicating systems for rated voltages above 1 kV and up to and including 52 kV

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

[23] SANS 62271-4 High-voltage switchgear and controlgear: Part 4: Handling procedures for sulphur hexafluoride (SF6) and its mixtures

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

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

[26] 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

2.2.1.3 International Standards and Specifications

[27] BS 4579 Specification for Performance of Mechanical and Compression Joints in Electric Cable and Wire Connectors.

[28] BS 6626 Maintenance of Electrical Switchgear and Controlgear for Voltages above 1 kV and up to and including 36 kV. Code of Practice.

[29] SANS 61869-2 Instrument Transformers Part 2: Additional Requirements for Current Transformer

[30] SANS 61869-3 Instrument Transformers Part 3: Additional Requirements for Inductive Voltage Transformers

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

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

[33] IEC 60376 Specification of technical grade sulphur hexafluoride (SF6) for use in electrical equipment.

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

[35] ISO 9001 Quality Management Systems.

2.2.2 Informative

The following documents (all parts including any amendments) contain provisions useful information that cover considerations related to the provisions of for this specification:

2.2.2.1 South African National Standards, Regulations, Codes of Practice and Specifications

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

[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 Standard for Low Voltage Switchgear and Controlgear (all parts)

[42] 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

[42] 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

2.2.2.2 International Standards and Specifications

[43] BS 3382 Specification for Electroplating Coatings on Threaded Components

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

[45] DIN 50050-1 Testing of Materials; Burning Behaviour of Materials; Small Burning Cabinet

[46] EN 50022 Mounting Rails. Top Hat Rails 35 mm Wide for Snap-on Mounting of Equipment

[47] EN 50035 Mounting Rails. G-profile for the Fixing of Terminal Blocks

[48] EN 50045 Mounting Rails. Top Hat Rails, 15 mm Wide for the Fixing of Terminal Blocks

[49] IEC 60038 Standard Voltages

[50] IEC 60417 Graphical symbols for use on equipment

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

[52] IEC 60898 Electrical Accessories – Circuit-breakers for Over-current Protection for Household and Similar Installations

[53] IEEE 142 Recommended Practice for Grading of Industrial and Commercial Power Systems

[54] EPRI 10003471 Electrical Connector Guideline

[55] ISO 898 Mechanical Properties of Fasteners made of Carbon Steel and Alloy Steel

2.3 DEFINITIONS

The definitions contained in IEC 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 and specified fault currents, but outside the normal system voltage and frequency.
Dummy Panel	A panel which is not intended to be used for any functional purpose but merely installed between two adjacent functional units to create space between them (i.e. to cross over a concrete beam).
Earth bar	Metallic bar forming part of the switchboard and used as a conductor for grounding such circuits as may be connected with it.
Electrical Life of Components	Usable operational life of equipment and components, in terms of the number of electrical operations, age, etc. in relation of the electrical design of the component.
Joggle chamber	Purpose-designed panel used to align the busbars of different types of

Definition	Description
	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.
Switchgear Panel/Panel	“Functional unit” in accordance with SANS 62271-200

2.3.1 Disclosure Classification

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

2.4 ABBREVIATIONS

Abbreviation	Description
AC	Alternating Current
AFLR	A-Classified, Front, Lateral, Rear
BS	British Standard
CoE	Centre of Excellence
CT	Current Transformer
DC	Direct Current
DIN	Code for German Standards
EPRI	Electric Power Research Institute
emf	Electromotive Force
HMI	Human Machine Interface
HRC	High Rupturing 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
HRC	High Rupturing Current
KKS	Kraftwerk Kennzeichen System
LSC	Loss of Service Continuity
LV	Low Voltage
mcb	Miniature Circuit-Breaker
MESG	Metal-Enclosed Switchgear and Controlgear

Abbreviation	Description
MV	Medium Voltage
NPS	Negative Phase Sequence
OHS	Occupational Health and Safety
ORHVS	Operating Regulations of High Voltage Systems
PM	Partitions Metallic
PPS	Positive Phase Sequence
RMS	Root Mean Square
RMU	Ring Main Unit
SANS	South African National Standards
THD	Total Harmonic Distortion
VT	Voltage Transformer
XLPE	Cross-linked Polyethylene

2.5 ROLES AND RESPONSIBILITIES

Group Technology, Generation Plant Engineering is the custodians of the standard and should ensure that acquisition of all Fixed Pattern Gas Insulated MV Metal-Enclosed Indoor Primary Switchgear and Controlgear is done in accordance to the provisions of this document.

2.6 PROCESS FOR MONITORING

Not applicable

2.7 RELATED/SUPPORTING DOCUMENTS

This document shall be used in conjunction with the following templates:

- 240-109713946: Technical A & B Schedule for Fixed Pattern Gas-Insulated Metal-Enclosed Indoor Primary Switchgear and Controlgear for rated voltages above 1kV up to and including 52kV.
- 240-141142647: Compliance Schedule for Fixed Pattern Gas-Insulated Metal-Enclosed Indoor Primary Switchgear and Controlgear for rated voltages above 1kV up to and including 52kV.
- 240-77300784: Electrical MV Switchgear Schedule Template
- 240-77301354: Electrical MV List of Switchboards Template.

3. SPECIFICATION FOR FIXED PATTERN GAS-INSULATED MEDIUM VOLTAGE METAL-ENCLOSED INDOOR PRIMARY SWITCHGEAR AND CONTROLGEAR

3.1 RATINGS AND OPERATING CONDITIONS

3.1.1 RATINGS

3.1.1.1 The ratings of the switchgear and controlgear, their operating devices and the auxiliary equipment shall be in accordance with the values specified in the enquiry documentation i.e. Switchgear schedules (240-77300784), Technical Schedules A and B (240-109713946), Electrical MV List of Switchboards Template (240-56356465) etc.

3.1.1.2 The associated temperature rise for the normal currents shall be in accordance with SANS 62271-200. All normal current ratings and associated temperature rises shall be based on natural air cooling. Forced air cooling will not be accepted.

3.1.1.3 For motor starters, the thermal ratings shall take into account the impact of the motor starting current and the number of starts per hour specified.

3.1.1.4 Rated voltage shall be in accordance with Table 1, this specification and the values specified.

3.1.1.5 The rated insulation levels of switchgear shall be in accordance with the values given in Table 1. The rated insulation levels offered shall be stated in schedule B.

Table 1: Rated voltage and insulation levels[1]

Nominal system voltage U_n *[kV (r.m.s.)]*	**Rated voltage U_r** *[kV (r.m.s.)]*	**Rated short-duration power-frequency withstand voltage U_d** *[kV (r.m.s.)]*		**Rated peak lightning impulse withstand voltage U_p** *[kV (peak)]*	
		Common value	**Across isolating distance**	**Common value**	**Across isolating distance**
3.3	3.6	10	12	60	70
6.6	7.2	20	23	75	85
11	12	28	32	95	110
15[4]	17.5	38	45	125	145

NOTES
1. The information in this table is extracted from SANS 62271-1 and SANS 1019.
2. In this table, the withstand voltage applies at the standardised reference atmosphere (temperature, pressure and humidity) in accordance with IEC 60071-1.
3. Due to the fact that fixed-pattern switchgear is gas-insulated and/or fully screened solid-dielectric insulated with no external insulation, no altitude correction in accordance with SANS 62271-1 is required.
4. The 15kV rated voltage and insulation levels were specifically added for the Kusile Power Station system voltage.

