Eskom	Standard	Technology

Title: **OUTDOOR CIRCUIT BREAKERS FOR SYSTEM WITH NOMINAL VOLTAGES FROM 6.6KV UP TO AND INCLUDING 765KV STANDARD**

Unique Identifier: **240-56063756**

Alternative Reference Number: **<n/a>**

Area of Applicability: **Engineering**

Next Review Date: **STABILISED**

COE Acceptance

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Date:09/04/2021

This document is **STABILISED.** The technical content in this document is not expected to change because the document covers: *(Tick applicable motivation)*

1	A specific plant, project or solution	X
2	A mature and stable technical area/technology	
3	Established and accepted practices.	

PCM Reference: **240-53459006**

SCOT Study Committee Number/Name: **Plant Equipment Study Committee**

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Unique Identifier:	**240-56063756**
Alternative Reference Number:	**32-1166**
Area of Applicability:	**Engineering**
Documentation Type:	**Standard**
Revision:	**6**
Total Pages:	**97**
Next Review Date:	**September 2020**
Disclosure Classification:	**Controlled Disclosure**

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PCM Reference: **< 240-53459006 >**

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Content

Figures

Tables

1. Introduction

This standard sets out Eskom's specific and standardised requirements for outdoor air-insulated circuit-breakers for use in three-phase 50 Hz alternating current systems with nominal voltages from 6,6 kV up to and including 765 kV. The requirements for circuit-breakers are based on SANS 62271-100 (High-voltage alternating-current circuit-breakers). The standard covers both live-tank and dead-tank circuit-breakers. The circuit-breakers may be specified with or without current transformers (CTs). 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 IEC62271-100 standard.

NOTE: In special cases this standard shall be used for high voltage DC applications, e.g. traction, bypass bridges, DC-pole switching, whereby a separate technical schedule A and B shall be issued.

2. Supporting clauses

2.1 Scope

2.1.1 Purpose

This standard provides the specific and standardised requirements for outdoor air-insulated circuit-breakers in accordance with SANS 62271-100. The circuit-breakers are intended for use in substations having three-phase 50 Hz alternating current (a.c.) nominal operating voltages from 6,6 kV up to and including 765 kV. Circuit-breakers are required for general purpose power switching and protection applications as well as for special purpose applications such as the switching of earthed shunt capacitor banks, shunt reactors, capacitor-reactor combinations and generator unit synchronising. In special cases this standard shall be used for high voltage DC applications, e.g. traction, bypass bridges, DC-pole switching, whereby a separate technical schedule A and B shall be issued.

The standard covers both live-tank and dead-tank circuit-breakers. The circuit-breakers may be specified with or without current transformers (CTs). 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 IEC62271-100 standard.

A set of technical schedules A and B accompanies this standard, which are as per Appendix B (Generic). Additional and special requirements are also included in schedule A.

The standard covers the design, manufacture, testing, supply, delivery, storage, installation, pre-commissioning and guarantee of circuit-breakers and associated equipment specified herein.

This standard includes the requirement for the full detailed maintenance analysis FMECA (Appendix D). It also includes the option of the digital secondary plant interface (Appendix C).

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 Normative/informative references

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

2.2.1 Normative

NOTE: IEC standards (including IEC documents adopted as SANS standards without changes)

[1] SANS 60137, Insulated bushings for voltages above 1000V

[2] SANS 60044-1, Current Transformers

[3] SANS 60044-6, Current Transformers – Part 6: Requirements for protective current transformers for transient performance

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

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

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

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

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

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

[10] SANS 60815-2:2009, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramic and glass insulators for a.c. systems.

[11] SANS 60815-3:2009, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 3: Polymer insulators for a.c. systems.

[12] SANS 61462, Composite hollow insulators — Pressurized and unpressurized insulators for use in electrical equipment with rated voltage greater than 1 000 V — Definitions, test methods, acceptance criteria and design recommendations.

[13] SANS 62155, Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V.

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

[15] SANS 62271-100, High-voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers.

[16] SANS 62271-110, High-voltage switchgear and controlgear – Part 110: Inductive load switching.

[17] SANS 62271-203, High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV.

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

[19] SANS 62271-302, High-voltage switchgear and controlgear – Part 302: Alternating current circuit-breakers with intentionally non-simultaneous pole operation.

[20] Occupation Health and Safety Act (OHS Act) No 85 of 1993 – Construction and Electrical Machinery Regulations.

[21] NRS 029, Current transformers for rated a.c. voltages from 3,6 kV up to and including 420 kV (maximum voltage for equipment).

[22] NRS 087, Guidelines for the management of SF6 (sulphur hexafluoride) for use in electrical equipment.

[23] SANS 1091, National colour standard.

[24] IEC 6189-1, Instrument transformers – Part 1 General requirements

[25] IEC 61850/ SANS 61850 (All parts) Communication networks and systems for power utility automation

[26] SANS 62271-3/ IEC 62271-3 High-voltage switchgear and controlgear — Part 3: Digital interfaces based on IEC 61850

[27] 240-42066934 IEC 61850 Protocol implementation document for the purposes of substation automation

[28] 240-64685228 Generic specification for protective Intelligent Electronic Devices (IEDs)

[29] 240-68107841 Eskom IEC61850 standard requirements for PICS, PIXIT and TICS

[30] 240-68235024 Eskom IEC 61850 station bus interoperability test standard

[31] ESP 32-846: Operating Regulations for High Voltage Systems (ORHVS).

