Eskom	Standard	Technology

Title: **STANDARD FOR OUTDOOR AIR INSULATED MV CIRCUIT-BREAKERS WITH COMBINED CURRENT TRANSFORMERS & CONTROL GEAR FOR 11 KV, 22 KV AND 33 KV**

Unique Identifier:	**240-66581487**
Alternative Reference Number:	**<n/a>**
Area of Applicability:	**Engineering**
Documentation Type:	**Standard**
Revision:	**3**
Total Pages:	**50**
Next Review Date:	**November 2024**
Disclosure Classification:	**Controlled Disclosure**

Compiled by	Approved by	Authorized by
Isaac Sibeko	Jabulani Cebekhulu	Bheki Ntshangase
HV Plant Engineering	AIS Care Group Convener	Senior Manager HV Plant
Date: 29/10/2019	Date: 29/10/2019	Date: 29/10/2019

Supported by SCOT/SC

Bheki Ntshangase
Plant Equipment SC Chairperson
Date: 29/10/2019

PCM Reference: **<xxxxxx>**
SCOT Study Committee Number/Name: **<Number or name>**

Content

Page

1. Introduction 5
2. Supporting Clauses 5
   - 2.1 Scope 5
     - 2.1.1 Purpose 5
     - 2.1.2 Applicability 5
   - 2.2 Normative/Informative References 5
     - 2.2.1 Normative 6
     - 2.2.2 Informative 7
   - 2.3 Definitions 7
     - 2.3.1 Disclosure Classification 7
   - 2.4 Abbreviations 7
   - 2.5 Roles and Responsibilities 8
   - 2.6 Process for monitoring 8
   - 2.7 Related/Supporting Documents 8
3. Ratings 8
   - 3.1 Rated voltage (Ur) and number of phases 8
   - 3.2 Rated insulation levels 9
   - 3.3 Rated frequency (f_r) 9
   - 3.4 Rated normal current (I_r) and temperature rise 9
   - 3.5 Rated short-time withstand current (I_k) 10
   - 3.6 Rated peak withstand current (I_p) 10
   - 3.7 Rated duration of short circuit (t_k) 10
   - 3.8 Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a) 10
   - 3.9 Rated supply frequency of closing and opening devices and of auxiliary circuits 11
   - 3.10 Rated short-circuit breaking current (/SC) of the circuit-breaker 11
   - 3.11 Transient recovery voltage related to the rated short-circuit breaking current of circuit-breakers 11
   - 3.12 Rated short-circuit making current of circuit-breakers 11
   - 3.13 Rated operating sequence for circuit-breakers 11
   - 3.14 Characteristics for short-line faults 12
   - 3.15 Rated out-of-phase making and breaking current for circuit-breakers 12
   - 3.16 Rated capacitive switching currents for circuit-breakers 12
   - 3.17 Inductive load switching for circuit-breakers 13
   - 3.18 Rated time quantities for circuit-breakers 13
   - 3.19 Number of mechanical operations for circuit-breakers 13
   - 3.20 Classification of circuit-breakers as a function of electrical endurance 13
4. Design and construction 15
   - 4.1 Service conditions 15
   - 4.2 General 15
   - 4.3 Construction requirements 16
   - 4.4 Circuit-breaker operating mechanism enclosure requirements 17
   - 4.5 Circuit-breaker support structure and foundation 18
   - 4.6 Corrosion protection and lubrication 19
   - 4.7 Circuit-breaker operating mechanism enclosure heaters 20
   - 4.8 Terminal requirements 20

4.9 Safety clearances and personnel safety 21
4.10 Insulation requirements 21
4.11 Position / status indication 22
4.12 Labels 23
4.13 Requirements for environmental friendly alternatives sulphur hexafluoride free (SF_6 free) gas (where applicable) 23
4.14 Requirements for Vacuum Interrupter (where applicable) 25
4.15 Current transformers (CTs) 25
4.16 Switching surge control (where applicable) 26
4.17 Controlled switching 26
4.18 Auxiliary and control circuits 26
4.19 Nameplates 27
4.20 Tools and spares 28
4.21 Documentation requirements 28
4.22 Packaging and preservation requirements 31

5. Type tests 33
5.1 General 33
5.2 Witnessing of tests 33
5.3 Type test certificates and reports 33
5.4 Type and routine test requirements 33
5.5 Tests after installation on site (pre-commissioning tests) 35

6. Manufacturing, transport, storage, installation, pre-commissioning and after sales technical support 36
6.1 General 36
6.2 Inspection of manufacturing facilities and circuit-breakers 36
6.3 Conditions during transportation 37
6.4 Transportation and off-loading 37
6.5 Storage and preservation 37
6.6 Installation 38
6.7 Pre-commissioning (where applicable) 39
6.7.1 Required measurements records 39
6.7.2 Measured values 39
6.7.3 Clear copies 40
6.7.4 The switchgear and control gear shall be subject to a final inspection by Eskom 40
6.7.5 Safety related data (where applicable) 40
6.7.6 Requirements for pressure vessels (where applicable) 40
6.8 After sales technical support 40

7. Inspection and Maintenance 40
7.1 Maintenance Video 42
7.2 Spares 42
7.3 Modifications to circuit-breakers during their service life 44
7.4 Condition monitoring of circuit-breakers 44

8. Manuals 44
8.1 General content 45
8.2 Transport and storage instructions 45
8.3 Installation instructions 46
8.4 Testing 46
8.5 Inspection and maintenance 46
8.5.1 Dismantling, repair, settings inspection and lubrication 46

8.5.2 Spare parts....46

9. Training....47

10. Safety, health, environment and quality....47

11. Authorisation....47

12. Revisions....47

13. Development team....47

14. Acknowledgements....48

Annex A – Supplier and Eskom responsibilities....49

Tables

Table 1: Rated voltage and insulation levels....9

Table 2: Rated normal currents (I_r)....9

Table 3: Standardised rated short circuit-breaking, short-time and peak withstand currents....10

Table 4: Classification of circuit-breakers (SANS 62271-100)....14

Table 5: Eskom standard civil design drawings for outdoor live-tank circuit-breaker steel support structures and concrete foundations....19

Table 6: Material and Corrosion Protection Information....20

Table 7: Standard Electrical and Working Clearances....21

Table 8: Summary of the Various CT Options Required by Eskom....26

1. Introduction

This standard sets out Eskom's specific and standardised technical requirements for outdoor air-insulated circuit-breakers for use in three-phase 50 Hz alternating current systems with nominal voltages from 11 kV, 22 kV and 33 kV. The requirements for circuit-breakers are based on SANS 62271-100 (High-voltage alternating-current circuit-breakers) and the requirements for current transformers (CT's) are based on SANS 61869. The standard covers live-tank circuit-breakers that are specified with current transformers (CTs) that are mounted on the same base frame. The circuit-breaker designs that offer environmental friendliness and meet this standard shall be considered. These shall have been designed and type tested in accordance with SANS 62271-100 (High-voltage alternating-current circuit-breakers) and the current transformers (CT's) based on SANS 61869 standard.

The design of the circuit-breaker should be based on safety to personnel and equipment during operation and maintenance, reliability of service, ease of maintenance, mechanical protection of equipment, interchangeability of equipment and ready addition of future loads.

2. Supporting Clauses

2.1 Scope

2.1.1 Purpose

This standard intended to cover the design, manufacture, assembly and testing at manufacturer's works of 11 kV, 22 kV and 33 KV, 3 phase, 50 Hertz 1250 A, 1600 A and 2500 A, 25 kA and 31,5 kA, outdoor type, vacuum circuit-breaker for efficient and trouble-free operation as specified hereunder.

This standard provides the specific and standardised requirements for outdoor air insulated Medium Voltage (MV) circuit-breakers with combined current transformers and controlgear. The intended application of this circuit-breaker (CB) is the same as that of the outdoor metal enclosed kiosk CB. The switchgear is intended for use in Eskom substations having nominal operating voltages of 11 kV, 22 kV and 33 kV. A set of technical schedules A and B accompanies this standard. Schedule A gives the relevant clause number and requirement of this standard where possible. Additional and special requirements are also included in schedule A.

The MV circuit-breakers shall include a fixed (non-withdrawable) three-pole operated circuit-breaker with integrated protection and measurement current transformers. In addition, the switchgear shall be supplied with a combination of associated control, measuring, indicating, and alarm, protective and regulating equipment – including interconnections, accessories, and points of interface with Eskom's standard steel support structures. These MV circuit-breakers are used in Eskom substations for general purpose medium voltage power switching and protection applications, as well as for special purpose applications such as the restrike-free switching of shunt capacitor banks.

MV circuit-breakers may be used for a variety of applications such as transformer, bus-section or feeder etc.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 Normative/Informative References

Parties using this standard shall apply the most recent edition of the documents listed below. Suppliers are responsible for obtaining copies of all NRS, South African National Standards (SANS) and international standards referred to in this standard. Copies of the latest revision of Eskom documents will be supplied by the purchaser and will form part of the enquiry documentation.

Note: When issuing an enquiry based on this standard, it should be stated in the enquiry that the editions of the normative references that are current at the *date of issue* of the enquiry shall apply, unless otherwise agreed with Eskom. However in special cases, the responsible engineer may rule that the editions of one or more normative references applicable at the effective date of the Eskom specification shall apply.

2.2.1 Normative

[1] SANS 62271-1, High-voltage switchgear and control gear – Part 1: Common specifications.

[2] SANS 62271-100, High-voltage switchgear and control gear – Part 100: High-voltage alternating-current circuit-breakers.

[3] SANS 61869-1, Instrument Transformers- Part 1: General requirements

[4] SANS 61869-2, Instrument Transformers- Part 2: Additional requirements for current transformers

[5] IEC 60071-1, Insulation coordination – Part 1: Definitions, principles and rules.

[6] IEC 60073, Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators.

[7] IEC 60112, Method for the determination of the proof and the comparative tracking indices of solid insulating materials.

[8] IEC 60447, Basic and safety principles for man-machine interface, marking and identification – Actuating principles.

[9] SANS 60137, Insulated bushings for alternating voltages above 1 000 V.

[10] SANS 60270, Partial discharge measurements.

[11] SANS 60273, Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than *1 000 V*.

[12] SANS 60060-1, High-voltage test techniques — Part 1: General definitions and test requirements.

[13] SANS 62271-301, High-voltage switchgear and control gear – Part 302: Dimensional standardisation of high-voltage terminals.

[14] SANS 60529, Degrees of protection provided by enclosures (IP code).

[15] SANS 60815-1:2009, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles.

[16] SANS 1019, Standard voltages, currents and insulation levels for electricity supply.

[17] SANS 1091, National colour standard.

[18] SANS 1574-3, Electric flexible cores, cords and cables with solid extruded dielectric insulation – Part 3: PVC flexible cores and cables.

[19] NRS 012, Cable terminations and live conductors within air-insulated enclosures (insulation co-ordination) for rated ac voltages of 7, 2 kV and up to and including 36 kV.

[20] 240-56062515, Distribution Standard Part 15: Specification for labels on control panels, relay panels and other indoor and outdoor equipment.

[21] 240-114967625: Operating Regulations for High Voltage Systems (ORHVS)

[22] 240-56030489, Distribution Standard Part 7: Standard requirements for the wiring of outdoor switchgear used in systems of nominal voltage up to and including 132 kV.

[23] 240-75655504, Distribution Standard Part 4: Corrosion protection specification for new indoor and outdoor Distribution equipment manufactured from steel.

[24] 240-56065202, Distribution Standard Part 7: Switchgear training requirements from original equipment manufacturers.

[25] 240-75881784, KIPTS natural ageing and pollution performance test procedure for outdoor insulator products section 2 – particular requirements for through-wall bushings.

[26] 240-100495413, KIPTS natural ageing and pollution performance test procedure for outdoor insulator products section 0 – general requirements.

[27] 240 56062846, Current Transformers Eskom Specific Requirements for Voltages up to 132 kV in accordance with NRS 029 Standard.

[28] 240-53902499, Standard for the transport, handling, storage and preservation of HV and MV switchgear.

[29] 240-105658000, Supplier Contract Quality Requirements Specification.

[30] 240-142598739, Rescinding of KIPTS testing as mandatory requirement and guidance on technical standards applicable for pollution related qualification of high voltage equipment.

[31] D-DT-5216, Combo / Kiosk circuit-breaker foundation details and steelwork.

[32] D-DT-5407, Wiring of outdoor circuit-breakers.

[33] D-DT-5270, A-frame drawing.

2.2.2 Informative

None

2.3 Definitions

For the purposes of this standard and clause 3 of SANS 62271-1, the following terms, definitions and abbreviations are applicable:

Definition	Description
Breakdown Maintenance	Unplanned (or unscheduled) maintenance work required to repair a fault and thus restore the switchgear and control gear to an acceptable condition after a failure.
Corrective Maintenance	The maintenance carried out after a failure has occurred and intended to restore an item to a state in which it can perform its required function.
Preventative Maintenance	The maintenance carried out at predetermined intervals or corresponding to prescribed criteria, and intended to reduce the probability of failure or the performance degradation of an item.
Routine Inspection	Visual investigation of the principal features of the switchgear and control gear in service without dismantling. **Notes:** 1) This inspection is generally directed toward pressures and/or levels of fluids, tightness, position of relays, pollution of insulating parts, but actions such as lubricating, cleaning, washing, etc. which can be carried out with the switchgear and control gear in service are also included. 2) Observations resulting from inspection can lead to the decision to carry out overhaul. 3) As indicated in note 1 above, routine inspection may include scheduled maintenance activities in accordance with the manufacturer's maintenance manual. 4) Routine inspection may also be referred to as 1st line maintenance. 5) This is the definition of "inspection" given in 3.1.8 of SANS 62271-1.
Specialised tools	Any purpose-built tools that is necessary to carry out major (or specialised) maintenance on a circuit-breaker and its components.

2.3.1 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to External Parties (either enforced by law, or discretionary)

2.4 Abbreviations

The abbreviations shall apply:

Abbreviation	Description
AMSL	Above mean sea level
ARC	Auto re-closing (i.e. an O-CO operation under command of a relay)
CB	Circuit-breaker
DC	Direct Current
DN8	8 mm SF_6 free coupling. D = Diameter, N = Nominal and 8 = 8 mm inside diameter to determine the gas flow capacity. Coupling thread size is M 26 x 1,5
HV	High Voltage
kV	Kilovolt
MV	Medium Voltage
OEM	Original equipment manufacturer
PDE	Power Delivery Engineering
SANS	South African National Standards
SCD	Specific creepage distance
USB	Universal Serial Bus
USCD	Unified specific creepage distance

2.5 Roles and Responsibilities

PDE HV Plant shall ensure that the approved standard is in place for use by Eskom Transmission and Distribution.