3.1.1.6 Rated frequency shall be in accordance with SANS 62271-200, this specification and the values provided.

3.1.1.7 Rated normal current and temperature rise shall be in accordance with SANS 62271-200, this specification and the values provided.

3.1.1.8 Rated short-time withstand current shall be in accordance with SANS 62271-200, this specification and the values provided.

3.1.1.9 Rated peak withstand current shall be in accordance with SANS 62271-200, this specification and the values provided.

3.1.1.10 Rated duration of short circuit shall be in accordance with SANS 62271-200, this specification and the values provided.

3.1.1.10.1 The rated duration of the short circuit (tk) or the main circuit (i.e. including busbars, circuit-breakers and disconnectors) and earthing switches shall be 3 seconds.

3.1.1.10.2 The rated duration of the short circuit (tke) or the earthing circuit (i.e. earthing bars of the earthing system) shall be 3 seconds.

3.1.1.11 Rated supply voltage of closing and opening devices shall be in accordance with SANS 62271-200, this specification and the values provided.

3.1.1.11.1 The rated d.c. supply voltage (Ua) of closing and opening devices, motorised disconnectors and of auxiliary and control circuits shall be 220 V.

3.1.1.11.2 The rated a.c. supply voltage (Ua) of a.c. auxiliary circuits shall be single-phase 230 V.

3.1.1.12 The circuit-breaker shall be capable of interrupting, making, latching against and able to withstand the specified fault duties at the maximum specified voltage.

3.1.1.13 The circuit-breaker shall be classified as Class E2 in accordance with SANS 62271-100 without reclosing.

3.1.1.14 The circuit-breaker shall be classified as Class M2 in accordance with SANS 62271-100.

3.1.1.15 Switch-disconnectors shall be classified as Class M1 in accordance with SANS 62271-102, if applicable.

3.1.1.16 Switch-disconnectors shall have the capability to withstand rated normal and fault current. The device shall have the capacity to break normal current but not necessarily the fault current, if applicable.

3.1.1.17 Earthing devices shall be classified as Class E2 in accordance with SANS 62271-102, as a minimum.

3.1.1.18 Earthing devices shall be capable of enduring a minimum of 2000 mechanical operations.

3.1.1.19 The short-circuit withstand current rating and insulation level of an earthing device shall match that of the panel. The duration for the test will be 3 seconds.

3.1.1.20 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.

3.1.2 Switchgear Operating and Service Conditions

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

3.2 PANEL DESIGN AND CONSTRUCTION

3.2.1 General Requirements

3.2.1.1 The switchgear and controlgear shall be of indoor use, gas-insulated, fixed-pattern metal-enclosed internal arc classified in accordance with SANS 62271-200 and this specification. Where conflicting requirements exist, the requirements of this specification shall take precedence.

3.2.1.2 The switchgear and controlgear shall be internal arc classified AFLR in accordance with SANS 62271-200, for a duration of 1 second in accordance with the technical schedule A short time withstand current rating.

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

3.2.1.4 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.

3.2.1.5 Circuit-breakers shall comply with the requirements of SANS 62271-100 and the requirements of this specification. Where conflicting requirements exist, the requirements of this specification shall take precedence.

3.2.1.6 Circuit-breakers shall be three-pole operated and designed for stored energy operation where energy is stored in a spring, unless otherwise approved by Eskom. It shall be possible to charge the circuit-breaker mechanism spring both manually and electrically. Electrical charging shall be via a spring charging motor. Both manual and electric energy release shall be provided. A mechanical device shall be provided to prevent over-charging of the closing spring when the manual charging facility is employed.

3.2.1.7 Circuit-breaker operating mechanisms shall be designed in such a way that in the case of failure to latch or for a command to trip during a closing operation, safe conditions are produced for the elements controlling the circuit-breaker.

3.2.1.8 Circuit-breakers shall be provided with a mechanical TRIP and CLOSE control facility. Only the TRIP control facility shall be available on the front of the circuit-breaker panel.

3.2.1.9 The interrupting medium of circuit-breakers shall be of vacuum type. The type of interrupting technology offered shall be stated in the technical schedule B.

3.2.1.10 Circuit-breaker mechanisms shall be designed as maintenance free or limited non-intrusive maintenance in accordance with the electrical and mechanical endurance class. They shall be accessible for inspection and maintenance without the need for opening the gas system (where applicable).

3.2.1.11 Disconnectors shall comply with the requirements of SANS 62271-102 and the requirements of this specification. Where conflicting requirements exist, the requirements of this specification shall take precedence. The type of disconnector offered (e.g. three-position disconnector) shall be stated in schedule B.

3.2.1.12 Each switchgear panel (functional unit) shall include a mimic indicating the ON, OFF and EARTH positions of the main circuit.

3.2.1.13 The switchgear shall be designed to provide maximum service continuity and reliability. Details regarding the procedure for the on-site replacement of a damaged/faulted panel in a switchboard, including the necessary in-situ gas-work (where applicable), shall be provided with the tender documentation

3.2.1.14 The switchgear shall be sealed for life with a minimum maintenance-free period of 30 years for all high-voltage parts. In the case of gas-filled compartments, this implies sealed pressure systems where the period to replenishment of the insulating medium shall not be less than 30 years. The insulating medium and maintenance-free period shall be stated in schedule B.

NOTES:

1. Sealed for life switchgear, which utilises, for example, gas-filled (e.g. dry air, SF6, etc.) sealed pressure system compartments and/or fully screened solid dielectric insulation technology, does not have any exposed or external insulation in ambient air and thus the performance thereof is not affected by the environment (ambient pollution, altitude, humidity, condensation, etc.).

3.2.1.15 In the case of gas-insulated switchgear, details of the effect of reduced internal gas-pressure on the operation, safety and insulation levels of the switchgear (down to atmospheric pressure) shall be provided with the tender documentation

3.2.2 Segregation of Compartments

3.2.2.1 General

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

a) Low voltage compartment

b) Circuit-breaker or Circuit-breaker and disconnector compartment

c) Main Busbar and Busbar VT or Main Busbar, Busbar VT and disconnector compartment

d) Power cable, CT and Cable VT compartment

3.2.2.2 Low Voltage Compartment

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

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

3.2.2.2.3 The IED operator panel/Human Machine Interface (HMI) is required to be mounted on the LV compartment door as either integrated with the IED or detached from the IED. The IED/s shall be in accordance with 240-56358929.

3.2.2.2.4 The compartment door shall be of swing frame design.

3.2.2.2.5 The locking mechanisms shall be in accordance with 0.00/10341 Sheet 5.

3.2.2.2.6 The low voltage compartment design shall allow for both the top and the bottom control cables entry.

3.2.2.2.7 Removable and drillable gland plates shall be fitted at the top left and right hand sides of the LV compartment for control cables top entry and glanding. Each gland plate shall have a minimum usable area of 150 mm x 100 mm.

3.2.2.2.8 The bottom control cables entry shall be provided on both the left and right hand sides of the LV compartment.

3.2.2.2.9. If required at the time of tender, the LV compartment door shall include a cut out aperture and a mounting plate for the mounting of the on-board protective, monitoring and control devices. The size and design of the cut-out aperture and mounting plate shall be provided at the time of tender.