[32] 240-56062328, Distribution Standard Part 0: KIPTS natural ageing and pollution performance test procedure for outdoor insulator products section 0 – general requirements.

[33] 240-56062515 (DISSCAAK9), Distribution Standard Part 15: Specification for labels on control panels, relay panels and other indoor and outdoor equipment.

[34] DSP 34-1658, Distribution Standard Part 4: Corrosion protection specification for new indoor and outdoor Distribution equipment manufactured from steel.

[35] 240-56065202, Distribution Standard Part 7: Switchgear training requirements from original equipment manufacturers.

[36] 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.

[37] QM-58, Supplier contract quality requirements specification.

[38] 240-56063765, Eskom health and safety management – supplier requirements.

[39] Technical Bulletin: 06TB-027: CAP's Requirements For KIPTS Test reports.

[40] DST_240-53902499, Standard for the transport, handling, storage and preservation of HV and MV switchgear.

[41] 240-56062864, Current transformers Eskom specific requirements up to 132kV in accordance with NRS 029 standard

[42] Appendix A – Supplier and Eskom's responsibilities

[43] Appendix B – Technical Schedules

[44] Appendix C – Technical Schedules for the digital secondary plant interface

[45] Appendix D – Maintenance Analysis

[46] D-DT-5200-1, Outdoor 132 kV circuit-breaker foundation details

[47] D-DT-5200-2, Outdoor 66/132 kV circuit-breaker support details

[48] D-DT-5201, Outdoor 66 kV circuit-breaker foundation details

[49] D-DT-5407, Wiring of outdoor circuit-breakers up to and including 132 kV

[50] 0.54/7471-0-0, 275 kV circuit-breaker foundation details

[51] 0.54/7472-0-0, 400 kV circuit-breaker foundation details

[52] 0.54/7479-0-0, 275 kV and 400 kV circuit-breaker support details

[53] 0.54/07529, Wiring of outdoor 220 kV, 275 kV, 400 kV and 765kV Live Tank circuit-breakers

[54] 0.54/8557, Wiring of outdoor 220 kV, 275 kV, 400 kV and 765kV Dead Tank circuit-breakers

[55] 240-46425564, Technical evaluation criteria for High Voltage Switchgear standard

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
routine inspection	visual investigation of the principal features of the switchgear and controlgear in service without dismantling. **NOTES** a) 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 controlgear in service are also included. b) Observations resulting from inspection can lead to the decision to carry out an overhaul. c) As indicated in note 1 above, routine inspection may include scheduled maintenance activities in accordance with the manufacturer's maintenance manual. d) Routine inspection may also be referred to as 1st line maintenance. e) This is the definition of "inspection" given in 3.1.8 of SANS 62271-1.
minor maintenance	the execution of scheduled or preventive maintenance work in accordance with the manufacturer's maintenance manual and requiring the switchgear and controlgear to be taken out of service (i.e. in a down state). **NOTES** a) Observations resulting from minor maintenance can lead to the decision to carry out an overhaul. b) Scheduled maintenance is defined in 3.1.7 of SANS 62271-1. c) Minor maintenance may be time-based and/or condition-based. d) Minor maintenance may also include circuit-breaker examination (refer to 3.1.10 of SANS 62271-1) with diagnostic tests (refer to 3.1.9 of SANS 62271-1). e) Minor maintenance may also be referred to as 2nd line
major maintenance (overhaul)	work performed with the objective of repairing or replacing parts which are found to be out of tolerance by inspection, test, examination, or as required by manufacturer's maintenance manual, in order to restore the component and/or the switchgear and controlgear to an acceptable condition (within tolerance). **NOTES** a) This is the definition of "overhaul" given in 3.1.11 of SANS 62271-1. b) Major maintenance involves the execution of specialised maintenance where specialised knowledge and skills are required and is also sometimes referred to as specialised maintenance.
breakdown maintenance	unplanned (or unscheduled) maintenance work required to repair a fault and thus restore the switchgear and controlgear to an acceptable condition after a failure
specialised tools	any purpose-built tools that are necessary to carry out major (or specialised) maintenance on a circuit-breaker and its components
working clearance	straight line distance (clearance) from the closest live part at service voltage to ground level required to safely conduct work.
Intelligent Electronic Device (IED)	A device incorporating one or more processors with the capability to execute application functions, store data locally in a memory and exchange data with other IEDs (sources or sinks) over a digital link [IEC 61850-5].

Definition	Description
Process Interface Unit (PIU)	Also referred to as a 'digital merging unit' or 'binary input/output device'; an Intelligent Electronic Device (IED) that collects binary data from process devices, typically electrical primary plant equipment, by way of status contacts, and processes and publishes this data to other IEDs in a digital format (e.g. IEC 61580-based communication). The device similarly converts digital commands from other IEDs into electrical control signals to the primary equipment.