The detailed list of Suppliers and Eskom responsibilities are covered under Appendix A.

2.6 Process for monitoring

Quality Management shall ensure that the standard is correctly complied with. This shall be achieved by conducting conformity assessments which is a process to show that a product meets specified requirements. The conformity assessments involve one or more activities such as inspection, testing and certification.

2.7 Related/Supporting Documents

Technical schedules A & B and Eskom standard drawings.

3. Ratings

3.1 Rated voltage (U_r) and number of phases

a) The rated voltage of circuit-breakers shall be in accordance with the values given in Table 1. The rated voltage required will be specified in schedule A. The rated voltage offered shall be stated in schedule B.

Note: The nominal system voltages (U_n) in Eskom's MV network are 11 kV, 22 kV and 33 kV.

b) It is only applicable to three-pole circuit-breakers for use in three-phase systems.

3.2 Rated insulation levels

The rated insulation levels of circuit-breakers shall be in accordance with the values given in Table 1. The rated insulation levels offered shall be stated in schedule B. No additional altitude correction factors need be applied for equipment installed up to 1800 m AMSL.

Table 1: Rated voltage and insulation levels

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	**Common value**
11	12	28	95
22	24	50	150
33	36	70	200

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) specified in SANS 60071-1.

3) Due to the fact that the equipment may be installed at altitudes of up to 1800 m AMSL (Above Mean Sea Level) as well as in areas having a high degree of exposure to lightning over-voltages, the lightning impulse withstand voltage insulation levels specified are selected to account for altitude correction above 1000 m AMSL – in accordance with Eskom's insulation co-ordination philosophy and SANS 1019 (List 3 insulation levels). Therefore no further altitude correction factors need be applied in accordance with SANS 62271-1 for equipment installed up to 1800 m AMSL.

3.3 Rated frequency (f_r)

The rated frequency shall be 50 Hz.

3.4 Rated normal current (I_r) and temperature rise

a) The rated normal current of MV circuit-breakers shall be either 1250 A, 1600 A or 2500 A and in accordance with the requirements of Table 2. The rated normal current will be specified in schedule A. The rated normal current offered shall be stated in schedule B.

b) The standard rated normal currents of MV circuit-breaker main circuits are given in Table 2.

Table 2: Rated normal currents (I_r)

Nominal system voltage U_n [kV]	**Rated normal current (I_r) [A]**		
	1250	**1600**	**2500**
11	-	-	×
22	×	×	×
33	-	×	×

c) The associated temperature rise limits for the rated normal current given as per table above shall be in accordance with SANS 62271-1.

d) Based on the actual results of the circuit-breaker temperature rise type testing, the calculated maximum continuous current that the circuit-breaker can carry, without exceeding the maximum allowable temperatures for the major components, shall be stated in schedule B for a maximum ambient temperature of i) 40 ^{o}C and ii) 45 ^{o}C (refer to 3.4 a)).

e) Based on the actual results of the circuit-breaker temperature rise type testing, the highest measured temperature rise values for the major components (refer to SANS 62271-1 3) when carrying rated current shall be stated in schedule B.

3.5 Rated short-time withstand current (I_k)

The rated short-time withstand current of circuit-breakers shall be in accordance with the values given in Table 3. The rated short-time withstand current required will be specified in schedule A. The rated short-time withstand current offered shall be stated in schedule B.

3.6 Rated peak withstand current (I_p)

The rated peak withstand current of circuit-breakers shall be in accordance with the values given in Table 3. The rated peak withstand current required will be specified in schedule A. The rated peak withstand current offered shall be stated in schedule B.

3.7 Rated duration of short circuit (t_k)

The rated duration of the short circuit (t_k) shall be 3 seconds.

Table 3: Standardised rated short circuit-breaking, short-time and peak withstand currents

Nominal system voltage U_n [kV]	Rated short-time (3 sec) withstand current (I_k) and Rated short-circuit breaking (I_{SC}) [kA (r. m. s.)]	Rated peak withstand current I_p [kA (peak)]
11	25	63
11	31.5	80
22	25	63
22	31.5	80
33	25	63
33	31.5	80

3.8 Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)

a) The rated DC supply voltage (U_a) of closing and opening devices and of auxiliary and control circuits shall be 110 V or 220 V. The rated DC supply voltage will be specified in schedule A. It shall be possible to change the DC control voltage at which the switchgear operates by only replacing the opening and closing coils, mechanism motors and motor contactor coils.

Notes:

1) Switchgear shall only be required to operate at one DC control voltage i.e. the closing and opening devices, mechanism motors and motor contactor coils to be supplied with the switchgear are required to be suitable for operation at either 110 V DC or 220 V DC as specified in schedule A.

2) A readily available DC supply voltage “conversion kit” is required by Eskom from the supplier in order to convert the circuit-breaker operating mechanism from 110 V to 220 V DC or vice versa. Refer to 4.18.

3) Refer to 240-56030489 for control circuitry’ voltage range, also spring rewind motor must be able to operate at this range without burning out.

b) The rated ac supply voltage (U_a) of heaters and other ac auxiliary circuits shall be single-phase 230 V.

3.9 Rated supply frequency of closing and opening devices and of auxiliary circuits

The standard value of rated supply frequency shall be 50 Hz.

3.10 Rated short-circuit breaking current (*I*SC) of the circuit-breaker

a) The rated short-circuit breaking current (I_{SC}) of circuit-breakers shall be equal in value to the rated short-time withstand current (I_K) specified in Table 3. The rated short-circuit breaking current required will be specified in schedule A. The rated short-circuit breaking current offered shall be stated in schedule B.

b) Under certain system neutral earthing conditions, the single-phase (phase-to-earth) fault level may exceed the three-phase (phase-to-phase) symmetrical fault level and a higher single-phase-to-earth rated short-circuit breaking current may be required. The factor (up to 1, 15) by which the 100 % symmetrical and asymmetrical single-phase rated short-circuit breaking current of the circuit-breaker exceeds the same three-phase rating will be specified in schedule A. The factor offered shall be stated in schedule B.

3.11 Transient recovery voltage related to the rated short-circuit breaking current of circuit-breakers

a) The first-pole-to-clear factor (k_{pp}) for MV circuit-breakers shall be 1, 5 in accordance with SANS 62271-100, i.e. as applicable to circuit-breakers used in non-effectively earthed systems. The first-pole-to-clear factor shall be stated in schedule B.

b) The standard values of prospective transient recovery voltages given in SANS 62271-100 shall apply according to the circuit-breaker class specified in 3.1.20 for the relevant circuit-breaker application and as defined in SANS 62271-100.

3.12 Rated short-circuit making current of circuit-breakers

The rated short-circuit making current of circuit-breakers shall be equal in value to the rated peak withstand current specified in Table 3. The rated short-circuit making current required will be specified in schedule A. The rated short-circuit making current offered shall be stated in schedule B.

3.13 Rated operating sequence for circuit-breakers

a) The following rated operating sequence shall apply to all three-pole operated circuit-breakers. The rated operating sequence required will be specified in schedule A.

Three-phase auto-reclosing: O – t – CO – t' – CO (all poles),

Unless otherwise specified:

t = 3 min for circuit-breakers not intended for rapid auto-reclosing;

t = 0, 3 s for circuit-breakers intended for rapid auto-reclosing (dead time);

t' = 3 min.

Note: Instead of t' = 3 min, other values: t' = 15 s and t' = 1 min are also used for circuit-breakers intended for rapid auto-reclosing.

b) The following rated operating sequence shall apply to all circuit-breakers not intended for rapid auto-reclosing. The rated operating sequence required will be specified in schedule A.

CO – t'' – CO with:

t'' = 15 s for circuit-breakers not intended for rapid auto-reclosing

c) The rated operating sequence offered shall be stated in schedule B. The minimum resting time (in minutes) required, in order to ensure dependable interruption capability within the circuit-breaker's rated characteristics, following the rated operating sequence under the most unfavourable conditions shall be stated in schedule B.

d) All circuit-breakers, irrespective of whether they are intended for rapid auto-reclosing, shall be able to open-close-open before the closing spring needs to be charged again.

3.14 Characteristics for short-line faults

Characteristics for short-line faults tests are required for class S2 circuit-breakers designed for direct connection to overhead lines, irrespective of the type of network on the source side, having a rated voltage equal or higher than 15 kV and less than 100 kV and a rated short-circuit breaking current exceeding 12,5 kA. Characteristics for short-line faults are also required for all circuit-breakers designed for direct connection to overhead lines having a rated voltage of 100 kV and above and a rated short-circuit breaking current exceeding 12, 5 kA.

3.15 Rated out-of-phase making and breaking current for circuit-breakers

The rated out-of-phase breaking current is the maximum out-of-phase current that the circuit-breaker shall be capable of breaking under the conditions of use and behaviour as prescribed in clause 4.106: SANS 62271-100.

The rated out-of-phase breaking current required will be specified in schedule A in accordance with 4.106 of SANS 62271-100. The rated out-of-phase making and breaking currents of the circuit-breaker offered shall be stated in schedule B.

3.16 Rated capacitive switching currents for circuit-breakers

a. The classification of circuit-breakers according to their restrike performance for line- and-cable charging current switching shall be in accordance with 3.20 for the specified circuit-breaker application. The circuit-breaker class offered for line- and cable-charging current switching shall be stated in schedule B.

b. The rated line- and cable-charging breaking currents for circuit-breakers shall be in accordance with the preferred values given in SANS 62271-100.

c. If specified in schedule A, the circuit-breaker shall be classified as a class C2 circuit-breaker and shall be capable of switching capacitor banks with a no probability of restrike during capacitive current breaking. In this case, the following requirements are applicable:

1) the circuit-breaker shall be capable of switching single capacitor banks as well as back-to-back capacitor banks;

2) the rated capacitor bank switching currents shall be in accordance with the preferred values given in SANS 62271-100. The rated capacitor bank switching currents (i.e. the rated single capacitor bank breaking current, the rated back-to-back capacitor bank breaking current and the rated back-to-back capacitor bank inrush making current) and inrush current frequency shall be stated in schedule B; and

3) all circuit-breakers supplied for capacitor-bank switching shall be capable of capacitor switching without the need for controlled opening and/or closing.

Notes:

1) Shunt capacitor banks will be connected to a substation bus bar.

2) The ratings of existing shunt capacitor banks are typically 3 MVAr at 22 kV.

3) The backup circuit-breakers in the particular substations may not have adequate capacitive switching capabilities. This means that the MV circuit-breakers intended for shunt capacitor bank switching will have to be relied upon to satisfactorily and reliably switch the capacitive currents associated with the shunt capacitor banks.

4) The shunt capacitor bank circuit-breaker may be called upon to switch twice a day – in a single and/or back-to-back situation of the rating specified – with up to three banks installed on a single substation bus bar.

5) The capacitor bank will be disconnected automatically upon operation of the unbalance, overvoltage or overcurrent protection systems.

6) Eskom shall be informed about the limitations of the switching capabilities for the particular circuit-breaker. For the sake of standardisation, the circuit-breaker offered for capacitor switching duty should preferably be identical to a general-purpose circuit-breaker. However, special-purpose circuit-breakers will be considered.

7) All circuit-breakers supplied for the specified capacitor-bank switching duty shall be capable of capacitor switching duty without the need for controlled opening and/or closing.

8) The use of controlled switching to provide optimal capacitor-bank switching is recommended.

9) The class C2 classification the supplier shall specify whether the circuit-breaker passed on the line switching duty/cable switching duty/ shunt capacitor duty (Single capacitor bank or back-to-back switching)

3.17 Inductive load switching for circuit-breakers

When switching small inductive current such as shunt reactor current, the circuit-breaker will clear current at first current zero when the system voltage is at maximum. All circuit-breakers will “chop” current, i.e. before actual zero is reached. This creates a reaction from the inductive circuit since magnetic stored energy is released and generation of a transient over-voltage on the load side occurs. Invariably the transient over-voltage is of sufficient magnitude to cause breakdown of the main contact gap. This is termed a “re-ignition”.

3.18 Rated time quantities for circuit-breakers

The rated opening time, arcing time, break-time, closing time, open-close time, reclosing time and close-open time of the circuit-breaker offered shall be stated in schedule B.

3.19 Number of mechanical operations for circuit-breakers

The number of mechanical operations of circuit-breakers shall be in accordance with the mechanical endurance class specified in Table 4 for the specified circuit-breaker application and as defined in SANS 62271-100. The circuit-breaker class offered shall be stated in schedule B.

3.20 Classification of circuit-breakers as a function of electrical endurance

The classification of circuit-breakers as a function of electrical endurance shall be in accordance with Table 4 for the specified circuit-breaker application. The circuit-breaker class offered shall be stated in schedule B.

Table 4: Classification of circuit-breakers (SANS 62271-100)

Circuit-breaker	Circuit-breaker application	Circuit-breaker class	Electrical endurance	Re-strike performance during capacitive current breaking (line- and cable- charging)	Mechanical endurance
11 kV, 2500 A, 25 kA [3)]	Transformer / bus-section	S1 [10)]	E2 [1)]	C1	M1
11 kV, 2500 A, 31,5 kA [3)]	Transformer / bus-section	S1 [10)]	E2 [1)]	C1	M1
22 kV, 1250 A, 25 kA [4)]	Transformer / bus-section / feeder	S2 [11)]	E2 [2)]	C1	M2
22 kV, 1250 A, 31.5 kA [4)]	Transformer / bus-section / feeder	S2 [11)]	E2 [2)]	C1	M2
22 kV, 1600 A, 25 kA [5)]	Transformer / bus-section / feeder	S2 [11)]	E2 [2)]	C1	M2
22 kV, 1600 A, 31.5 kA [5)]	Transformer / bus-section / feeder	S2 [11)]	E2 [2)]	C1	M2
22 kV, 2500 A, 31.5 kA [6)]	Transformer / bus-section / feeder	S2 [11)]	E2 [2)]	C1	M2
33 kV, 1250 A, 25 kA [7)]	Feeder	S2 [11)]	E2 [2)]	C1	M2
33 kV, 1250 A, 31.5 kA [7)]	Feeder	S2 [11)]	E2 [2)]	C1	M2
33 kV, 1600 A, 25 kA [8)]	Feeder	S2 [11)]	E2 [2)]	C1	M2
33 kV, 1600 A, 31.5 kA [8)]	Feeder	S2 [11)]	E2 [2)]	C1	M2
33 kV, 2500 A, 31.5 kA [9)]	Transformer / bus-section / feeder	S2 [11)]	E2 [2)]	C1	M1

Notes:

1) Class E2: Extended electrical endurance without auto-reclosing duty capability.