3.2.2.2.10 LV compartment doors shall be equipped with travel stops, which shall retain the door in the open position.

3.2.2.3 Power Cable Compartment

3.2.2.3.1 The power cable terminations, CTs, cable VTs and cable earthing device shall be positioned and accessible inside the power cable compartment.

3.2.2.3.2 The panel shall be designed such that it allows for connection and disconnection of power cables, removal and replacement of CTs and cable VTs with the main busbars energised.

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

3.2.2.3.4 Access to the cable trench/slot shall be from the rear of the switchgear in the case of rear-entry Power cable compartment or from the front of the switchgear in the case of front-entry Power cable compartment.

3.2.2.3.5 Access to the Power cable compartment for the termination of the cables shall not be adversely obstructed.

3.2.2.3.7 Where ring type CTs are provided, the arrangement shall ensure that the live conductors passing through the CTs are fully insulated and screened.

3.2.2.3.8 Where ring-type CTs are provided around the power cables, the inner dimensions of the CTs shall accommodate the number and size of cables specified in the switchgear schedules. The arrangement shall be subject to approval by Eskom.

3.2.2.3.9 Accessibility to power cable compartment shall be in accordance with SANS 62271-200.

3.2.2.3.10 Cable earthing shall be provided via the circuit-breaker in combination with a three-position disconnector or as an integral cable earthing switch of minimum class E1 in accordance with SANS 62271-102. In the latter case, a cable earth mechanical interlocking system shall be provided to ensure that operation of the cable earthing switch is prevented unless the associated disconnector is only in the open (disconnected) position and the cable live indication system (VDS) confirms the cable is de-energised. The interlocking device shall prevent the disconnector from being closed when the associated cable earthing switch is closed.

NOTE:
The above requirement ensures that simultaneous busbar connection and earthing is prevented.

Cable live indication system (VDS) confirmation that the cable is de-energised is also required for cable earthing via the circuit breaker in combination with the three position disconnector.

3.2.2.4 Main Busbar and Busbar VT or Main Busbar, Busbar VT and disconnector compartment (Main busbar compartment)

3.2.2.4.1 The switchgear shall be of the single busbar design.

3.2.2.4.2 The main busbar compartment shall house the main busbars and busbar VT or, main busbars, busbar VT and disconnector.

3.2.2.4.3 Switchgear shall be of separate circuit-breaker or circuit-breaker and disconnector compartment, to the busbar and VT - or to the busbar, VT and disconnector compartment.

3.2.2.4.4 Earthing of the busbar shall be by means of the circuit-breaker in combination with a two/three-position disconnector. Alternatively, an integral busbar earthing switch of minimum class E1 in accordance with IEC 62271-102 shall be provided.

NOTE:
The following two options are considered for earthing devices (refer to Section 3.6):
a) Busbar earthing via the circuit-breaker in combination with a disconnector; or
b) Busbar earthing via a separate integral earthing switch.

3.2.2.4.5 The busbar earthing device shall require the switchboard and all incoming supplies to be confirmed isolated and the busbar live indication system (VDS) confirms the busbar is de-energised. The isolations shall comply with requirements of ORHVS (240-114967625) and PSR (36-681).

3.2.2.4.6 The busbar earthing device shall be operated from the front.

3.2.2.4.7 The busbar earthing device shall be of the fixed type.

3.2.2.4.8 The busbar VT shall be of the fixed type.

3.2.2.4.9 The busbar VT shall be mounted in the incomer panel.

3.2.2.4.10 Accessibility to the busbar compartment shall be in accordance with SANS 62271-200.

3.2.2.5 Circuit Breaker or Circuit Breaker and Disconnector Compartment

3.2.2.5.1 Circuit-breaker- or circuit-breaker and disconnector compartment shall be gas-insulated.

3.2.2.5.2 A dedicated compartment shall be provided to house the circuit-breaker or circuit-breaker and disconnector.

3.2.2.5.3 The circuit-breaker shall be of fixed mounted type.

3.2.2.5.4 The compartment of the fixed mounted device shall not be an operator-accessible compartment.

3.2.3 Service Continuity Classification

3.2.3.1 The loss of service continuity category shall be LSC2 in accordance with SANS 62271-200.

> NOTE:
>
> Loss of service continuity is only applicable to accessible compartments. In the case of fixed pattern gas-insulated switchgear, it is therefore only applicable to the cable compartment.

3.2.4 Partition Class

3.2.4.1 Partition class “PM” classification (i.e. metallic partitions) in accordance SANS 62271-200.

3.2.5 Special Labelling for Internal Arc Classified Boards

3.2.5.1 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 to fulfil the IAC requirements, the switchboard shall be labelled to provide warning messages to people working on the panels.

3.2.5.2 The following is the prescription for the warning labels required:

3.2.5.2.1 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.

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

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

3.2.6 Cooling

3.2.6.1 All normal current ratings and associated temperature rises shall be based on natural air cooling. Forced air cooling will not be accepted.

3.2.7 Degree of Protection

3.2.7.1 The various parts of switchgear panel shall have the following minimum degrees of protection in accordance with SANS 60529:

a) IPXXD for Live parts
b) IP4X for screened busbars where applicable;
c) IP4X for cable compartment; and
d) IP65 for gas-filled compartments.

3.2.8 Panel Fasteners, Doors and Covers

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

3.2.8.2 If the panel fastener is also the locking mechanism, provision shall be made for a padlock with dimensions as specified in drawing number 0.00-10341-Sheet 05.

3.2.8.3 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 removable if the cable earth switch is applied.

3.2.8.4 All circuit-breaker/circuit breaker and disconnector compartment doors/covers housing a circuit-breaker shall have a mimic indicating the configuration of the breaker, earthing device and disconnector, including their statuses.

3.2.8.5 All power cable compartments shall be fitted with a bolted cover in addition to the interlocking provided.

3.2.8.6 Empty compartments in dummy panels shall be fitted with bolted covers.

3.2.8.7 Where doors are provided for empty compartments, the doors shall be pad-lockable.

3.2.9 Corrosion Protection

3.2.9.1 Steelwork shall be protected against corrosion in accordance with the specification 240-75655504.

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

3.2.10 Colour Coding

3.2.10.1 Switchboard parts that need to be painted are painted per system voltage. Table 2 below provides specification for colour coding of the boards of different voltage ratings.

Table 2: Colour Coding of Switchboards.

Voltage (kV)	Colour Code	Colour Name
15	Local H09 Imported RAL 6028	Pine green
11	Local H09 Imported RAL 6028	Pine green
6.6	Local B32 Imported RAL 2000	Yellow-Orange
3.3	Local B32 Imported RAL 2000	Yellow-Orange

3.2.11 Busbars and Connections

3.2.11.1 The main busbars and connections inside the busbar compartment shall be gas insulated or solid dielectric and screened.

3.2.11.2 Cables shall not be used as part of the busbars.

3.2.11.3 All busbars connection points shall be marked in such a manner that they are easily identifiable as to the phase or pole they are connected to. The material used for marking the busbars is subject to Eskom acceptance.

3.2.11.4 The busbar connections between each panel shall be of the plug-in type and shall be type tested.

3.2.11.5 The busbar connections/sections shall be sealed to avoid ingress of contaminants that might degrade the connection.