2) Class E2: Extended electrical endurance intended for auto-reclosing duty for overhead line feeder application.

3) The 11 kV 2500 A circuit-breaker is used for transformer and bus-section applications at 11 kV only. 22 kV 1250 A circuit-breakers are used for feeder applications at 11 kV.

4) The 22 kV 1250 A circuit-breaker is for transformer, bus-section and feeder application at 22 kV. It is also used for feeder application at 11 kV.

5) The 22 kV 1600 A circuit-breaker is for transformer and bus-section application at 22 kV and it is also used for feeder application at 22 kV.

6) The 22 kV 2500 A circuit-breaker is for transformer and bus-section application at 22 kV and is also required for Transmission substation applications

7) The 33 kV 1250 A circuit-breaker is for feeder applications at 33 kV.

8) The 33 kV 1600 A circuit-breaker is for feeder applications at 33 kV.

9) The 33 kV 2500 A circuit-breaker is for transformer and bus-section application at 33 kV and is also required for Transmission substation applications.

10) Class S1 circuit-breakers (i.e. circuit-breakers intended to be used in line systems) are restricted to systems of rated voltages equal to or higher than 15 kV and less than 100 kV – in accordance with SANS 62271-100. Circuit-breakers for use at 11 kV are therefore classified as class S1 circuit-breakers.

11) Class S2 circuit-breakers are specified due to the fact that they are used in systems with direct connection to overhead lines / outdoor bus bars without intervening cables.

4. Design and construction

Note: During the period covered by a particular contract or product acceptance cycle, the Supplier shall not make any changes to the equipment or materials supplied to Eskom without first receiving approval from Eskom. All concessions shall be approved by Eskom. No changes will be permitted to the mounting details of the equipment or in other points of interfacing with Eskom standard structures. If the Supplier decides to make any changes to the agreed-upon design of the circuit-breaker, then the change(s), together with the reasons for making the change(s), shall be forwarded to the Eskom contract manager and relevant technical specialists in writing for approval (refer to 7.3 and 240-105658000).

4.1 Service conditions

a) The normal service conditions for outdoor switchgear and control gear specified in SANS 62271-1 shall apply. The following additional specific requirements shall be taken into account:

- a minimum ambient air temperature of -10 ^{O}C;
- a maximum ambient air temperature of +45 ^{O}C (refer to 3.4d));
- Rapid temperature changes. The condensation of water vapour can take place within operating mechanism enclosures and hollow components and must be compensated for;
- solar radiation up to a level of 1 100 W/m^2 (on a clear day at noon);
- the circuit-breakers shall be installed up to altitudes of 1 800 m;

Note: Due (in part) to the fact that the switchgear and control gear shall be used up to altitudes of 1800 m AMSL (Above Mean Sea Level), altitude-corrected insulation withstand levels are specified in this document. No further altitude correction factors are therefore required for altitudes above 1000 m AMSL in accordance with SANS 62271-1.

- the class of pollution characterising the site severity will be specified in schedule A in accordance with SANS 60815-1:2009 (e.g. class "e" corresponding to "very heavy", 31mm/kV); and
- Seismic activity up to 0,3g.

b) Circuit-breakers for use in systems of nominal voltage up to and including 52 kV shall be suitable for operation in systems that incorporate a non-effectively earthed neutral. Circuit-breakers for use in systems of nominal voltage above 132 kV shall be suitable for operation in systems that incorporate an effectively earthed neutral.

4.2 General

a) Outdoor circuit-breakers shall comply with the requirements of SANS 62271-100 and where conflicting requirements exist, the requirements of this standard shall take precedence.

b) Circuit-breakers shall be of the live-tank design. The type of design required will be specified in schedule A. The type of design offered shall be stated in schedule B.

c) If specified in schedule A, live-tank circuit-breakers shall be supplied with outdoor post-type CTs. For further information on CT requirements, refer to 4.15.

d) Circuit-breakers shall be supplied complete with all the necessary components for the assembly. Live-tank circuit-breakers for use in systems of nominal voltage up to and including 52 kV shall be supplied suitable for a pole-beam support arrangement (two-column support with common base frame) and A-frame.

Notes:

1) For further information relating to the Supplier's and Eskom's scope of responsibility, refer to Annex A.
2) For live-tank circuit-breakers for use in systems of nominal voltage up to and including 52 kV, the steel common base frame shall be supplied with the circuit-breaker (refer to 4.2 b)).

e) Circuit-breaker operating mechanisms:

- Circuit-breakers shall be three-pole ("3P") operated (i.e. single operating mechanism) as specified in schedule A.

- Circuit-breakers shall be 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 operating mechanism spring both manually and electrically. Electrical charging shall be via a spring charging motor, unless otherwise approved by Eskom. Both manual and electric energy release shall be provided. The mechanical energy stored in the charged spring shall be stated in schedule B. A mechanical device shall be provided to prevent over-charging of the closing spring when the manual charging facility is employed.

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

f) The interrupting and internal insulating medium of the circuit-breaker shall be either vacuum, environmental friendly medium or SF_6 free gas. The type of interrupting and internal insulating medium technology offered shall be stated in schedule B. For SF_6 free gas circuit-breakers, the type of interrupter design (e.g. puffer, self-blast, etc.) as well as the configuration of the moving contacts (e.g. single, double or triple motion design) shall be stated in schedule B.

Note: The circuit-breaker designs that offer vacuum or environmental friendly medium that meet this standard shall be preferred. These shall have been designed and type tested in accordance with IEC62271-100.

g) Circuit-breakers shall be designed for minimal maintenance in accordance with the electrical and mechanical endurance class as specified in Table 4. The minimum expected lifespan shall be 40 years. Premature failures experienced in service of similar design circuit-breakers supplied elsewhere by the manufacturer shall be made known to Eskom, together with the recommended modifications. This information shall be provided with the tender documentation (refer to 4.21).

4.3 Construction requirements

The circuit-breakers and their components shall be capable of withstanding the mechanical forces and thermal stresses of the short circuit current of the system without any damage or deterioration of material.

The design and layout of the circuit-breaker, including control cable interfacing, shall facilitate installation with a minimum of on-site assembly work. The degree of assembly work in the factory shall be optimised such that on-site installation work is minimised. The following principles shall apply to the design of the equipment:

a) The various elements of the circuit-breaker shall be standardised. Standardisation of parts shall be pursued;

b) Modular, pre-assembled elements shall be designed to facilitate better handling and installation. The circuit-breaker shall fit on the Eskom standard steel support structures;

c) The equipment shall be designed to facilitate construction and maintenance activities for personnel as well as inspections performed at ground level; and

d) SF_6 free filter material housing shall be located (at the circuit-breaker pole) in such a manner so as to provide easy access when maintaining the unit.

e) All circuit breakers to be supplied with galvanised steel surge arrester mounting brackets fitted on the breaker load side adjacent to the current transformer pole. The minimum surge arrester mounting bracket interface dimensions shall be 70 x 70 mm. Each surge arrester mounting bracket shall be provided with a pre-drilled 14 mm diameter hole in the centre of the interface bracket to accommodate the surge arrester M12 x 50 mm mounting stud. The surge arrester mounting brackets shall be used as the surge arrester discharge path to earth and shall be electrically bonded to the circuit-breaker base frame. The surge arrester mounting brackets shall be designed to carry the rated fault current and the interfacing surfaces shall not be painted. When fitted the surge arrester bracket 14 mm diameter hole centre shall be at least 250 mm horizontally from the CT outer edge and its minimum height above foundation level shall be:

- 11 kV 2500 mm
- 22 kV 2480 mm
- 33 kV 2470 mm

4.4 Circuit-breaker operating mechanism enclosure requirements

a) Circuit-breaker operating mechanisms, local control facilities and all parts requiring lubrication shall be protected by weather proof enclosures. The degree of protection provided by these enclosures shall comply with the following minimum requirements in accordance with SANS 60529. The degree of protection offered shall be stated in schedule B.

- Enclosures containing exposed bearings, auxiliary switches, motors and other electrical devices shall comply with IP 55 (i.e. operating mechanism enclosure);
- Where applicable, all open areas in the circuit-breaker common base frame as well as externally mounted indicating devices where there is a high probability of birds nesting, shall be suitably covered to IP 2X; and
- All other enclosures provided shall comply with IP 54.

b) The operating mechanism enclosure, handles and fixings shall be manufactured from 3CR12 or better stainless steel with corrosion protection in accordance with 4.6, unless otherwise approved by Eskom.

c) Operating mechanism enclosures shall be arranged to facilitate easy access for inspection and scheduled maintenance which may include permissible in-situ cleaning, lubrication, repairs and adjustments to the operating mechanism. Any removable covers provided shall have bolt fastenings, subject to Eskom approval. All bolts shall be inherently corrosion resistant and have hexagon heads. Self-tapping screws, captive head nuts or cage nuts are not acceptable.

d) The circuit-breaker shall be designed for operation from the front of the operating mechanism enclosure from ground level.

e) The maximum height to the top of mechanism enclosure requiring access shall be 2000 mm.

f) The circuit-breakers shall have motor wound spring charged trip free mechanism with anti-pumping feature, and shunt trip. In addition, facility for manual charging of spring, shall be provided.

g) Access to the LV compartment and circuit-breaker operating mechanism enclosure shall be through a hinged front access door allowing clear access to control levers, push buttons, MCBs and secondary wiring terminal strips in accordance with sub-clause 6.4.3.2 of SANS 62271-1. These shall be easily accessible from ground level.

h) The front access door shall be secured with a heavy-duty locking mechanism.

i) The operating mechanism enclosure shall be capable of being padlocked to prevent unauthorized access. The locking facility shall accommodate padlocks that have a shackle diameter of 6 mm

j) The front access door of the operating mechanism enclosure shall be equipped with a travel stop, which shall retain the door in the open position. The facility shall be robust enough to withstand the force of wind in accordance with 4.1.

k) A rigid, corrosion resistant, documentation pocket shall be provided for the safe-keeping of all relevant documentation (i.e. the installation, operating and maintenance instructions for the circuit-breaker and all routine test certification), on the inside of the operating mechanism enclosure front access door. The documentation pocket shall be securely attached and the means used (e.g. pop rivets) to secure the pocket shall not protrude through the door.

l) Suitable facilities for storage and securing of the hand-operating tool(s) shall be provided on the inside of the operating mechanism enclosure front access door.

m) Earthing of the operating mechanism enclosure shall be via the steel support structure (e.g. via the common base frame and support legs or via the steel column support). If additional / visual earthing is required for the operating mechanism enclosure, all earthing terminals, fastenings and conductors shall be supplied and fitted by the Supplier and will be subject to approval by Eskom.

Note: The use of bare copper or aluminium is considered to present a theft risk and will not be accepted.

n) Operating mechanism enclosures shall make provision for the entry of Eskom control cabling from the bottom. Refer to 4.18 c) for the requirements of the control cable entry gland plates. All circuit-breaker cabling (i.e. to / from density monitoring devices and between poles) shall also enter the operating mechanism enclosure(s) from the bottom, unless otherwise approved by Eskom.

Note: The use of plug-in type cable is not acceptable. Eskom requires the normal gland plate (non-plastic material) and terminations made on terminals.

o) Where applicable, metallic cable racking used to mechanically protect and/or support circuit-breaker cabling (e.g. inter-pole cabling) shall be manufactured using galvanized steel, unless otherwise approved by Eskom.

Note: The use of bare aluminium cable racking is considered to present a theft risk and will not be accepted.

p) Gaskets shall be made of neoprene rubber, nitrile rubber or cork, unless otherwise approved by Eskom. Felt or natural rubber gaskets are not acceptable. The gasket material offered shall be stated in schedule B.

q) The lifting eyes shall be designed to provide for the lifting of the complete operating mechanism enclosure. Lifting eyes with a minimum diameter of 30 mm shall be provided.

r) Where applicable, the colour for the enclosure shall be "light grey" (G29) in accordance with SANS 1091 unless otherwise specified in schedule A or approved by Eskom.

4.5 Circuit-breaker support structure and foundation

a) The following mechanical loads and parameters relating to the design of the circuit-breaker support structure and foundation shall be stated in schedule B and be shown on the general arrangement drawing (refer to 4.21):

- "static" dead weight of the circuit-breaker (N);
- the rated "static" terminal forces F_{shA}, F_{shB} and F_{sv} (loads) of the circuit-breaker (N) due to connected conductors;

Note: Static terminal loads (forces) due to flexible and tubular conductors (not including wind, ice load or the dynamic loads on the circuit-breaker itself) shall be in accordance with Table 14 of SANS 62271-100. Refer to 6.101.6 of SANS 62271-100.

- "dynamic" horizontal force (load) exerted during operation on the foundation (N);
- "dynamic" vertical force (load) exerted during operation on the foundation (N);
- "dynamic" moment (torque) exerted during operation about the foundation (Nm);
- "dynamic" horizontal force exerted between circuit-breaker poles (centre phase interrupter chamber) during a rated (terminal fault) short-circuit (N);
- wind force (load) exerted on the circuit-breaker due to a wind velocity of 34 m/s (N);
- maximum torque required for the foundation holding down bolt nuts used to secure the support structure column to foundation (Nm);
- mounting and fastening arrangement for the circuit-breaker support structure onto the foundation including the minimum required length of foundation holding down bolts; and
- Centre of gravity of the circuit-breaker.

b) In the case of live-tank circuit-breakers for use in systems of nominal voltage up to and including 52 kV, the circuit-breaker common base frame (i.e. for a pole-beam support arrangement) shall be supplied with the circuit-breaker and designed to interface with the standard Eskom steel support structure and concrete foundation in accordance with the drawings specified in Table 5.

Table 5: Eskom standard civil design drawings for outdoor live-tank circuit-breaker steel support structures and concrete foundations

System voltage [kV]	Concrete foundation drawing number (Combo circuit- breakers)	Steel support structure drawing number (Combo circuit- breakers)
11	D-DT-5216-1A	D-DT -5216-3A
22	D-DT-5216-1B	D-DT -5216-3B
33	D-DT-5216-1C	D-DT -5216-3C

4.6 Corrosion protection and lubrication

a) All exposed metal shall be protected against corrosion in accordance with 240-75655504 for outdoor “high” to “very high” (i.e. coastal) corrosivity rating environments.

b) The minimum detailed specification (“DS”) for all exposed metal in accordance with 240-75655504shall be “DS-11”.