3.2.11.6 The gas-insulated busbar sections of the single panels shall allow for easy exchange of a cubicle without or with limited SF6 works required.

3.2.11.7 In the case of solid dielectric insulated busbar systems, the complete busbar system, including all busbar connections shall be fully screened.

3.2.11.8 Corrosion protection shall be applied for all exposed joints and tees in busbar connections.

3.2.12 Busbar bushings and insulators

3.2.12.1 Moulded type bushings shall be used as the connection between circuit-breakers and busbar compartments.

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

3.2.13 Insulating Materials

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

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

3.2.14 Auxiliary Circuit Wiring

3.2.14.1 The wiring, terminals, lugs, identification and installation shall be in accordance with 240-56358929 and the requirements of this specification.

3.2.14.2 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.

3.2.14.3 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).

3.2.14.4 Control wire sheaths shall be coloured as follows:

3.2.14.4.1 AC circuits: Black

3.2.14.4.2 DC circuits: Grey

3.2.14.4.3 Earthing: Green and yellow

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

3.2.14.4.4.1 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.

3.2.14.4.4.2 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.

3.2.14.5 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 mm² each.

3.2.14.6 Gland plates for top entry 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 provided for that specific panel. Allowance shall be made for any possible inter-panel or looped bus wiring, from low voltage compartment to low voltage compartment.

3.2.14.7 Flexible cables shall be brought into the low voltage compartment, within a separate channel from the power cable compartment. The specification of the flexible cables for control wiring shall be in accordance with SANS 1574.

3.2.14.8 To facilitate LV control cable entry and connection, the distance between any part of the terminal strip and the top or bottom entry gland plate shall not be less than 150 mm. The terminal strips shall be positioned and spaced to provide easy access to the terminals to insert the wiring.

3.2.15 Power Cable Entry and Termination

3.2.15.1 Power Cable Termination

3.2.15.1 Cable compartments shall be suitable for the following cable termination types in accordance with SANS 876:

3.2.15.1.1 Type 4 cable terminations (outside cone screened separable connectors) – as shown in **Error! Reference source not found.**; or

3.2.15.1.2. Type 5 cable terminations (inside cone screened separable connectors) – as shown in **Error! Reference source not found.**.

3.2.15.2 Cable compartment design and construction (i.e. distances from cable support clamps to terminal fixing points, etc.) shall comply with the requirements of SANS 876.

3.2.15.3 All switchgear panels shall be designed to accommodate the number, type and size of cables specified in the switchgear schedules.

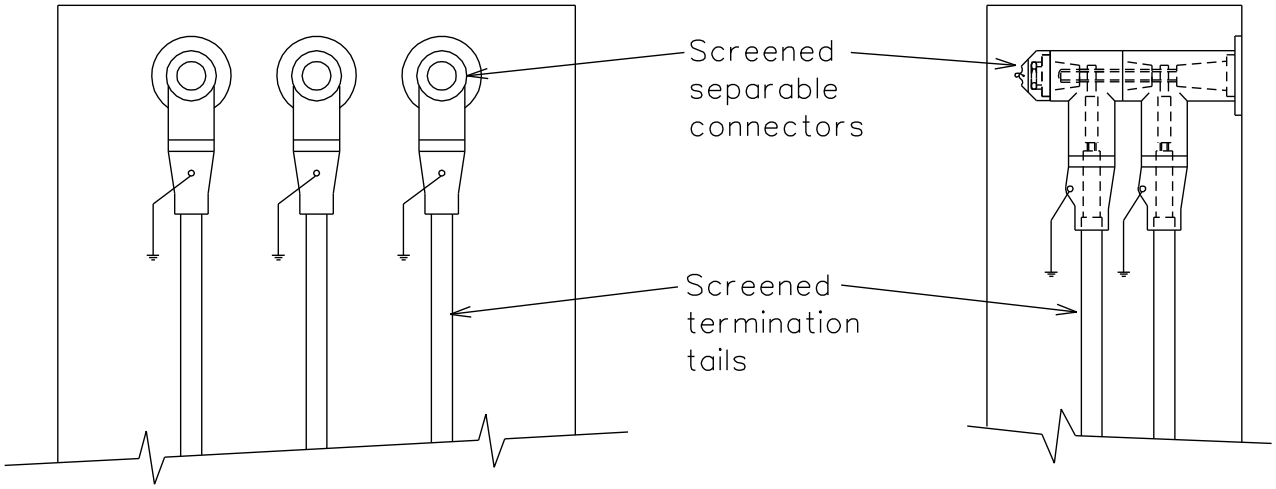

Figure 1: Type 4 cable termination for 1-core cables

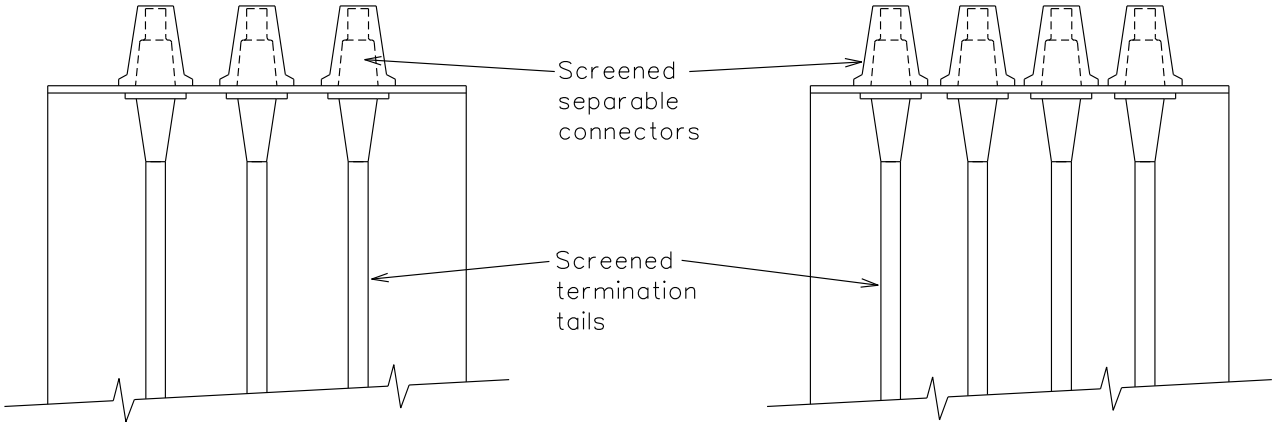

Figure 2: Type 5 cable termination for 1-core cables

3.2.15.4 Individual cable support clamps in accordance with SANS 876 and suitable for the cables specified in the switchgear schedule shall be fitted for each 1-core cable.

3.2.15.5 The distance from the cable support clamp centerline to the bushing centerline shall be in accordance with Table 3 and as shown in **Error! Reference source not found.**.