Note: Plastic or fibre-reinforced plastic materials for operating mechanism enclosures, or other applications where exposure to the elements is involved will be not accepted.

c) The corrosion protection system (i.e. the equivalent detailed specification “DS” number in accordance with 240-75655504) offered by the manufacturer for the following components shall be stated in schedule B. Details shall be provided with the tender documentation (refer to 4.21):

- enclosures;
- nuts, bolts, studs and washers;
- cable glands (non-plastic);
- cable strapping (non-plastic) unless in inside mechanism enclosure;
- structural steel (i.e. common base frame, support structure legs, etc.); and
- Other exposed metal (excluding main terminals) i.e. cable ties of stainless steel material.

d) The behavior of lubricants that are exposed to air, SF_6 free gas and its arcing products (where applicable) shall be stable over the intervals between maintenance. The supplier is required to identify the lubricants used and to submit details with the tender documentation (refer to 4.21) of tests carried out to prove suitability for the application. If possible, a list of equivalent lubricants from South African sources shall be provided. All liquids or chemicals shall be supplied with Material Safety Data Sheets (MSDS).

e) For all circuit-breaker types, the supplier shall give details with the tender documentation (refer to 4.21) of the measures taken to prevent flange corrosion. The use of split compression washers on the flange shall not be accepted (where applicable).These details shall include drawings of the flange arrangements, treatments and service experience.

f) Material and Corrosion Protection Information

The Supplier shall provide with the tender documentation the information on each supplied equipment type specified below:

Table 6: Material and Corrosion Protection Information

Material and Corrosion Protection Information		
Eskom specified requirements	**To be completed by supplier**	**Completed Example**
Item or part Description		Support structure
Drawing number		DEMO1
Material type		EN8
Material grade		(BS 970 080M40)
Type of corrosion protection		HD galvanising
Minimum thickness of protective coating		85 micro
Verification tests carried out on coating e.g. Thickness with thickness gauge		6 measurements along profile
Expected life of coating (Industry/marine)		Marine = 5 years Industry = 8 years
Maintenance frequency of protection coating		Repair installation damage on commissioning and thereafter once a year
Maintenance type of protection coating		Patch repair with Zinc-fix
Bi-metallic corrosion prevention		Coat both sides
Crevice corrosion prevention		Seal with crevice with Zinc-fix
Item or part weight in Kilogram		7kg
Field experience		Equipment used at coastin USA
Remarks/General comments		Debris, scratches and indentation have been removed prior to galvanising.

4.7 Circuit-breaker operating mechanism enclosure heaters

a) Suitably rated electric heater(s) shall be installed to prevent moisture condensation inside the circuit-breaker operating mechanism enclosure. The heater size offered shall be stated in schedule B.

b) Heaters shall maintain a dew-point greater than the ambient temperature and shall circulate the air constantly to all parts of the enclosure.

c) The electrical supply for heaters shall be single-phase 230 V ac.

d) Heater control and alarm circuits shall comply with the requirements of 240-56030489. In the case of circuit-breakers for use in systems of nominal voltage up to and including 132 kV, heater fail alarm circuits shall be wired to terminals in accordance with D-DT-5407.

4.8 Terminal requirements

a) Main (HV) terminals

1) The type of circuit-breaker main terminals required will be specified in schedule A. Unless otherwise specified in schedule A, the circuit-breaker main terminals shall be in accordance with SANS 62271-301 and either:

2) an 4 hole (2 x 2 hole pattern) aluminium flat pad with a 50 mm pitch (distance between holes). The diameter of the holes shall be 14 mm (M12); or

3) an adapter flat pad to round terminal must be available as an option

b) Earthing terminals

Note: Earthing of the circuit-breaker to the main substation earth grid is achieved through the support structure and the foundation holding down bolts, unless otherwise specified or approved by Eskom.

1) If the continuity between the circuit-breaker and support structure is not achieved, then a suitably rated conductor (not copper) shall be provided between the circuit-breaker and the support structure.

2) In the case where the steel support structure is supplied with the circuit-breaker, an additional M16 (Ø18 mm hole) hole shall be provided in the steel support structure approximately 100 mm above the base of the support structure (i.e. above the concrete foundation) for the connection of external earthing conductors.

3) Details of the circuit-breaker earthing shall be provided on the general arrangement drawings as described in 4.21.

4.9 Safety clearances and personnel safety

a) Live parts shall be isolated by means of elevation.

Note: The use of protective fences to prevent contact with live parts is not acceptable.

b) The electrical clearance from ground to live parts at system voltage, which based on the minimum safety clearances as required by statutory requirements contained in the Occupational Health and Safety Act No. 85 of 1993, shall be complied with. Electrical working clearances are given in Table 8.

Table 7: Standard Electrical and Working Clearances

System voltage [kV]	Minimum Electrical Clearance [mm]		Working clearance (Vertical) [mm]
	Phase-To-Earth (C_e)	Phase-To-Phase (C_p)	
11	200	270	2 700
22	320	430	2 800
33	430	580	2 900
Note: The working clearance is calculated by summating the height of a (average) person with his/her arm in an extended upward position (i.e. 1 800 + 700 = 2 500 mm) and the minimum safety clearance as required by the Occupational Health and Safety Act No. 85 of 1993.			

c) The distance from ground level to the base of any high-voltage (i.e. > 1000 V) insulation shall not be less than 2 500 mm.

d) While working clearance to live metal is desirable for the safety of personnel engaged on operations or maintenance, it is not practical to ensure that such clearance exists from every position in an H.V. yard which a person might conceivably be able to occupy. When the circuit-breakers are installed on the standard Eskom structures as specified in Table 5, the minimum vertical working clearances as specified in Table 7 shall be maintained.

4.10 Insulation requirements

a) Hollow insulators

- The insulator material shall be of the silicone rubber composite type. If applicable, the material type will be specified in schedule A. The type of insulator material offered and manufacturer shall be stated in schedule B.
- Insulators of the silicone rubber composite type shall be in accordance with the requirements of SANS 61462 and SANS 60815-3.

- Circuit-breakers and, where applicable, post-type current transformers for use in systems of nominal voltage up to and including 132 kV shall be tested at Eskom's KIPTS pollution test site in accordance with 240-56062328 or 240-142598739.

b) Minimum creepage distances

- The minimum unified specific creepage distance (USCD) required in accordance with SANS 60815-1 for external insulation shall be as specified in schedule A. The unified specific creepage distance (USCD) for external insulation has been rationalised to 53, 7 mm/kV for "heavy" to "very heavy" pollution conditions. The 53, 7 mm/kV corresponds to a previous specific creepage distance (SCD) of 31 mm/kV.
- The actual creepage distance offered shall be stated in schedule B.

c) Clearances in air

- The phase-to-phase clearance, measured by the taut string method, shall be as follows:
  1) for 11 kV: 600 mm);
  2) for 22 kV: 400 mm; and
  3) for 33 kV: 700 mm.

Notes:

1) The specified phase-to-phase clearances for 11 kV are based on the fact that twin conductors are required for the 2500 A current rating.

2) Eskom reserves the right to call for clearances greater than those already successfully proven by dielectric tests.

4.11 Position / status indication

a) The circuit-breaker main contact position indication shall be clearly visible from ground level and from outside the circuit-breaker operating mechanism enclosure when the front access door is closed.

b) The following symbols and colours shall be used for the position indication of the circuit-breaker main contacts:

- Circuit-breaker closed: "I" in white lettering on a red background
- Circuit-breaker open: "O" in white lettering on a green background

c) Lettering size shall be at least 30 mm, unless otherwise approved by Eskom.

d) The closing-spring condition (i.e. charged or discharged) shall be indicated by a mechanical device. It shall be clearly visible from outside the circuit-breaker operating mechanism enclosure when the front access door is closed. The words "SPRING CHARGED" and "SPRING DISCHARGED" shall be displayed in black lettering on a white background. The lettering height shall be at least 15 mm. The use of symbols to indicate spring condition will not be accepted.

e) Each circuit-breaker shall be provided with an operation counter that is advanced each time the circuit-breaker main contacts open or alternatively each time the main contacts close (i.e. not both). Mechanical operation counters are preferred, but electrical counters are also acceptable. The circuit-breaker operation counter shall be non-resettable. The counter shall have, at least, a capability of counting up to 99 999 operations. The operation counter shall be connected prior to routine testing to reflect all factory and pre-commissioning operations. The type of operation counter shall be stated in schedule B. The Supplier shall submit full details of the operation counter on request by Eskom.

f) In the case of is correct and to prevent ageing of the device, and this requirement applies to all circuit-SF_6 free circuit-breakers, pressure gauges (compensated for temperature and responding to SF_6 free gas density) shall be provided. These devices shall be sheltered from the elements to ensure that the reading provided breaker types.

g) All indicating devices and operations counter shall be clearly visible and legible by persons with normal vision standing at ground level. In addition, it shall be possible to carry out all routine inspection activities from the ground level.

4.12 Labels

a) Operating labels associated with local operation of the circuit-breaker shall be securely attached to the inside of the operating mechanism enclosure front access door and be as follows (black text on white background, in English):

- Instructions for tripping and closing the circuit-breaker: These instructions shall be titled “TO TRIP” circuit-breaker and “TO CLOSE” circuit-breaker, respectively. Additional information required to perform these functions shall be referred to Eskom; and
- Instructions for charging the closing spring: The instruction shall be titled “TO CHARGE SPRING” and located near the actuator for local mechanical spring charging.

b) The actuator(s) for local opening and closing of the circuit-breaker shall be identifiable by all three of the following methods:

- By labelling, in English, printed with black text on a white background reading “TRIP” and “CLOSE”, respectively. The symbols “O” and “I” may be used as additional means to identify the respective trip and close controls;
- By actuating direction or position. A rotary switch shall be turned anti-clockwise to trip the circuit- breaker and clockwise to close the circuit-breaker. Trip and close push buttons shall be oriented vertically or horizontally and shall have the trip button at the bottom or to the left of the close button [IEC 60447]; and
- By colour coding. The colour green shall be associated with the trip control and red with the close control. Alternatively the controls shall be without unique colour.

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).

c) An appropriate warning label shall be displayed to draw attention to the danger of performing manual operations without an adequate amount of interrupting and internal insulating medium inside of the circuit-breaker and indicating protection is not operational.

d) A warning label shall be displayed within the operating mechanism enclosure to draw attention to the minimum time interval required between repeated CO operations during testing.

e) All relays, instruments, MCBs, control switches, luminous indicators and links, the functions of which are not clearly identified by signs or pictograms, shall be clearly labelled to indicate their functions. These labels shall be in text using black letters at least 5 mm high on a white background.

f) Where applicable, all labels shall be manufactured in accordance with 240-56062515 and shall be attached using inherently corrosion-resistant rivets or self-tapping screws. No stickers, stick-on labels, double sided tape or glue is accepted, unless otherwise approved by Eskom.

4.13 Requirements for environmental friendly alternatives sulphur hexafluoride free (SF_6 free) gas (where applicable)

SF_6 free -gas is widely used in medium and high voltage switchgear today because of its excellent insulation and current interruption capabilities. However, due to its high global warming potential, there is a political pressure to replace it wherever possible, resulting in a need for new solutions in the design of compact low-cost switchgear.

NOTE: Requirements below, where applicable, shall be fulfilled by the Supplier for all Kiosk circuit-breakers that are using environmental friendly interrupting and internal insulating medium and furthermore, the Supplier shall provide additional specific details.

Where applicable, the following information shall be provided by the manufacturer: type and required quantity and quality of gas to be used in switchgear and controlgear:

a) When installation is called for, SF_6 free circuit-breakers shall be filled with new SF_6 free gas at the rated normal pressure. All SF_6 free circuit-breakers shall be factory filled with new SF_6 free gas at the rated transportation pressure. This shall be applicable to other environmental friendly insulating medium.

b) The maximum SF_6 free gas leakage rate for the complete equipment shall be 0, 5 % per year. The leakage rated offered shall be stated in Schedule B. This shall be stated for all the gas in the equipment as well as for any individual gas-filled compartment.

c) A certificate guaranteeing SF_6 free purity to IEC 60376 shall be supplied with the circuit-breaker. Upon filling and testing the circuit-breaker, a SF_6 free purity analysis shall be carried out by the Supplier not less than 7 days after commissioning or as recommended by the OEM. All gas filling shall be done by an accredited person. The following parameters shall be checked, recorded and a report submitted to Eskom after filling:

- SF_6 free content (purity) - not less than 98%
- Dew-point at rated filling pressure - at least -5 ^{O}C

d) The following requirements are applicable to SF_6 free gas-filled circuit-breaker filling and pressure monitoring (also the other environmental friendly insulating medium):

- In the case of circuit-breakers for use in systems of nominal voltage up to and including 52 kV, gas filling/evacuation points with DILO DN8 connections shall be provided.
- Access to gas filling/evacuation points shall be at a height of not more than 2 400 mm above ground level. This allows for access to the filling/evacuation point without leaving the ground level.
- The gas filling/evacuation point and the gas pressure gauge shall be separated and it shall not be necessary to remove the pressure gauge in order to access the filling/evacuation points.
- A dial type gauge responding to medium density and indicating pressure compensated for temperature shall be suitably sized (typical 80-100 mm diameter).
- A medium 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 specified in 240-56030489.
- Pressure gauges shall be numerically marked and calibrated in Pascal's (kPa or MPa). Gauges shall measure "absolute" pressure and shall be clearly labelled 'ABSOLUTE'. Rated pressure shall be no more than 80% of the full-scale reading.
- The density monitoring device shall be suitable for outdoor application and resistant to operating vibrations, outdoor elements [hail / snow / UV (Ultraviolet)], etc.
- The type of gauge utilised shall be designed such as to prevent any corrosion of moving parts and contacts inside the gauge.
- Provide certification that the pressure vessel complies with the OSHA.

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

- Medium density monitoring devices shall be shielded against direct sunshine and internal operating mechanism enclosure heater elements which could give rise to false readings and alarms.
- Non-return valves shall be fitted on all DN8 / DN20 fittings and pipe-work such that the gas pressure is maintained in the system and pipe-work when a circuit-breaker pole or the density monitoring device is removed / disconnected. The Supplier shall submit details of the arrangements offered together with the tender documentation (refer to 4.21).
- Any pipe work shall be made of stainless steel and mounted in such a manner that it is mechanically protected. The use of copper pipes is acceptable if painted in the factory before mounting to the circuit-breaker common base frame.

- For circuit-breakers with physically separated poles and associated operating mechanisms, a separate filling/evacuating and medium density monitoring point per pole shall be provided. For circuit-breakers with a common base frame, a single common filling/evacuating and medium density monitoring point for all poles may be provided.
- Electrical connections to the density monitoring device shall not be the plug-in type. However, density-monitoring devices with locking facilities will be accepted.
- Cabling to the medium density monitoring device shall be secured, protected from the elements and run into enclosures through a suitable compression gland or rubber grommet.
- 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 included with the tender documentation (refer to 4.21).
- Electrical interlocks and alarms provided by the gas density monitoring device shall be in accordance with 240-56030489.
- Pressure devices are expected to have a life span of 40 years.

e) The management of SF_6 free gas shall be in accordance with NRS 087.