Table 3: Distance from bushing centerline to the cable support clamp

1	2	3	4
Symbol for clearance (**Error! Reference source not found.**)	**Cable type and size**	**Distance** *[mm]*	
		Voltage rating of panel *[kV]*	
		12	24 and 36
e	Single-core cables : All sizes	600	600

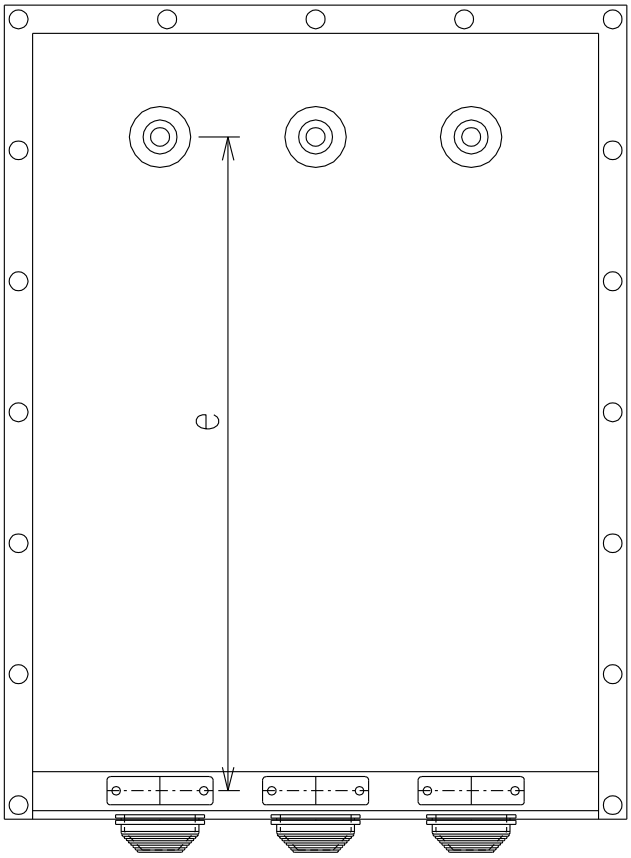

Figure 3: Typical cable compartment for type 4 cable terminations showing distance from cable support clamp to bushing centerline

3.2.15.4 Where vermin proofing plates are provided to seal off the bottom of the cable compartment, the plates shall be manufactured from a non-ferrous metal to prevent iron losses (induced eddy currents). The vermin proofing plates shall have pre-drilled/punched cable entry holes that are positioned to correspond with the cable support clamp positions. Each hole in the vermin proofing plates shall be fitted with a grommet having a range-taking capability at least equivalent to that of the cable support clamp. The number of holes provided in the vermin proofing plate shall be suitable to accommodate the number of cables to be installed as indicated in the switchgear schedules.

3.2.15.4 Suitably positioned copper earthing bars in accordance with **Error! Reference source not found.** shall be provided in each cable compartment for the connection of each cable termination main earthing conductor and where applicable for type 4 termination, the screen earth conductor. No more than two cable termination main earthing conductors shall be connected per hole (i.e. no more than one back-to-back connection per hole provided in the copper earthing bar). Each hole in the earthing bar shall be fitted with an M12 stainless steel or brass set screw, washer, spring washer and nut. The copper earthing bar(s) in each cable compartment shall be connected to the switchgear main earthing bar.

3.2.15.2 Gland Plates

3.2.15.2.1 If required, 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.

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

3.2.15.2.3 For single-core cables or tails, non-ferrous or split-stainless steel gland plates shall be used to eliminate eddy currents.

3.2.15.3 Cable Entry Arrangements

3.2.15.3.1 The minimum requirements shall be as per SANS 876. Distance from terminal centre line to gland plate or cable clamping bar (if applicable).

3.2.15.3.2 Requirements for cable entry are as follows:

3.2.15.3.2.1 Entry of one three-core cable with a trifurcating kit that splits the three core cable in three single core tails (one single core tail per phase).

3.2.15.3.2.2 Entry of two three-core cables in parallel with trifurcating kits that splits the three core cables in six single core tails (two single core tails per phase)

3.2.15.3.2.3 Entry of multiple single-core cables. Single core cables shall either be armoured or un-armoured.

3.2.15.3.2.4 Provision shall be made for the required non-magnetic glands (clamps) or split gland plates.

3.2.15.4 Vermin and Fire Proofing of Cable Compartment and LV Compartment

4.2.15.4.1 All switchgear boundary elements of a specified fire zone, which includes cable entries (power and control), shall be designed to be sealed off with fire retardant material of at least 50 mm thick at floor level, after all cables have been installed, in accordance with 240-54937450.

4.2.15.4.1 Fire barrier/Fire retardant material has a fire rating of two hours minimum in compliance with the fire resistance criteria for insulation, stability and integrity as specified.

3.2.15.4.2 The space provided shall allow for the fire retardant material to be filled such that during an internal arc in the cable compartment there shall be no pressure release or any smoke or heat to the front, rear, in the cable trench or tunnel or any adjacent compartments and functional units.

3.2.16 Earthing

3.2.16.1 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.

3.2.16.2 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.

3.2.16.3 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.

3.2.17 Dummy Panels

3.2.17.1 The dummy panel shall be designed and constructed using the same standards as those of the type tested panel.

3.2.17.2 Where dummy panels are installed the main busbars shall not be accessible from the dummy panel.

3.2.18 Insulation requirements for gas-filled compartments (where applicable)

3.2.18.1 All gas-filled compartments that do not require gas-filling on site shall be factory gas-filled with new gas and tested at the rated filling pressure.

NOTE: Preference will be given to factory assembled, factory gas-filled and factory tested compartments.

3.2.18.2 No routine gas replenishment shall be required during normal service. This implies that the period to replenishment of the gas will be not less than 30 years. The maximum gas leakage rate per year for all gas-filled compartments shall be stated in Schedule B. The quantity of gas required for each separately filled compartment shall be stated in Schedule B.

3.2.18.3 SF6 gas shall comply with the requirements of IEC 60376.

3.2.18.4 Where applicable, a certificate guaranteeing SF6 purity to IEC 60376 shall be supplied with the switchgear. The following parameters shall be checked, recorded and a report submitted to Eskom after filling:

3.2.18.4.1 SF6 content – not less than 98%

3.2.18.4.2 Dew-point at rated filling pressure – at least -30˚C

3.2.18.7 The following requirements are applicable to gas-filled compartment filling and pressure monitoring:

3.2.18.7.1 When provided, a gas filling/evacuation point with a DILO DN8 connection shall be provided for each gas-filled compartment.

3.2.18.7.2 The gas filling/evacuation point and the gas pressure gauge shall be separated i.e. it shall not be necessary to remove the pressure gauge in order to access the filling/evacuation points.

3.2.18.7.3 A gauge responding to gas density and indicating gas pressure compensated for temperature shall be provided for each circuit-breaker/compartment and installed in such a position that it can be easily read when viewed from the front of the switchgear and from ground level. Alternative solutions, such as the use of gas pressure sensors/devices with discreet gas status indications (e.g. red and green), may be accepted and will be subject to approval by Eskom.

3.2.18.7.4 A gas density monitoring device (density switch), which may also be integrated into the dial type gauge as a dual function device, shall be provided. The density monitoring device switch shall provide the necessary contacts.

3.2.18.7.5 Electrical interlocks and alarms to be provided by the gas density monitoring device to ensure the safety of the equipment and personnel.

3.2.18.7.6 Pressure gauges shall be numerically marked and calibrated in Pascal's (kPa or MPa). Only gauge pressure shall be indicated and rated pressure shall be no more than 80% of the full-scale reading. Gauge markings shall be clearly labelled 'Absolute' for gauges measuring absolute pressure or 'Atmospheric' for gauges measuring pressure exclusive of the atmosphere.

3.2.18.7.7 The density monitoring device shall give a positive and reliable response on reaching the operating values (no contact bounce).

3.2.18.7.8 The type of gauge utilised shall be designed such as to prevent any corrosion of moving parts and contacts inside the gauge.

NOTE: Gauges filled with an inert gas to prevent corrosion and the ingress of moisture are acceptable.

3.2.18.7.9 Non-return valves shall be fitted on all DN8 fittings. The gas pressure shall be maintained in the system when the density monitoring device is removed or replaced. The supplier shall provide the details of the arrangements offered.

3.2.18.7.10 Any exposed pipe work shall be made of stainless steel or copper and mounted in such a manner that it is mechanically protected.

3.2.18.7.11 Device actuation and de-actuation differentials shall be consistent over the ambient temperature range as specified in clause 3.1.2.

3.2.18.7.12 Complete details of all gas pressure devices, including drawings, manufacturer's specifications, performance and test data, details of production tests and a quality control programme, shall be provided.

3.2.18.19 Where applicable, gas storage vessels shall be manufactured and tested in accordance with a code of practice recognised by the OHS Act. Measures shall be taken to prevent ingress of contaminants such as moisture and dirt as well as over-pressurising during the gas-filling process.

3.2.18.20 Where applicable, the management of SF6 gas shall be in accordance with NRS 087.

3.2.18.21 In the case of SF6 switchgear, the supplier shall render a service to recover and replenish SF6 gas after its service life.

3.3 SPECIAL CONDERATION FOR INTERNAL ARC PROOF DESIGN

3.3.1 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.

3.3.2 Each functional unit shall contain the arc without spreading it to any other functional unit.

3.3.3 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.

3.3.4 Where additional ducting is required in order to achieve the specified internal arc classification, this shall be stated in schedule B and details shall be provided with the tender documentation.

3.3.5 Where internal arc absorbers/coolers are offered, this shall be stated in schedule B and details shall be provided with the tender documentation (refer to **Error! Reference source not found.**). Preference will be given to switchgear offering integrated arc absorbers/coolers. Any ducting system for internal arc pressure relief/absorption shall be a type tested design.

3.3.6 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.

NOTE: For fixed pattern gas insulated switchgear, ducting is not required to exhaust the internal arc by-products outside the substation

3.4 CIRCUIT BREAKERS

3.4.1 General

3.4.1.1 Circuit-breakers are in accordance with SANS 62271-100 and this specification. Where conflicting requirements exist, the requirements of this specification shall take precedence.

3.4.1.2 Circuit-breakers are of the triple-pole fixed pattern with visible indication which is mechanically interlocked with the circuit-breaker.

3.4.1.3 The arc-quenching medium and/or insulation are of the type as stated in Schedule A.

3.4.1.4 The use of oil as an-quenching medium is not acceptable.

3.4.1.5 Total break time is as defined in SANS 62271-100 and is not greater than the time duration specified, under all operating conditions.

3.4.2 Mechanisms

3.4.2.1 Mechanisms as per SANS 62271-1, SANS 62271-100 and SANS 62271-200 shall be provided.

3.4.2.2 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.

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

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

3.4.2.5 All operating coils of solenoid coil contactors shall be continuously rated while the contacts may be short-time rated in accordance with the current drawn for the operating time. A normally-closed auxiliary contact is to be wired in series with the closing coil.

3.4.3 Tripping Devices

3.4.3.1 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.

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

3.4.3.3 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.

3.4.3.4 Circuit-breakers design shall make provision for the installation of an under voltage release coil as per the voltage specified (i.e. 220V, 110V, 24V).

3.4.3.5 This under voltage release coil shall form an integral part of the design of the circuit-breaker complete with interlocking operating below 35% of nominal voltage.

3.4.3.6 Where a circuit breaker is used for safety application, such as Boiler/Turbine Protection Systems, it shall meet the specified safety integrity level (SIL) requirement as a minimum. A confirmation that the safety requirement is met must be provided to Eskom with tender submissions in the form of a certification, datasheet, specification, etc.

3.4.4 Indicating Devices

3.4.4.1 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:

a) ON or I -white lettering on a red background

b) OFF or O -white lettering on a green background

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

3.4.4.3 The circuit-breaker closing spring status (charged or discharged) shall be indicated by a mechanical device, which is clearly visible with the mechanism enclosure closed. The words “SPRING CHARGED” and “SPRING DISCHARGED” or the symbols for “SPRING CHARGED” and “SPRING DISCHARGED” shall be displayed in black lettering on a white background.

NOTE:

Where electromagnetic mechanisms are offered, appropriate terminology will be required (e.g. “CAPACITORS CHARGED”, etc.).

3.4.4.4 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 plus 1000 operations to prove the reliability of the indicating mechanism.

3.4.5 Auxiliary Contacts

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

3.4.5.2 Auxiliary contacts positively follow the action of the main contacts.

3.4.5.3 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.

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

3.4.6 Additional Circuit Breaker Auxiliary

3.4.6.1 Under-voltage release (No Voltage coil) - below 35% of the rated supply voltage.

3.4.7 Insulation Level

3.4.7.1 The insulation level of all circuit-breaker circuits, busbars and busbar connections shall be in accordance with the values specified in the switchgear schedules.

3.4.7.2 No insulation material shall be used that are of the design to degrade below acceptable insulation levels specified over time or cause the partial discharge of the panel to increase due to ageing or possible dust collection.

3.4.7.3 Where insulating materials are part of the integral design of the switchgear, the life expectance shall be guaranteed by testing.

3.5 DISCONNECTORS

3.5.1 Disconnectors are in accordance with SANS 62271-102 and this specification. Where conflicting requirements exist, the requirements of this specification shall take precedence.

3.5.2 All disconnectors shall be of the triple-pole, gang-operated type.

3.5.3 The disconnector can be of three-position type combining the functions of a disconnector and that of an earthing switch. The type of disconnector offered (e.g. three-position disconnector) shall be stated in schedule B.

3.5.4 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, closed or earthed shall be provided.

3.5.5 All disconnectors shall be operated from the front and outside of the panel by means of a handle.

3.5.6 Provision shall be made for a mechanism that enables padlocking in the “ON”, “OFF” and Earthed positions to inhibit operation of the disconnector. The padlocking mechanism shall allow for use of a padlock with dimensions as specified in drawing number 0.00-10341 Sheet 5.

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

3.5.8 Where applicable, the following symbols and colours shall be used to indicate the position of a switching device:

a) closed position: “I” in white lettering on a red background

b) open position: "O" in white lettering on a green background

c) earthed position: ⏚ (the earth symbol) in black on a yellow background

3.5.9 Lettering size shall be at least 10 mm, unless otherwise approved by Eskom. The method of securing the labels shall be as per the requirements of this specification.

3.5.10 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.

3.5.11 Each disconnector shall be motorised using an integral internal motor.

3.5.12 The auxiliary supply for the motorised disconnecting device shall be 220 V d.c. The continuous power rating of the motor together with the total disconnecting time (i.e. time taken for the motor to operate the disconnector) shall be stated in schedule B. The motorised disconnecting device shall be suitable for operating at any voltage between 85% and 110% of the rated control voltage measured at the device terminals.

3.5.13 Disconnector switching motor control circuit shall accept pulsed operating (e.g. open / close) signals and which ensure that the required operation is fully completed.