4.14 Requirements for Vacuum Interrupter (where applicable)

a) Each vacuum Circuit-breaker shall comprise of three identical poles linked together electrically and mechanically for synchronous operation.

b) The vacuum interrupter, consisting of fixed contact and moving contact, shall be interchangeable among the same type interrupter. Short circuit capacity of vacuum bottle should be 31, 5 KA and design life should be 100 nos. operation at rated short circuit level i.e. at 31, 5 KA.

c) Constructional features of the vacuum chamber along with its functional arrangements are to be shown in a drawing submitted along with tender documents.

d) The gap between contacts of the Circuit-breaker inside interrupter should be capable of withstanding 1.5 time voltage to neutral at one atmospheric pressure at normal ambient condition within Breaker in the event of vacuum pressure drop due to leakage.

e) In vacuum interrupter the contact configuration, contact area, contact pressure will be sufficient for carrying rated current and short time rates current, without any abnormal phenomena.

f) Complete details of main contacts shall be furnished. The material of contacts and coating of the contacts shall be suitable for vacuum Breaker technology. Evaporation of metal during arcing and deposition of the same in the inner surface of vacuum interrupter should be restricted by adopting suitable material.

g) The vacuum pressure within interrupter shall be adequate to interrupt the fault current. Precaution shall be taken so that there will be no flush over on outside of the vacuum interrupter inside the porcelain insulator.

h) Design of the vacuum bottle and its insulator encasing should be suitable for outdoor use, taking care of required creepage distance considering possibility of moisture condensation if any, in the annular space between the vacuum bottle and insulator enclosure.

i) Type test with similar bottle with similar encasing arrangement shall be done and accordingly Report shall be submitted along with tender document.

4.15 Current transformers (CTs)

a) Current transformers (CTs) shall be outdoor post-type, manufactured and tested in accordance with 240-56062864.

b) The number and type of CT cores required per phase, together with their position relative to the circuit-breaker and their respective standards or specifications will be specified in schedule A.

c) The CT terminal numbering and wiring interface shall be in accordance with the drawing specified in schedule A.

d) The CTs shall be properly fixed and mechanically supported so that no movement is allowed during transportation or service fault conditions.

e) Where post-type CTs are provided, bolted tinned copper conductors, suitably dimensioned in accordance with the circuit-breaker and CT current ratings, shall be supplied and fitted between the CTs and the circuit-breaker terminals. The cross-sectional area of the copper conductors shall be stated in schedule B. The CT main terminals shall be in accordance with a). The CTs shall be mounted on galvanized steel support brackets attached to the circuit-breaker base frame. OEM to provide an approved lifting method when required to replace.

f) It shall be possible to remove and replace the CTs without dismantling the circuit-breaker.

Table 8: Summary of the Various CT Options Required by Eskom

Item	Short Description	Core Layout	Protection Core (P)	Bus Zone Core (B)	Measuring Core (M)
1.	CT 11 kV 2 500 A 25 kA 2P2M	PPMM	1/2 400T MR	–	2 400/1 MR
2.	CT 22 kV 1 600 A 25 kA 2P2M	PPMM	1/1 600T MR	–	1 600/1 MR
3.	CT 22 kV 2 500 A 25 kA 2P2M	PPMM	1/2 400T MR	–	2 400/1 MR
4.	CT 33 kV 1 600 A 25 kA 2P2M	PPMM	1/1 600T MR	–	1 600/1 MR
5.	CT 33 kV 2 500 A 25 kA 2P2M	PPMM	1/2 400T MR	–	2 400/1 MR

4.16 Switching surge control (where applicable)

For the switching of capacitor banks, reactor banks and transformers, the preferred solution for switching surge control is by means of precise and repeatable operating characteristics in conjunction with an electronic controller (synchronous control switching device) (refer to 3.16) and/or the application of metal oxide surge arresters connected in parallel with the circuit-breaker interrupters.

4.17 Controlled switching

a) Full details of the controlled switching system offered, i.e. the manufacturer's technical specification/manual for the controller and necessary sensors and auxiliary equipment required to achieve controlled switching, shall be supplied with the tender documentation (refer to 4.21). However, the circuit-breaker shall be capable of switching without the use of a controlled switching system.

b) The Supplier shall state in schedule B whether the circuit-breaker offered has been tested in accordance with SANS 62271-302. The Supplier shall indicate whether the circuit-breaker offered was tested independent from any particular controller or whether it was tested with a dedicated controller and the necessary sensors and auxiliary equipment which form part of the tested equipment.

4.18 Auxiliary and control circuits

a) The auxiliary and control circuits shall be designed and implemented in accordance with the requirements of 240-56030489.

b) In the case of circuit-breakers for use in systems of nominal voltage up to and including 52 kV, the circuit-breaker auxiliary and control circuit wiring interface shall be in accordance with D-DT-5407.

c) A removable 3 mm thick brass gland plate (undrilled) having a minimum usable area of 200 mm x 100 mm shall be fitted at the bottom of the enclosure below the terminal strips for the bottom entry and glanding of all control cables. The gland plate shall be secured by a minimum of six M8 set screws with nuts and washers, unless otherwise approved by Eskom. In the case where CTs are supplied with the circuit-breaker, two gland plates each having a minimum usable area of 200 mm x 100 mm shall be fitted below each terminal strip. Earthing of the gland plate shall be via the set screws.

d) To facilitate LV control cable entry and connection, the distance between any part of the terminal strip and the 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.

e) A suitable earthing point shall be provided inside the operating mechanism enclosure to allow earthing of at least 10 spare secondary control cabling cores. This shall be achieved using a suitable number of earthed terminal blocks.

f) Induced electromagnetic disturbances in the secondary system of the circuit-breaker shall not cause spurious operation or damage. This applies under both normal operation and switching conditions, including interruption of fault currents in the primary system.

g) It shall be possible to change the DC control voltage at which the circuit-breaker operating mechanism operates by only replacing the opening and closing coils, operating mechanism motors and motor contactor coils.

Notes:

1) Switchgear shall only be required to operate at one DC control voltage i.e. the closing and opening devices; operating mechanism motors and motor contactor coils to be supplied with the switchgear are required to be suitable for operation at either 110 V DC or 220 V DC as specified in schedule A. The voltage variation is between 85% and 110% of the rated supply voltage U_a.

1) A readily available DC supply voltage "conversion kit" is required by Eskom from the Supplier in order to convert the circuit-breaker operating mechanism from 110 V to 220 V DC or vice versa. This shall be ordered as a separate line item.

4.19 Nameplates

a) The circuit-breaker nameplate shall contain the necessary information specified in SANS 62271-100 and the following:

- Eskom order and contract number
- Eskom stock (SAP) number
- Rated single-phase short-circuit breaking current - where applicable (refer to 3.10 b))

b) The operating device nameplate shall contain the necessary information specified in SANS 62271-100 and the following:

- Trip-coil rated voltage, current, DC resistance (at 20 ^{o}C)
- Close-coil rated voltage, current, DC resistance (at 20 ^{o}C)
- Motor rated voltage and current (starting peak current and nominal running current).

c) Circuit-breakers tested in accordance with SANS 62271-302 for controlled switching should make specific reference to SANS 62271-302 on their nameplates. The nameplates of circuit-breakers intended for controlled closing should indicate the rated making window in accordance with SANS 62271-302.

d) The nameplates and their fixings shall be weather-proof and inherently corrosion-resistant. They shall be either stamp engraved aluminium or stainless steel and are subject to approval by Eskom. All the letters and figures on the nameplates shall be permanently marked. The nameplates shall be securely fastened to the equipment in a reliable manner as in 4.12 f). The method used shall be stated in schedule B. The nameplate material offered shall be stated in schedule B.

e) Duplicate nameplates of the CTs shall be attached to the inside of the operating mechanism enclosure front access door in order for them to be read from ground level.

f) The actual ratings to which the circuit-breaker has been type-tested (and not merely the values specified) shall be displayed and the nameplate shall be visible in the position of normal service and installation.

4.20 Tools and spares

a) A full set of operating tools necessary to carry out all mechanical (manual) operations of the circuit-breaker shall be supplied with each circuit-breaker (e.g., spring charging handle, etc.). A full list of operating tools shall be provided with the tender documentation (refer to 4.21). If additional sets of operating tools are required, this will be specified in schedule A.

b) All operating tools shall be fitted on the inside of the front access door of the operating mechanism enclosure.

c) A detailed list of standard tools required for preventive maintenance shall be supplied with the tender documentation (refer 4.21)

d) to 4.21). Where applicable, the following tools are required for minor maintenance:

- slow operating device(s);
- hoses and fittings for draining and filling with SF_6 free gas or other interrupting and internal insulating medium; and
- other tools which may be required (e.g. contact alignment tools, insulating and internal insulating medium density meter checking device).

e) Should the circuit-breaker require additional specialised tools for major maintenance purposes, a full list of specialised maintenance tools shall be provided with the tender documentation (refer to 4.21).

f) A full list of spares required for maintenance shall be provided with the tender documentation (refer to 4.21).

g) The Supplier shall provide the written letter with the tender documentation that states that in case of the design obsolescence, they shall notify Eskom and present all spares manufacturing drawings and specification (i.e. metal, Bill of material, masses) for the maintenance spares required for circuit-breaker life expectancy.

4.21 Documentation requirements

The manufacturer shall provide the following documentation with the tender documentation:

a) Technical schedules

- Completed technical schedule B for each circuit-breaker size. The technical schedule B shall not be left blank. Where numerical values (e.g. rated values, dimensions, etc.) or specific information is required, the actual value/information offered shall be stated. In such cases, use of the words "COMPLY", "TBA", etc. is not acceptable;
- A full set of general arrangement (GA) drawings showing the following minimum information information to be provided in both CAD and paper format:
  1) Manufacturer’s drawing number and revision number. Provision shall be made for an Eskom-allocated drawing number as well as for the Eskom contract number - for population after awarding of the contract;
  2) a descriptive title of the drawing (e.g. "11 kV 2500 A 1-pole Operated Circuit-breaker General Arrangement");

3) critical dimensions such as overall dimensions, structure dimensions, phase to phase spacing, phase to phase and phase to earth air clearances, working clearance, height of lowest part of insulation above ground, height of top of operating mechanism enclosure above ground, operating mechanism enclosure dimensions, overall height, width and depth of circuit-breaker, etc.;

4) properly annotated drawing with a complete list of major components (bill of materials);

5) details of main terminals including dimensions of the fixing holes, terminal hole spacing, plate thickness and maximum permissible forces (loads) on main terminals (with directions) expressed in Newtons (N);

6) details of the main earthing terminal and operating mechanism enclosure earthing terminal;

7) Sectional views showing the general constructional features of the circuit-breaker including operating mechanism, arcing chambers, and contacts with lifting dimensions for maintenance.

8) Drawings showing control cabinets and circuit diagrams for operating mechanism.

9) Schematic diagrams of breaker offered for control, supervision and auto reclosing.

10) Outline drawings of bushings, terminals and terminal connectors.

b) Structural drawings and loading data for support structures:

1) mass of circuit-breaker in kilograms (kg), which shall include the empty mass, mass and description of heaviest component, total mass of circuit-breaker ready for service and mass of filling medium;

2) any special trenches or steelwork required between phases;

3) the steel support structure dimensioned outline and general arrangement;

4) the steel support structure label mounting holes;

5) in the case where the steel support structure is designed by the manufacturer, the steel support structure earthing terminal;

6) the concrete foundation dimensioned outline, design detail and general arrangement;

7) mounting and fastening arrangement for the circuit-breaker support structure onto the foundation including the minimum required length and diameter of foundation holding down bolts as well as the relative position of levelling nuts, spacers, washers, etc. in relation to the base plate;

8) Static and dynamic forces (loads), centre of gravity - refer to 4.21 a).

9) relative location of circuit-breaker poles, base frame, operating mechanism enclosure(s),

10) location of all enclosure doors and handles;

11) Location and annotation of control facilities (gas filling/evacuation points, SF_6 free density monitoring device with its environmental protection shelter/cover, etc.);

12) location and layout of LV control cable gland plates;

13) Insulation medium pressure and quantity requirements; and

14) location of nameplate on circuit-breaker;

- for all external insulation (i.e. post-insulators, circuit-breaker chamber insulators, bushings, etc.), detailed drawings showing the insulator material, shed profile dimensions including shed and insulation body/core diameters, shed spacing, creepage distance and dry arcing distances, etc.;

- Drawings showing the generic layout of all the nameplates (circuit-breaker, operating device(s), CTs) in accordance with 4.19. Provision shall be made for an Eskom-allocated drawing number as well as for the Eskom contract number - for population after awarding of the contract;
- Generic auxiliary and control circuit schematic wiring diagrams for the circuit-breaker.
- Electrical schematic and wiring diagram with explanatory notes, if any.
- Schematic diagram for spring charged operating mechanism schematic layout drawings.
- anti-pumping
- A general arrangement drawing of the operating mechanism enclosure. Provision shall be made for an Eskom-allocated drawing number as well as for the Eskom contract number - for population after awarding of the contract;

c) Maintenance and spares

- full list of spares required for maintenance (refer to 7.1 f) and section 7.3)
- full list of operating tools (refer to 4.20 a));
- detailed list of standard tools required for preventive maintenance (refer to 4.20 c));
- detailed list of additional specialised tools for major (specialised) maintenance (refer to 4.20 e));
- transport, storage, installation, operating and maintenance manuals (refer to section 6);
- impact indicator on each supplied unit

d) Test report

- full list as well as copies of type test certificates and reports (refer to 5.3);
- Type test of specific circuit-breaker and KIPTS certificate.
- generic routine test certificates for the circuit-breaker (refer to 5.3 b));

e) Miscellaneous

- training material (refer to section 9); and
- generic quality inspection and test plan (QITP)
- the submission, to include the following additional information:

1) details of corrosion protection and lubricants offered (refer to 4.6 d));
2) measures taken to prevent flange corrosion (refer to 4.6 e));
3) certification of all pressure vessel complete with all aspects of OSHA and further requirements like OSHA.
4) details of all gas pressure devices, including drawings, manufacturer's specifications, performance and test data, details of production tests and a quality control programme (refer to 4.13 d)) including certification and future requirements of OSHA compliance requirements;
5) information required for controlled switching (refer to 4.17);
6) maintenance requirement schedule and cost of parts
7) details of equipment requiring maintenance during storage (refer to 6.5 a));
8) a written commitment from the Supplier regarding the submission of the maintenance USB (refer to 7.2); and
9) Spares availability philosophy (refer to 7.3).

f) Unless otherwise specified in schedule A, the manufacturer shall submit the following documentation with each circuit-breaker delivered to Eskom:

- an auxiliary and control circuit schematic wiring diagram of the circuit-breaker;
- a complete set of routine test certificates;
- a commissioning signed off and hand-over test sheet; and
- one set of transport, storage, installation, operating and maintenance manuals.