3.5.14 The pulsed operating signals are provided via a remote switch interfaced via terminals which shall be provided in the corresponding LV compartment.

3.5.15 Manual operation of the disconnector shall be possible in the event of an emergency.

3.5.16 The operation of the disconnector shall only be possible when the circuit-breaker is in the open position. A suitable interlocking mechanism shall be provided for this requirement.

3.6 EARTHING DEVICES

3.6.1 General

3.6.1.1 The switchgear design shall include busbar and cable earthing device as an integral part of the associated functional unit.

3.6.1.2 Earthing device shall be an integrated earthing switching except for cases where a circuit-breaker is used as an earthing device.

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

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

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

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

3.6.1.7 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.

3.6.1.8 Where applicable, the following symbols and colours shall be used to indicate the position of switching device:

a) Earthed position: ⏚ (the earth symbol) in black on a yellow background

3.6.1.9 Lettering size shall be at least 10 mm, unless otherwise approved by Eskom. The method of securing the labels shall be as per the requirements of this specification.

3.6.1.10 All mechanical indicators shall be clearly visible from the front of the panel and are type test for the number of operations of the operating device.

3.6.2 Busbar Earthing Devices

3.6.2.1 Busbar earthing devices shall be provided for the main busbars.

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

3.6.2.3 The busbar earthing functionality shall be provided by the bus section panels or a separate busbar earthing panel or a separate integral earthing switch in the incomer panel.

3.6.3 Cable Earthing Device

3.6.3.1 Cable earth switches shall be provided for all incoming and feeder circuit panels.

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

3.6.3.3 Cable earthing device shall be connected between all three phases of the cable terminals and main earth bar.

3.7 ACCESSORIES

3.7.1 Current Transformers

3.7.1.1 Current transformers shall comply with SANS 61869-2.

3.7.1.2 Each functional unit shall be equipped with current transformers as specified in the switchgear schedules.

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

3.7.1.4 The short-time (thermal) and dynamic (peak) withstand current rating of current transformers shall not be less than that of the associated circuit-breaker.

3.7.1.5 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 isolating links. The isolating links shall not be removable from the terminal.

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

3.7.1.7 Additional rating plates made of a durable material shall be provided with permanent 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 in a conspicuous place within the low voltage compartment.

3.7.1.8 The phase colour with which each current transformer is associated shall appear beneath each rating plate.

3.7.1.9 CTs shall be properly fixed and mechanically supported so that no movement is allowed during transportation of service fault conditions.

3.7.1.10 CTs shall not be located inside any gas-filled compartment, unless accessible through suitably positioned repair openings. Unless otherwise approved by Eskom, CTs shall be accessible with only the circuit-side disconnected (isolated) for removal/replacement without extensive dismantling of the switchgear.

3.7.1.11 Where cable compartment block-type CTs in ambient air are provided, these shall be fully insulated and screened.

3.7.1.12 Where ring type CTs are provided, the arrangement shall ensure that the live conductors passing through the CTs are fully insulated and screened.

3.7.1.13 Where ring-type CTs are provided around the power cables, the inner dimensions of the CT shall accommodate the number and size of cables specified in the switchgear schedules. The arrangement of the CTs shall be subject to approval by Eskom.

3.7.2 Voltage Transformer

3.7.2.1 VTs shall comply with SANS 61869-3.

3.7.2.2 Each functional unit shall be equipped with voltage transformers as specified in the switchgear schedules.

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

3.7.2.4 VTs shall be of the single-phase design, fully insulated and screened.

3.7.2.4 Busbar and Cable VTs shall be of the plug-in type.

3.7.2.5 VTs shall be interchangeable as individual phases.

3.7.2.6 The primary side of busbar VT shall be connected to the busbars through adequately rated HRC fuses. It shall not be possible to gain access to these HRC fuses with the VT in service.

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

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

3.7.2.11 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.

3.7.2.12 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.

3.7.2.13 The VT shall be connected to the earth bar by means of isolating links. The isolating links shall be removable from the terminal by use of a tool. The links shall be accessible and safe to remove with the VT racked out.

3.7.1.7 Additional rating plates made of a durable material shall be provided with permanent markings as per SANS 61869-3. The information on the additional rating plates shall be duplicated from that appearing on each voltage transformer and shall be located in a conspicuous place within the low voltage compartment.

3.7.1.8 The phase colour with which each voltage transformer is associated shall appear beneath each rating plate.

3.7.2.14 Suitable protection shall be provided to prevent ferro-resonance.

3.7.2.15 The busbar VT shall be located in the bus section panel or a separate panel housing both the VT and the busbar earth-switch or in the incomer panel.

3.7.2.16 A suitable means to disconnect the VT from the busbar shall be provided.

3.7.3 Indicating and Measurement Instruments

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

3.7.3.2 Transducers shall comply with IEC 60688.

3.7.4 Selector Switches

3.7.4.1 All selector switches shall be of the pistol-grip type.

3.7.4.2 The selector switches shall comply with 240-56358929.

3.7.5 Cable Live Indicators

3.7.5.1 Cable live indicators shall be installed on all outgoing and incoming cable and transformer circuits.

3.7.5.2 Cable live indicators shall comply with SANS 62271-206.

3.7.5.3 An “integrated” voltage detection system (VDS) with fixed voltage indicators and test points shall be provided.

3.7.5.4 The VDS systems shall be fitted above the cable compartment door. A spare status contact from each VDS shall be wired to terminals in the LV compartment

3.7.6 Terminals

3.7.6.1 Material and Construction

3.7.6.1.1 Terminals shall be in accordance with 240-56358929, of the types as shown on drawing 0.00-10341 Sheet 1 and 0.00-10341 Sheet 3 and adhering to the limitations as indicated on the drawing.

3.7.6.2 Mounting

3.7.6.2.1 Rail mounted terminal blocks shall comply with the requirements for the dimensions of mounting rails in accordance with 240-56358929.

3.7.6.3 Types

3.7.6.3.1 The terminal types shall be selected for voltage and current rating application in accordance with 240-56358929.

3.7.6.3.2 Instrument test blocks or terminals shall be provided in the relevant low voltage compartment to facilitate connecting of external instruments in the various current and voltage transformer secondary circuits.

3.7.6.3.3 The test block or terminal shall be accessible from the front of the terminal without opening the low voltage compartment door.

3.7.6.3.4 Test blocks and terminals shall have terminal strips and links for performing the various short-circuiting and bridging functions.

3.7.6.3.5 Test blocks and terminals shall have removable covers, which shall be secured in position.

3.7.6.3.6 The test blocks and terminals shall automatically perform the short-circuiting or bridging functions when the test block covers are removed.

3.7.7 Wiring and Cable Lugs

3.7.7.1 Control wiring lugs and their application with different types of terminals shall be in accordance with 240-56358929 and as detailed on Drawing 0.00-10341 Sheets 1 to 4.

3.7.7.2 Crimping on of power lugs shall be in accordance with BS 4579. Crimping tools shall be re-calibrated according to their manufacturer's specifications. The crimped area shall be equal to the conductor square area.

3.7.8 Labels

3.7.8.1 All labels shall be in accordance with labelling specifications found in 0.00-10343 Sheets 1 and 2.

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

3.7.9 Nameplates

3.7.9.1 Each switchboard nameplate shall be provided with a nameplate which complies with the specifications found in 0.00-10343 Sheets 1 and 2.