The above documents supplied with the circuit-breaker shall be stored in the documentation pocket on the inside of the circuit-breaker operating mechanism enclosure front access door.

Note: In addition to the documents supplied with the circuit-breaker, all documents shall be made available in electronic format for publication on the Eskom internal equipment database.

g) The manufacturer shall submit the following documentation to the contract manager and relevant Eskom specialist upon awarding of a contract:

- circuit-breaker analyser data required for condition monitoring (refer to 7.4);
- detailed scope of works (job plan) for each type of prescribed maintenance intervention with tender to determine total cost of ownership (TCO);
- detailed work instructions (task manual) for each type of prescribed maintenance intervention;
- Detailed works reports (check sheet) for each type of prescribed maintenance intervention, and
- Quality inspection and test plan (QITP) in accordance with 240-105658000 clause 6c and Appendix I.

4.22 Packaging and preservation requirements

a) Each circuit-breaker shall be “unit-packed”. In other words, the components making up a complete circuit-breaker shall be delivered to site in one or more packing containers which shall contain only the component for one complete individual circuit-breaker.

Note: Eskom will not accept equipment if the various components of the different circuit-breakers are delivered in the same packing containers.

b) All circuit-breaker components shall be packed in containers (e.g. wooden crates) that are suitable for transport and storage over long periods (for up to 18 months). Refer to 240-105658000 on how to address the preservation requirements of Eskom.

c) Mechanism heaters are required for storage period these will be accessible for connection without opening crates.

d) The packaging shall be able to withstand impact loadings of at least 18 kN. The mechanical strength of the packaging shall not be dependent on the strength of the top cover, i.e. it shall be possible to remove and subsequently replace the top cover without losing any mechanical strength of the packaging.

e) Where more than one crate is used per circuit-breaker, each crate shall be clearly and sequentially marked in order to identify each crate as belonging to a specific circuit-breaker (e.g. “CRATE 1 of 3”, “CRATE 2 of 3”, etc.).

f) Each container/crate shall be clearly marked with a durable label using an indelible font at least 30 mm high indicating the following information:

- Eskom order number;
- Eskom SAP number;
- short circuit-breaker description (including the rated voltage, normal current, rated short-circuit breaking current, auxiliary DC. control voltage; specific creepage; “3P”) ;

- manufacturer's name (i.e. make of circuit-breaker);
- manufacturer's circuit-breaker product designation/code (i.e. type of circuit-breaker);
- manufacturer's serial number(s);
- contents of the crate (i.e. a parts list);
- the crate number (e.g. "CRATE 1 of 2", "CRATE 2 of 2");
- the crate overall dimensions (in mm); and
- total mass of each crate (e.g. "TOTAL MASS: 1000 KG");
- pictograms / symbols showing correct storage and stacking instructions for crates

g) Exposed shafts, bearings and machined surfaces shall be treated with a temporary anti-corrosive coating.

h) Loose components or components that are subject to damage from exposure to dust or water shall be packed in hermetically sealed plastic bags with moisture control.

i) All components shall be clearly marked. Components that are physically impossible to mark shall be individually packed and the packaging shall be marked.

j) Lifting points shall be provided on the packaging, where applicable. These points shall be braced as though it were a lifting pallet (for mechanical support during lifting activities).

k) A readily accessible (i.e. without the need to remove / disturb the external packaging) external temporary 230 V ac supply connection point for the heater circuit during storage shall be provided and wired to the Eskom side of the terminal strip in the factory. This shall consist of an electrical cord wired to a screw-type connection block for the connection of the temporary ac. supply used during storage. Heater connections shall be designed in such a manner so as not to cause a hazardous situation when energised. No internal wiring should need be modified to remove the temporary supply leads. The connection point shall be labelled "230 V AC HEATER CONNECTION: CONNECT IF STORED > 2 DAYS" or similar.

l) A non-resettable impact recorder/detector shall be provided and located in such a position so as to record/detect the acceleration of the circuit-breaker body and not the packaging and shall be set to the design impact level in each of 3 planes –longitude, latitude and vertical.

m) Where applicable, the circuit-breaker shall be transported with a positive gas pressure of maximum 150 kPa.

n) A copy of the BOM shall be provided with the delivery note for each circuit-breaker supplied in order to allow the recipient to confirm that all items on the BOM have been delivered, and for record purposes.

5. Type tests

5.1 General

a) Manufacturer's testing capabilities

The manufacturer shall be fully responsible for performing or having performed all the required type tests as specified. Suppliers shall confirm the manufacturer's capabilities in this regard when submitting tenders. Any limitations shall be clearly stated. The Supplier shall be responsible for all costs related to type testing.

5.2 Witnessing of tests

Eskom reserves the right to be present at any of the type tests specified. The Supplier shall ascertain the sequence of tests required in each particular case and whether witnessing of tests is required, and, after completion of all preliminary tests, shall then give Eskom sufficient, agreed upon, advanced notice of the firm date when the circuit-breaker and associated apparatus will be ready for the witnessing of testing.

Note: Where applicable, the minimum required notification period for overseas travel from South Africa is 12 weeks.

Eskom shall be notified within 48 hours of all test failures and corrective measures in writing. This shall take the form of abbreviated reports that shall, upon request, be supported by more detailed reports. It is desirable that Eskom is notified of test failures to allow in situ inspection if desired.

5.3 Type test certificates and reports

a) Type test certificates together with each complete test report (in English) shall be supplied with the tender documentation (refer to 4.21) in digital data storage electronic format, USB.

b) Generic routine test certificates/reports shall be supplied with the tender documentation (refer to 4.21) in digital data storage electronic format, USB. The test certificate shall indicate (make provision for) the tests performed, results, identification of the equipment tested, etc. The format of the test certificate/report shall make provision for approval by an authorised Eskom representative.

c) One hardcopy of the routine test certificates/reports shall be supplied with each circuit-breaker and stored in the documentation pocket inside the operating mechanism enclosure. In addition to the hardcopy, the routine test certificates/reports shall be made available in electronic format and submitted to Eskom

5.4 Type and routine test requirements

a) The manufacturer shall perform a complete set of type tests for each circuit-breaker design offered. The type test certificates and reports shall be submitted for review during the tender or product evaluation stage. The type test reports shall be according to IEC 62271-100. All type test done on IEC60056 shall not be accepted. If any type testing is carried out during a contract period, Eskom shall be invited as a witness.

Note: If, in the opinion of Eskom, repeat or new type-tests are necessary, the cost of these tests will be taken into account in the evaluation of tenders. In such a case, Eskom may request the supplier to submit details of the cost of carrying out each applicable type test.

b) The circuit-breaker shall be type tested in accordance with SANS 62271-100, the tests shall be carried out from an accredited or government recognised laboratory and shall include the following tests:

- equipment insulation level (SANS 62271-100, 6.2);
- temperature rise and measurement of resistance of circuits (SANS 62271-100, 6.5 & 6.4);
- current withstand - main circuit (SANS 62271-100 6.6);
- circuit-breaker short-circuit making and breaking capacities (SANS 62271-100 6.102 to 6.106);
- critical current tests (where applicable) (SANS 62271-100 6.107);
- single-phase tests (for Un ≤ 52 kV) (SANS 62271-100 6.108);

- double earth fault tests (for Un ≤ 132 kV) (SANS 62271-100 6.108);
- short-line fault tests (for class S2 circuit-breakers and Un ≤ 52 kV) (SANS 62271-100 6.109);
- out-of-phase making and breaking tests (applicable if an out-of-phase rating is assigned) (SANS 62271-100 6.110);
- capacitive current switching tests (SANS 62271-100 6.111);
- switching of shunt reactors (for Un ≥ 52 kV) (SANS 62271-110);
- electrical endurance tests (for class E2 circuit-breakers) (SANS 62271-100 6.112);
- circuit-breaker mechanical operation (SANS 62271-100 6.101.2.1 - 6.101.2.3);
- circuit-breaker extended mechanical endurance tests (for class M2 circuit-breakers) (SANS 62271-100 6.101.2.4);
- verification of the protection (IP coding) (SANS 62271-100 6.7)
- tightness test (SANS 62271-100 6.8)
- EMC tests (SANS 62271-100 6.9) - where applicable;
- X-radiation test procedures for vacuum interrupters (SANS 62271-100) - where applicable;
- static terminal load tests (for Un ≥ 52 kV) (SANS 62271-100 6.101.6);
- additional tests on auxiliary and control circuits (SANS 62271-100 6.10);
- insulator tests (as per 240-142598739) and
- corrosion test on earthing connections and mechanisms

c) Time-current curves of the electrical tripping and closing circuits shall be provided, both for normal operation, and in the event that the tripping/closing plunger is prevented from moving. The resolution of the function times shall be clearly indicated in the test reports.

d) The circuit-breaker shall be routine tested in accordance with SANS 62271-100 and shall include the following tests:

- Dielectric test on the main circuit (SANS 62271-100 7.1);
- tests on auxiliary and control circuits (SANS 62271-100 7.2);

Note: In the case of switchgear supplied from an overseas OEM where the wiring of auxiliary and control circuits is done locally, the tests on auxiliary and control circuits are to be done locally as part of the local factory acceptance testing (refer to 4.18.

- measurement of the resistance of the main circuit (SANS 62271-100 7.3);
- all functional and timing tests
- tightness test (SANS 62271-100 7.4)
- design and visual checks (SANS 62271-100 7.5);
- pressure tests of enclosures and
- Mechanical operating tests on circuit-breaker (SANS 62271-100 7.101).

e) The following characteristics, in addition to those specified in SANS 62271-100, shall be measured and recorded during the mechanical operating tests (where applicable):

- closing and opening speeds;
- timing tests on each type of auxiliary switch contact in relation to the main contacts (including relative timing between main and auxiliary contacts of single-pole operated circuit-breakers when operated simultaneously);
- settings of pressure switches / gas density monitoring devices; and

- Time-current curves of the electrical tripping and closing circuits for normal operation. The resolution of the function times shall clearly be indicated on the test reports.

f) Where applicable, circuit-breakers intended for operation with intentionally non-simultaneous poles shall be tested in accordance with SANS 62271-302 (performance verification tests and parameter definition tests for controlled switching applications).

g) Circuit-breakers and, where applicable, post-type current transformers for use in systems of nominal voltage up to and including 132 kV shall be subjected to the KIPTS pollution performance test in accordance with 240-100495413 or 240-142598739.

h) Where applicable, CTs shall be tested in accordance with SANS 61869, NRS 029, as applicable.

i) Insulators of the composite type shall be tested in accordance with SANS 61462 and SANS 60815-3.

5.5 Tests after installation on site (pre-commissioning tests)

a) Commissioning checks and a test programme (as determined by the manufacturer) and approved by Eskom shall be carried out in accordance with SANS 62271-100 10.2.101 and 10.2.102 for all circuit-breakers. The test programme shall be incorporated into the circuit-breaker inspection and test plan. This shall include checks after installation, mechanical tests and measurements, checks of certain specific operations and electrical tests and measurements.

b) Electrical tests shall include, but are not limited to, the following:

- measurement of the steady-state contact resistance of the main circuit; and
- Measurement of the dynamic contact resistance of the main circuit.

c) The measurement of the time quantities shall be done at nominal and minimum coil control voltage.

Note: The measured times for nominal and minimum coil control voltage should be within ± 5 % of the times, as specified on the circuit-breaker pass sheet supplied by the OEM.

d) For each measurement of the operating time, a recording shall be made of each individual operating coil current - namely close, trip I (main) and trip II (back-up). The resolution of the function times shall be clearly indicated in the test reports.

e) During the measurement of the re-charging time of the closing spring, the peak motor current in the spring charging process shall be measured as well as the continuous motor current. Measurements shall be made both at the nominal and minimum control voltage.

Note: The results should be within ± 2 % of the circuit-breaker pass sheet results supplied by the OEM.

f) For the recording of the mechanical travel characteristics, travel curves for each phase shall be recorded. The location of the travel transducers on the circuit-breakers shall be clearly indicated in the test report. The following measuring results shall be provided:

- the total travel (in mm)
- the over-travel (in mm)
- the rebound (in mm)
- the under-travel (in mm)
- the contact penetration (in mm)
- moving-contact or operating rod position at the time of make or break
- anomalies which are evident from the trace
- the average speed on closing (in m/s) and actual
- the average speed on opening (in m/s) and actual

g) For the measurement of the steady-state contact resistance of the main circuit, a DC current of at least 100 A shall be used. The dynamic contact resistance shall be measured during a close and open operation of the circuit-breaker. This shall be done for each main contact separately. A detailed diagram of the measurement set-up shall be given (sketched) in the pre-commissioning test report. If any difficulties have occurred during erection or commissioning, this shall be clearly stated in the pre-commissioning test report. The results shall be given in μΩ and the resolution shall be at least 1 μΩ.

h) Reasons for differences between the results of the tests made on-site and the results of the tests as they were carried out at the OEM's works (the circuit-breaker pass sheet) shall be clearly stated and corrections shall be made.

i) Where applicable, circuit-breakers intended for operation with intentionally non-simultaneous poles shall be tested in accordance with SANS 62271-302 10.101 (commissioning of circuit-breakers for controlled switching applications)

j) The results of pre-commissioning tests after installation on site shall be documented, signed off and a copy of the results included with the switchgear documentation for hand-over as part of the quality process. All tests may be witnessed by Eskom. Refer to 4.21 for further information on the pre-commissioning test report.

6. Manufacturing, transport, storage, installation, pre-commissioning and after sales technical support

6.1 General

a) The manufacturing, transport, storage, installation and pre-commissioning of switchgear and control gear, as well as their operation and maintenance in service, shall be carried out in accordance with the instructions given by the OEM.

b) The supplier shall provide instructions for the transport, storage, installation; operation and maintenance of the equipment according to the requirements set out by the OEM (refer to 4.21).

c) The operation of any impact recorder must be immediately be reported to Eskom and tests carried out to confirm that current state to be suitable for operation before any further work is completed.

6.2 Inspection of manufacturing facilities and circuit-breakers

a) Eskom reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the circuit-breakers offered - both before and at any time during manufacturing.

b) Eskom reserves the right to inspect any ordered circuit-breaker before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, switchgear schedules and the approved manufacturer's drawings.

c) With the tender documentation (refer to 4.21), the supplier shall submit the quality control plans to Eskom, indicating all inspection hold points. Eskom may add the necessary inspection hold and/or witness points for Eskom or its appointed representative. The supplier shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. Eskom will not accept late delivery on the basis of inspection delays.

Note: Where applicable, the minimum required notification period for overseas travel from South Africa is 12 weeks.

d) Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the Deviation Schedule with reasons for such deviation included. Such listed deviations may not be accepted. Deviations not mentioned in the Deviation Schedule will not be considered.

e) Any deviations in the circuit-breaker design shall be pointed out in accordance with the tendered deviation schedule and the type test certificates provided for the specific unit design. No clearance will be given where there is no satisfactory evidence of the relevant type test certificates, where such tests are required.

f) Clearance shall be obtained before dispatching the equipment. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT) or from this inspection. Within one month of contract award a design review of each type of circuit-breaker will be carried out.

6.3 Conditions during transportation

Note: Refer to 240-53902499, for the requirements on transport, handling, storage and preservation.

a) Conditions can be expected to be onerous during transport, storage and installation. Adequate precautionary measures shall be provided for the packaging and protection of sensitive components such as insulating parts and operating mechanisms during transport, storage and installation (including corrosion of exposed parts).

b) Vibrations and impacts during transport shall also be considered. Refer to 4.22 l) for the requirements for non-resettable impact recorders.

c) The supplier shall demonstrate - either by testing or through previous satisfactory experience - which the equipment complies in this respect. Testing may include the following:

- shipping test: this test shall cover all the conditions to be encountered during transportation from factory to the designated site, including loading/off-loading from one mode of transport to another;
- vibration test: this test may be used to supplement actual shipping tests to check for unexpected shortcomings in the equipment and packaging; and
- Weather-proof test: this test may demonstrate the adequacy of the packaging to prevent ingress of moisture and water from weather or sea conditions and control condensation.

6.4 Transportation and off-loading

a) The requirements for packaging for transportation and storage refer to 6.

b) The Supplier shall be responsible for the transportation and off-loading of the equipment on site. Off-loading includes transportation from the point of off-loading the equipment after transportation to the point of installation.

c) The Supplier shall provide his own means of off-loading at the point of installation.

6.5 Storage and preservation

a) If any equipment requires maintenance or attention during storage, this shall be clearly stated in the contract and Eskom's attention shall be drawn to this fact. This information shall be submitted with the tender documentation (refer to 4.21) as well as with orders upon awarding of a contract.

b) At the time of off-loading at an Eskom facility, the Supplier has the responsibility to ensure that the necessary steps are taken by Eskom to ensure satisfactory storage.

c) Where heaters need to be energised, a clearly marked electrical connection point (refer to 4.22k) shall be provided to enable Eskom to supply power to the heaters without opening.

d) The Supplier shall implement proper storage and handling (de-stuffing) procedures, which should always be part of site delivery documentation. A copy of the storage and handling procedures shall be made available to Eskom for acceptance (refer to 4.21). This shall indicate the maximum recommended period of storage, as well as recommended actions to be taken if a longer storage period (preservation) is required.

e) The Supplier shall provide the storage and preservation protocol from the OEM at tendering stage for Eskom evaluation, namely site requirements, spares requirement and stores facility requirement.

6.6 Installation

a) Unless otherwise specified and agreed (the OEM certified training and/or supervision is provided) on-site installation and operating training, the supplier where applicable shall be responsible for the installation and pre-commissioning of the equipment. This includes the supply of all installation tools, lifting tackle and test equipment.

Note: Eskom will normally provide the support structures (unless otherwise specified) under a separate contract/order.

b) Installation includes mounting and securing the equipment and its support structure onto the concrete support foundation, levelling of the switchgear, filling of gas (other medium), where applicable must identify all risk and mitigate.

c) For each type of circuit-breaker, the installation instructions provided by the supplier (refer to 4.21) according to the OEM's instructions shall at least include the items listed below:

- unpacking and lifting instructions: all information required for unpacking and lifting safely shall be given, including details of any special lifting and positioning devices that are necessary;
- Assembly: when the switchgear is not fully assembled for transport, all transport units shall be clearly marked. Drawings showing the assembly of these parts shall be provided with the switchgear;
- Mounting: instructions for mounting the common base frame, poles, operating device(s) and auxiliary equipment shall include sufficient details to enable site preparation to be completed. These instructions shall also indicate:
  1) the total mass of the equipment, inclusive of extinguishing or insulating gases;
  2) the mass of extinguishing or insulating gases; and
  3) the mass of the heaviest part of the apparatus to be lifted separately if it exceeds 100 kg;
- Qualification of personnel: all personnel employed by the Supplier who are involved in the installation and pre-commissioning of the circuit-breaker shall be trained and accredited by the OEM. Proof of this accreditation shall be included in the quality control plan and shall be submitted to Eskom for approval prior to installation and pre-commissioning of equipment by the individuals concerned; and
- Final installation inspection and testing: instructions shall be provided for inspection and testing after the switchgear and control gear has been installed and all the interfacing connections have been completed. These instructions shall include the following:
  1) procedures for carrying out any adjustment that may be necessary to achieve correct operation;
  2) recommendations for any relevant measurements that should be made and recorded to help with future maintenance decisions; and
  3) Instructions for final inspection and testing.

d) The Supplier shall be responsible for ensuring the training and accreditation of persons employed for the installation and pre-commissioning of switchgear.

e) During the performance of the work at the substation site, the Supplier shall comply with all the relevant statutes, regulations, bylaws and codes, as well as all the safety and quality requirements pertaining to the work. The Supplier shall provide all apparatus including safeguards and personal protective equipment (PPE), including a Fall Arrest System (FAS), necessary for the performance of the work.

f) Installation tools / equipment and debris shall be removed from site when installation is completed.

g) Where ac. power supplies cannot be made available to the Supplier for installation and pre commissioning purposes, the Supplier shall be responsible for providing his own ac. power supply (e.g. generator) for the installation and pre-commissioning of switchgear.

6.7 Pre-commissioning (where applicable)

a) Each circuit-breaker shall be tested after installation in accordance with 5.5

This is to assure proper installation and that no damage occurred during transportation. The pre-commissioning tests shall be witnessed by an appointed Eskom representative/official. To facilitate the testing, adequate DC power supplies, test equipment and suitably qualified and accredited personnel shall be provided by the Supplier.

b) A circuit-breaker pre-commissioning test report shall be submitted to Eskom, comprising the following parts:

6.7.1 Required measurements records

a) After the measurements at the substation site, a hand-written pre-commissioning test report shall be handed over to the appointed Eskom representative/official. Any special note shall be incorporated by the Supplier on this report, e.g. “Activate anti-condensation heaters”;

b) within two (2) weeks after the pre-commissioning tests, the Supplier shall submit an official report to Eskom (two hardcopies); and

c) An electronic copy of the official report shall be provided on a USB for each individual circuit-breaker. The software used shall be compatible with one of the types of test equipment mentioned above. Reports shall be in pdf or Microsoft Word (.doc) format.

6.7.2 Measured values

All the measured values shall be clearly stated in the report as well as the following:

a) Test/measuring equipment information/data:

- make and type of instruments;
- serial numbers of instruments;
- methods of triggering;
- measuring methods;
- the accuracy of the instruments; and
- calibration certificates of the measuring instruments used;

b) the circuit-breaker data:

- make and type;
- serial numbers of poles and operating mechanisms;
- rated voltage, normal current and short-circuit breaking current;
- the name of the feeder / line and section;
- circuit-breaker identification and application;
- any deviation to be highlighted.
- date of commissioning; and
- date and time of testing/measuring.

6.7.3 Clear copies

Clear copies of the complete printouts of the timing, travel characteristics and dynamic main contact resistance measurements shall be attached to the official report. The names of all parties concerned shall be clearly stated in the report. If the measured values differ from the values as they were measured at the manufacturer's works, an interpretation shall be given and, if Eskom deems it necessary, the deviation shall be corrected by the Supplier. If the circuit-breaker is found to be faulty during the tests, a fault report shall be completed in addition to the pre-commissioning test report and an NCR raised.

6.7.4 The switchgear and control gear shall be subject to a final inspection by Eskom

a) The switchgear and control gear shall be subject to a final inspection by Eskom after pre-commissioning in accordance with the approved quality control plan.

b) After the final inspection, the final commissioning of the plant is performed and the hand-over documents shall be provided to Eskom by the Supplier.

6.7.5 Safety related data (where applicable)

All liquids or chemicals, gasses or oils used during installation shall be supplied with Material Safety Data Sheets (MSDS).

6.7.6 Requirements for pressure vessels (where applicable)

Circuit-breakers, which are subject to the provisions of the Occupational Health and Safety Act regarding pressure vessels, shall be provided with certificates for the associated pressure vessels. These certificates shall be issued by an independent inspection authority approved by Eskom. The costs of such an inspection authority appointment shall be borne by the Supplier. The Supplier shall supply to the appointed inspection authority calculation sheets, design drawings and welding procedures of all pressure vessels for approval before manufacture commences. In addition, copies of sub-orders for bought-out vessels or works orders (if manufactured internally) shall be supplied to the appointed authority. Sufficient proof shall be provided that all welders employed in the fabrication of pressure vessels are adequately qualified and that their qualifications are valid. Each pressure vessel must be tested as per OHSA.

6.8 After sales technical support

The Supplier shall provide locally based technical specialist support on a full time basis for the duration of the contract.

7. Inspection and Maintenance

The manner of which the OEM prepared instructions and implemented by Eskom gives effectiveness to the maintenance requirements. The Supplier shall supply maintenance information in the form of maintenance manuals, field service bulletins and Universal Serial Bus (USB) material covering the following information listed below:

a) Extent and frequency of maintenance. For this purpose, the following factors should be considered:

   1) switching operations showing total current and number of operations (a graph showing the maximum number of guaranteed operations as a function of short-circuit breaking current shall be provided as well as the maintenance and time required to restore the circuit-breaker once the accumulated switching amperage limit has been reached);

   2) total number of operations;

   3) time in service (periodic intervals);

   4) environmental conditions;

   5) activity after a seismic event (if applicable);

6) measurements and diagnostic tests for condition monitoring including on-line, (if any).

b) Scope of work to be performed: It shall include the following:

1) recommended place for the maintenance work (indoor, outdoor, in factory, on site, etc.);
2) procedures for inspection, diagnostic tests, examination, overhaul;
3) reference to drawings;
4) reference to part numbers or standard kit of parts;
5) use of special equipment or tools;
6) precautions to be observed (for example cleanliness and possible effects of harmful arcing by-products);
7) lubrication procedures.

c) Comprehensive drawings of the details of the switchgear and controlgear important for maintenance, with clear identification (part number and description) of assemblies, subassemblies and significant parts.

Note: Expanded detail drawings which indicate the relative position of components in assemblies and subassemblies are a common illustration method.

d) Limits of values, which can be measured during operation or routine maintenance and tolerances which, when exceeded, make corrective action necessary, for example:

1) pressures, density levels, gas mixtures tolerance;
2) 2 resistance of the main current carrying circuits;
3) operating times and contact velocities;
4) resistance of the main circuits;
5) insulating liquid or gas characteristics;
6) quantities and quality of gas;
7) contact condition (including contact dimensions);
8) permissible erosion of parts subject to wear;
9) torque settings for fasteners;
10) important dimensions.

e) Specifications for auxiliary maintenance materials, including warning of known non-compatibility of materials:

1) grease;
2) oil;
3) fluid;
4) cleaning and degreasing agents.

f) List of standard and special tools (with description of their application and associated part number), lifting and access equipment.

g) Tests after the maintenance work (all tests shall be clearly described and shall include the parameters to be observed).

h) List of the recommended spare parts (description, reference number, quantities) and advice for storage.

i) Estimate of active scheduled maintenance time, carried out in accordance with an established time schedule.

j) How to proceed with the equipment at the end of its operating life, taking into consideration environmental requirements.

7.1 Maintenance Video

It is anticipated that maintenance intervals for the circuit-breakers will be very long, e.g. several years. Consequently, it is essential that the instruction manual be supplemented and supported by a maintenance-orientated video recording. The video recording shall be converted into a suitable USB format. A written commitment from the Supplier regarding the submission of the USB shall be provided with the tender documentation (refer to 4.21). The actual USB shall be supplied upon awarding of the contract following approval of the maintenance manual by Eskom. Copies of the USB shall be issued to the contract manager and relevant technical specialists.

The USB shall provide a record of the maintenance requirements and procedures for the equipment supplied. The USB and related instruction and maintenance manuals shall be detailed enough to enable a trained maintenance crew (with some general knowledge of the equipment) to perform all inspections and maintenance required on the equipment. It is anticipated that the instruction manuals will list what maintenance is required, while the USB will show how such maintenance is achieved.

The USB shall cover routine inspection, minor and major maintenance (overhaul) of all equipment requiring such work, as well as some trouble-shooting techniques and tips. It shall explain the normal operation of the equipment in sufficient detail for the maintenance crew to be able to differentiate between normal and abnormal equipment performance. The USB shall concentrate on equipment maintenance and shall not include any unnecessary sales or publicity material. Since the topics to be covered are extensive and complex, it may be considered an advantage to present the results in definite sections, covering the various aspects or portions of the equipment.

These sections may be on separate USBs or if consolidated into a single USB, there shall be adequate indexing to permit quick access to the desired section. For each piece of equipment requiring maintenance, the USB shall show:

- the tools, equipment and materials required to perform the maintenance, especially any special tools;
- the tests required prior to maintenance operations to record the status of the equipment and/or to indicate the areas requiring maintenance/re-adjustment;
- the dismantling steps, including any marking of positions required prior to dismantle, any discharging of pressure and/or stored energy;
- the dismantling, removal, replacement and re-assembly of any sub-components requiring scheduled maintenance/replacement;
- the re-assembly, realignment and re-installation of all components, including any lubrication of moving parts;
- a brief summary of the evacuation, refilling and leak testing of the re-assembled equipment;
- the testing of the re-assembled equipment, including acceptable values and tolerances of the measured/tested parameters;
- safety rules and mitigation
- Some trouble-shooting methods if the required tolerances are not achieved; and.

The trouble-shooting portion of the DVD shall record the normal/expected values of equipment performance, plus techniques and tips to analyse the cause of any abnormalities, and how to correct them.