3.8 SWITCHGEAR INTERLOCKING SYSTEMS

3.8.1 Safety interlocks shall be provided for the fixed pattern switchgear to ensure that:

3.8.1.1 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.

3.8.1.2 A cable earth mechanical interlocking system shall be provided to ensure that operation of the cable earthing switch is prevented unless the associated disconnector is only in the open (disconnected) position.

3.8.1.3 The cable earthing interlocking system shall use a contact from the cable live indication system to prevent the cable earth being applied to a live cable. The design shall be such that no improper situations can occur in case of lack (failure) of auxiliary supply. Alternative interlocking systems providing the same functionality may be accepted. The interlocking system shall be subject to acceptance by Eskom.

3.8.1.4 Any operation of the disconnector shall only be possible when the circuit breaker is in the open position, a suitable interlocking mechanism shall be provided for this requirement.

3.8.1.5 A disconnector is prevented from being closed when the associated cable earthing switch is closed. The above requirement ensures that simultaneous busbar connection and earthing is prevented.

3.8.1.6 Where a circuit-breaker is used for earthing, the electrical tripping circuit of the circuit-breaker shall be disconnected when in the earthing (EARTH) position.

3.8.1.7 A busbar earth interlocking system shall be provided to ensure that operation (i.e. Closing) of the busbar earthing switch or closing of the busbar earthing circuit-breaker shall be prevented unless all disconnectors (of the relevant bus-section to be earthed) are only in the open (disconnected) or earthed positions. The busbar earthing interlocking shall use a contact from the busbar live indication system as an additional measure to prevent earthing of a live busbar.

3.8.1.8 The interlocking system shall eliminate the possibility of closing any of the disconnectors while the busbar earth is applied. The design shall be such that no improper situations can occur in case of lack (failure) of auxiliary supply. Alternative interlocking systems providing the same functionality may be accepted. The interlocking system shall be subject to approval by Eskom.

3.8.1.8 Positive mechanical interlocking shall be provided to prevent inadvertent switching from the ON position to the EARTH position without a definite stop in the OFF position, or from the EARTH position to the ON position without a definite stop in the OFF position.

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

3.8.1.11 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.

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

3.9 TESTING

3.9.1 Type Test

3.9.1.1 Only type tested functional units shall be accepted for use in Eskom. The type tests shall be carried out on all types of functional units in accordance with SANS 62271-200.

3.9.1.2 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. The components shall be tested to be in compliance with Eskom specification.

3.9.1.3 CTs shall be type tested in accordance with SANS 61869-2.

3.9.1.4 VTs shall be type tested in accordance with SANS 61869-3.

3.9.1.5 Cable live indicators shall be type tested in accordance with SANS 62271-206.

3.9.1.6 The tested functional unit and associated components shall be a credible representation of the equipment under consideration.

3.9.1.7 Type test authorities for switchgear and controlgear shall be accredited in accordance with ISO 17025.

3.9.1.8 All type tests shall be verified and accepted by Eskom before manufacturing can start.

3.9.2 Routine Tests

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

3.9.2.2 Routine tests shall be conducted in a reputable testing facility that is acceptable to Eskom.

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

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

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

3.9.2.6 All the other components forming part of the functional unit shall be tested in accordance with the applicable standards to prove functionality and compliance with the relevant Eskom specifications.

3.9.2.7 If the prototype board is considered, a full range of required routine tests shall be conducted on it.

3.9.3 Special Tests

3.9.3.1 The following special tests shall be performed on all types of designs:

3.9.3.1.1 Mechanical Impact Test

3.9.3.1.1.1 The mechanical impact test shall be carried out on all types of functional units in accordance with SANS 62271-200.

3.9.3.1.2 Partial Discharge Test

3.9.3.1.2.1 The partial discharge test shall be carried out on all types of functional units in accordance with SANS 62271-200.

3.9.3.1.3 Internal Arc Compliance with open LV compartment door.

3.9.3.1.3.1 The internal arc test shall be carried out in accordance with SANS 62271-200 for AFLR with the LV compartment door open. The magnitude of the fault current shall be in accordance with the switchgear schedules and the duration of the test shall be a minimum of 1 second.

3.9.3.1.3.2 The test shall be carried out on all power compartments, which are busbar, circuit-breaker and cable compartment.

3.9.3.2 Type test authorities used to perform special tests shall be accredited in accordance with ISO 17025.

3.9.3.3 All special tests shall be verified and accepted by Eskom before manufacturing can start.

3.10 MAINTENANCE

3.10.1 Maintenance Tools

3.10.1.1 Any special tools or keys that may be required for maintenance or for adjustments shall be provided.

3.10.2 Maintenance Instructions

3.10.2.1 The works instructions or procedures shall be provided by the original equipment manufacturer detailing descriptions of the maintenance work in accordance with BS 6626 and SANS 62271-1.

3.10.2.2 The procedure shall cover the requirements for maintenance of the equipment over the design life.

3.11 DOCUMENTATION

3.11.1 Language

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

3.11.2 Type Test Reports

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

3.11.2.2 The information to be included in type test reports shall be in accordance with SANS 62271

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

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

3.11.2.5 Softcopies shall be provided for all type test documentation.

3.11.3 Manuals

3.11.3.1 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.

3.11.3.2 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.

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

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

b) Technical descriptions of the equipment and component parts

c) General arrangement drawings

d) Installation instructions with drawings or pictures

e) Operating and maintenance instructions for all components

f) Detailed parts lists (accompanied by exploded view type drawings clearly detailing the part and uniquely identifying it)

g) Spare part ordering instructions

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

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

3.11.3.7 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.

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

3.11.4 Drawings

3.11.4.1 All drawings to be in accordance with 240-86973501 (Engineering Drawing Standard – Common Requirements)

3.12 PACKAGING, TRANSPORTATION AND HANDLING

3.12.1 The functional unit shall be suitable for handling and removal by providing mechanism for crane hooks.

3.12.2 The functional unit shall be suitable for handling and removal by providing mechanism to avoid damage to the panel.

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

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

4. AUTHORISATION

This document has been seen and accepted by:

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5. REVISIONS

Date	Rev.	Compiler	Remarks
June 2018	0.1	M. Lentsoane	First Draft for comments review by Gx Plant Engineering - Electrical CoE Department.
July 2018	0.2	M. Lentsoane	Second Draft for comments review by the MESG Care Group and Generation Auxiliary Care Group.
Sept 2018	0.2	M. Lentsoane	Final Draft for Approvals
Oct 2018	1	M. Lentsoane	Final document for Authorisation and Publication

6. DEVELOPMENT TEAM

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

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7. ACKNOWLEDGEMENTS

- None

ANNEX 1: COMPLIANCE SCHEDULE FOR GAS-INSULATED FIXED PATTERN AC METAL-ENCLOSED SWITCHGEAR AND CONTROLGEAR FOR RATED VOLTAGES ABOVE 1KV UP TO AND INCLUDING 52KV

Note: The Compliance Schedule is available in Microsoft Excel Format which is a preferred format of submission.

Compliance Schedule Unique Identifier number: 240-141142647

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

Note: The Technical A&B Schedule is available in Microsoft Excel Format which is preferred format of submission.

Technical A&B Schedule Unique Identifier number: 240-109713946