7.2 Spares

a) General

Spares will normally be purchased at the same time that orders are placed for circuit-breakers. The Supplier shall provide a list of the minimum recommended spares together with prices in the pricing schedules for the circuit-breakers concerned and the schedule when required.

Note: Delivery to any of the specified destinations should remain valid for the duration of the contract period and be subject to the same Contract Price Adjustment formula as applied to the circuit-breakers.

b) Availability of spares

The Supplier (who 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.

Spares required under emergency breakdown conditions shall be readily available with a maximum lead time of 24 hours from date of purchase order. The Supplier shall state the lead time offered in schedule B. This excludes spares required for scheduled maintenance.

The following spares shall be readily available locally (in South Africa) within 12 hours:

- trip coils;
- close coils;
- Spring charging motors;
- SF_6 free density monitoring devices; and
- Contactors and relays.
- D.C. supply voltage conversion kits
- CT's
- x1 limb

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.

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 as well as all modifications within 2 months of such knowledge with spares lists and instructions to perform modifications throughout the life of plant:

- all design data;
- all material characteristics and parameters;
- all testing information (parameters, equipment, methods, criteria, etc.);
- all manufacturing information; and
- all relevant working drawings and information.

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 (refer to 4.21).

c) Identification of spares

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 metal label bearing the appropriate identification.

A parts list 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.

d) Packaging, preservation and storage of spares

The supplier to refer to 240-105658000 on to handle preservation. Care shall be taken to ensure that spares are protectively packed for satisfactory long-term storage. Maintenance spares will usually be stored indoors.

e) DC supply voltage conversion kits

DC supply voltage "conversion kits" shall be kept locally by the Supplier in South Africa for the duration of the contract to ensure that they are readily available as and when required. Separate conversion kits shall be available that are able to convert from 110 V DC to 220 V DC or from 220 V DC to 110 V DC refer to 4.18.

7.3 Modifications to circuit-breakers during their service life

If, during the normal service life of a circuit-breaker supplied, Eskom requires to be notified about a necessary modification, a field service bulletin shall be issued to the Eskom contract manager and relevant technical specialists giving details of the modification and the reason for it. Suitable training and parts shall be supplied to Eskom within 30 days of any modification required for all circuit-breakers supplied to Eskom. All concessions shall be approved by Eskom.

7.4 Condition monitoring of circuit-breakers

The Supplier is encouraged to develop practical and innovative methods to improve the reliability and maintainability of the circuit-breaker installation. This may include on-line condition monitoring and/or integrated diagnostic devices achieving the following functions:

- accumulated interruption amperage values (per pole);
- contact wear (per pole);
- continuous measurement of SF_6 free gas or other interrupting and internal insulating medium density, the instrumentation for which will provide information enabling early warning of insulation medium leaks and planned outages for refilling or repairs;
- analyser for SF_6 free gas quality and decomposition products (with alarms); and
- Continuous monitoring, recording and alarm signaling of the mechanical operating characteristics of the circuit-breaker.

The on-line condition monitoring and/or integrated diagnostic device shall be IEC61850 protocol compliant.

All information required to carry out condition monitoring of circuit-breakers (including, but not limited to, specification sheets, speed calculation points, travel curve values, etc.) shall be provided by the OEM for each type of circuit-breaker. This information shall be given to the Eskom contract manager and relevant technical specialist upon awarding of the contract.

8. Manuals

Transport, storage, installation (erection), operation and maintenance information shall be submitted in the form of manuals (refer to 4.21f)). These manuals shall be in English and provided in the following formats:

- hard copy A4 form; and
- electronic copy form copied onto an appropriate medium such as Universal Serial Bus (USB).

The manual and contents shall be approved by Eskom. The approval process shall be initiated immediately upon contract award and completed within two months. The onus shall be upon the Supplier to meet this programme. If further material is required, then this shall be subject to negotiation.

One set of sample manuals shall be supplied to Eskom with the tender documentation (refer to 4.21) for approval. After approval, the requisite number of manuals shall be supplied.

8.1 General content

The instruction manual(s) shall cover transport, storage, installation, operation and maintenance of the equipment. Qualified personnel shall install, operate, maintain and repair the equipment with the aid of the manufacturer's instruction manuals and USB Flash Drive aids. The manuals shall contain at least the following information (where applicable):

- the manuals shall be written in English only;
- it shall be specifically compiled for the circuit-breaker with which it has been supplied;
- torque wrench settings, clearances, settings and other important information shall be listed, e.g. the typical operating times, speed curves and tolerances in synchronism;
- it shall give a clear description of the operation, and the diagrams, photos and description shall be easily read together;
- routine inspection, preventative and corrective maintenance procedures shall be given together with a list of lubricants, recommended spares and/or special tools and so on, required for these activities;
- it shall contain high-quality diagrams and photos showing details of operating components of the circuit-breaker, which also identify and list separately each component making up the diagram;
- seals and gaskets requiring replacement during overhaul shall be detailed and the Suppliers of these components, together with the part number(s), shall be listed; and
- the names and addresses of suppliers of lubricants, oils, gases, and compounds and so on shall be listed.
- Title page: title of equipment, equipment ratings, contract and order numbers, Supplier's reference numbers. This information shall also appear on the outside of the binder and on the first page;
- table of contents: the manual shall be sectionalised and numbered sequentially;
- equipment make and type to which the manuals apply;
- list of all drawings, by number and title;
- description and summary of circuit-breaker operation;
- full details of method adopted for anti-pumping;
- where applicable, details of interlocking between phases;
- where applicable, details of auto-reclosing arrangements;
- schematic wiring diagram of circuit-breaker; and
- where applicable, full details of all valves, including information regarding materials of valves and valve seats. If materials such as synthetic rubber or other equivalent types are used, the method of bonding or clamping these materials shall be given.

8.2 Transport and storage instructions

- packaging requirements;
- transport instructions;
- storage instructions: indoor, outdoor and special information for equipment storage; and
- the measures required to make sure all the manufacturer's transportation and storage requirements are met.

8.3 Installation instructions

- complete step-by-step instructions and detailed drawings, including alignment, installation and dimensional tolerances for preparing the equipment for service;
- inspection procedures before and after unloading, pre-installation tests, gas-filling and monitoring procedures;
- the levels of expertise required for the construction team;
- a man-hour estimate for the installation work required on site;
- a list of special equipment and tools required for unloading and positioning components of the circuit-breaker on site; and
- tolerances for field assembly.

The Supplier shall supply a USB Flash Drive to supplement installation information given in the installation manual. This visual information may be provided separately or may form part of the maintenance USB Flash drive required.

8.4 Testing

- functional testing, dielectric testing, controlled switching testing, operating instructions, operating limits and starting-up instructions (complete with sketches or drawings); and
- a separate set of record sheets, showing measurements and tolerances for each test for separate items of equipment.

8.5 Inspection and maintenance

- the maintenance manual shall contain the typical contents as described in 7.

8.5.1 Dismantling, repair, settings inspection and lubrication

- instructions for dismantling the equipment, as well as repair instructions and settings of critical clearances and adjustments, complete with photographs and sketches or drawings;
- special tools shall be clearly described;
- guide to inspection frequency;
- all gaskets, seals and o-rings which have to be replaced during scheduled maintenance or after a specified period, shall be identified;
- lubrication chart and schedule (including component quantities). Lubricants shall be clearly identified. If no lubrication is required, it shall be clearly stated;
- procedures for the discharge of stored energies in the mechanical and electric systems;
- procedures for the safe disposal of decomposed SF_6 free gas products shall be described; and
- Trouble-shooting procedures shall be provided.

8.5.2 Spare parts

- Spare parts list, including quantities and manufacturer's part numbers. Spare part numbers shall be cross-referenced with drawings in the instruction manual;
- drawings (sectional or "exploded" views, etc.) of the equipment/sub-assemblies shall identify every component (excluding standard bolts, nuts, washers, etc.) referenced to the spare parts list, including component description and manufacturer's part number; and
- delivery times for recommended spare parts shall be stated. Drawings for equipment

- A complete set of approved drawings specific to the equipment being supplied. The drawings shall show dimensions and tolerances of the major components and assemblies. Details of the drawings required are given in 4.21.

9. 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.

10. Safety, health, environment and quality

For supplier management and the way that Eskom contracts with suppliers tenderers shall refer to ESP 32-1188 for Eskom's health and safety management requirements for Suppliers. Tenderers shall also refer to 240-105658000 for Eskom's quality management requirements for Suppliers.

11. Authorisation

This document has been seen and accepted by:

Name and surname	Designation
Bheki Ntshangase	Senior Manager HV Plant and Plant Equipment SC Chairperson
Jabulani Cebekhulu	AIS Care Group Convener
Richard McCurrach	Senior Manager PTM&C
Amelia Mtshali	Senior Manager DBOUS

12. Revisions

Date	Rev	Compiler	Remarks
Nov 2019	3	I Sibeko	Document modified and revised in various parts such as: Some abbreviations added and document numbering changed. 800 A rated normal current removed. 31.5 kA rated short-time withstand current introduced. SF_6 free gas replaced with SF_6 free gas environmentally friendly alternative. Requirements for surge arrester bracket updated.
March 2017	2	I. Sibeko	Formatted on the correct template and no content changed
Aug 2015	1	I. Sibeko	First issue as 240-66581487

13. Development team

The original document was compiled by Isaac Sibeko. The following people were involved in the development of this standard.

- Isaac Sibeko PDE-HV Plant
- Japhta Makgotlho GOU & NWOU - SI

• Mohamed Khan	KZN OU - SI
• Sphiwe Nkosi	PDE-HV Plant
• Thabang Motau	FSOU & NCOU - SI
• Shamona Sivasamy	MOU - SI
• Almund Cilliers	MOU - Plant
• Khutso Mokuwe	PDE – DBOUS
• Freddy Mvula	PDE-DBOUS
• Theunus Marais	PDE – Subs Design
• Mabatane Mariri	Group Commercial

14. Acknowledgements

Not applicable.

Annex A – Supplier and Eskom responsibilities

The responsibilities of Eskom and the Supplier of the switchgear and associated equipment shall be as defined below.

1) Supplier's responsibilities

The Supplier shall be responsible for, but not limited to, the following:

a) Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of Equipment must be mentioned in the Deviation Schedule with reasons of such deviation. Such deviation suggested may not be accepted. Deviations not mentioned in Deviation Schedule will never be considered.

b) All testing and recording of results required by this standard as well as the OEM's own protocols using accredited personnel including the use of approved and calibrated test equipment. Type testing shall be carried out in accordance with the relevant IEC product standards. All testing shall be done at accredited local test facilities (SANAS accredited – e.g. SABS) or accredited international testing authorities (e.g. KEMA/CESI/IPH);

c) in the case of evaluation at the factory of circuit-breakers for use on systems with nominal voltages up to and including 765 kV, the erection of a completely functional prototype at the Supplier's own premises under direct supervision of the OEM for a comprehensive evaluation by Eskom before erecting on site. Unless otherwise agreed by Eskom;

d) ensuring equipment is in an acceptable and safe working condition during all phases of transportation from factory to site, storage until the point of official handing over;

e) All necessary arrangements for factory acceptance, transporting and off-loading at the most convenient point (if applicable), as well as for transporting and off-loading at the ultimate destination. Eskom will only accept delivery to the destination specified at the time of placing the order – unless otherwise negotiated. Shafts, bearings and machined surfaces exposed during transport and storage shall be treated with a temporary anti-corrosive coating;

f) provision of OEM accredited installation and pre-commissioning services for all on-site work;

g) The supply of all documentation relevant to the circuit-breaker including routine factory test results. Records shall be available during the pre-commissioning (on-site) testing phase;

h) when required, the supply of a fully complete circuit-breaker assembled, installed, pre-commission (on-site) tested and ready for handover (including, where applicable, controlled switching systems);

i) where necessary (i.e. in the absence of an on-site ac. power supply), the supply of an ac. power supply (e.g. generator) for the installation and pre-commissioning of switchgear;

j) the supply of all conductor clamp main terminals on the supply and load side;

k) the supply of all necessary auxiliary equipment, including operating mechanisms, control, monitoring and protective devices, installed in suitable operating mechanism enclosures;

l) The supply of all auxiliary and control wiring and terminations for the circuit-breaker, including inter-pole cabling and cabling to the central control enclosure(s). For single-pole operated circuit-breakers the wiring shall be done in the factory. No additional inter-pole wiring on site is allowed;

m) the supply of all electrical and mechanical interconnections between the elements of the circuit-breaker – made to Eskom's satisfaction;

n) the supply of all fixing bolts, fasteners and adapter plates – excluding the bolts required for fixing support structures to concrete foundations (which are to be supplied by Eskom);

o) The supplier is responsible to ensure that a complete design review is carried out and signed off by Eskom before proceeding with contract.

p) where applicable, the first filling of the interrupting and internal insulating medium to the OEM's rated value;

q) when required, the supply of the steel support structures for the circuit-breaker;

r) when required, testing and recording of results required by this standard as well as the OEM's own protocols using accredited personnel including the use of approved and calibrated tools and test equipment;

s) provision of all training in accordance with 240-56065202 by OEM accredited trainers;

t) notify Eskom of all modifications timeously and provide spare kits where required;

u) notify Eskom of any modifications required during the circuit-breaker service life; and

v) Any other responsibilities as specified in this document.

2) Eskom's responsibilities

Eskom shall be responsible for the following:

a) the supply of the relevant standard(s) or specification(s) and completed schedule A's with the enquiry;

b) The evaluation of all equipment offered and documentation supplied with a tender. This includes the compilation of an evaluation report summarising the outcomes of the evaluation including TCO;

c) when required, the assessment and evaluation of the relevant manufacturing facilities;

d) when required, the assessment and evaluation of the relevant transport, installation and pre-commissioning facilities;

e) The approval of all drawings submitted by the Supplier (e.g. general arrangement, nameplate, schematic wiring, etc.);

f) The approval of all other documentation provided by the Supplier (e.g. manuals, training material, inspection and testing plans after installation, etc.);

g) the supply of a heater connection point for long term storage;

h) the provision of concrete foundations for the approved circuit-breaker support structure;

i) the stringing and clamping of main conductors;

j) the supply and installation of the control cabling to the circuit-breaker operating mechanism enclosure;

k) the supply and installation of all control, metering, relaying and annunciation equipment remote from the circuit-breaker;

l) specifying (at the time of placing the order) whether the steel support structure for the circuit-breaker is required to be supplied by the Supplier;

m) if necessary, provide suitable storage facilities where circuit-breakers are to be stored for extended durations prior to installation due to unplanned delays; and

n) The witnessing and approval of the first complete circuit-breaker installation and pre-commissioning.

o) Evaluation of local technical capabilities.