2.3.2 Disclosure classification

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

2.4 Abbreviations

Abbreviation	Description
AMSL	Above mean sea level
ARC	Auto re-closing
DN20	20 mm SF6 coupling. D = Diameter, N = Nominal and 20 = 20 mm inside diameter to determine the gas flow capacity. Coupling thread size is M 45 x 2
DN8	8 mm SF6 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.
OEM	Original equipment manufacturer
SCD	Specific creepage distance
USCD	Unified specific creepage distance
SPS class	Site Pollution Severity class
FMECA	Failure Modes, Effects and Criticality Analysis
ACSI	Abstract Communication Service Interface [IEC 61850-7-2]
GOOSE	Generic Object Oriented Substation Event [IEC 61850-8-1]

2.5 Roles and responsibilities

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

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

2.6 Process for monitoring

None

2.7 Related/supporting documents

Technical A & B schedules.

3. Specification for outdoor circuit-breakers for System with Nominal Voltages from 6.6kV Up To and including 765kV Standard

3.1 Ratings

3.1.1 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 2. 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 are 6,6 kV, 11 kV, 22 kV, 33 kV, 44 kV, 66 kV, 88 kV, 132 kV, 220 kV, 275 kV, 400 kV and 765 kV.

NOTE: In special cases this standard shall be used for high voltage DC applications, e.g. traction, bypass bridges, DC-pole switching, whereby a separate technical schedule A and B shall be issued. The nominal system voltage for HVDC scheme is +/- 533kV DC, the Thyristor Bridges and poles are rated for 133.3kV DC.

b) The number of phases shall be three.

3.1.2 Rated insulation levels

The rated insulation levels of circuit-breakers shall be in accordance with the values given in Table 2. 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 2: Rated voltage and insulation levels

Nominal system voltage U_n *[kV (r.m.s.)]*	**Rated voltage** *[kV (r.m.s.)]*	**Rated short-duration power-frequency withstand voltage** U_d *[kV (r.m.s.)]* U_r		**Rated lightning impulse withstand voltage** U_p *[kV (peak)]*		**Rated switching impulse withstand voltage** U_s *[kV (peak)]*	
		Phase-to-earth and between phases	**Across open switching device**	**Phase-to-earth and between phases**	**Across open switching device**	**Phase-to- earth and across open switching device**	**Between phases**
6,6 & 11	12	28		95		-	-
22	24	50		150		-	-
33	36	70		200		-	-
44	52	95		250		-	-
66	72,5	140		350		-	-
88	100	185		450		-	-
132	145	275		650		-	-
220	245	395		950		-	-
275	300	395	435	1050	1050 (+170)	850	1275
400	420	520	610	1425	1425 (+240)	1050	1575
400	550[e)]	620	800	1550	1550 (+315)	1175	1760
765	800	830	1150	2100	2100 (+455)	1550	2480
+/- 533 DC	[e)]						

NOTES

a) In this table, the withstand voltages apply at the standardised reference atmosphere (temperature, pressure and humidity) in accordance with SANS 62271-1.

b) The information in this table is based on SANS 1019 and SANS 62271-1.

c) The specification of the insulation levels given in this table is based on the SANS 1019 philosophy – i.e. by the judicious selection of protective devices and their location with respect to equipment to be protected, it is generally possible to adopt the same insulation level for internal insulation and external insulation for equipment suitable for use at altitudes up to 1 800 m AMSL (Above Mean Sea Level). This enables manufacturers and users to adopt internationally accepted designs for use in South Africa.

d) No additional altitude correction factors need be applied for equipment installed up to 1800 m AMSL.

e) The circuit-breakers specified for 550kV rating shall be installed on Eskom's 400kV network upon special requirements. The circuit-breakers required for generator synchronising, shall be provided with proof of having passed the power frequency withstand (Wet conditions) in accordance with IEC 60060-1.

f) The circuit-breakers specified for DC application shall be installed on Eskom's +/- 533kV HVDC network upon special requirements. The voltage across open contacts is 133.3 kV DC rating.

3.1.3 Rated frequency (f_r)

The rated frequency shall be 50 Hz.

3.1.4 Rated normal current (I_r) and temperature rise

a) The rated normal current of circuit-breakers shall be 1600 A, 2500 A, 3150 A and 4000 A.

b) The rated normal current required will be specified in schedule A. The rated normal current offered shall be stated in schedule B.

c) The standard rated normal currents of circuit-breakers are given in Table 3.

Table 3: Standardised rated normal currents (I_r)

Nominal system voltage ***Un*** *[kV]*	**Rated normal current (I_r)** *[A]*				
	1600	**2000**	**2500**	**3150**	**4000**
6,6 & 11	x	-	x	-	-
22	x	-	x [b)]	-	-
33	x	-x	x [b)]	-	-
44	x	x	x [b)]	-	-
66	x	x	x [a)]	x [b)]	-
88	x	x	x [a)]	-	-
132	x	x	x [a)]	x [b)]	-
220	-	-	x	x	-
275	-	-	x	x	x
400	-	-	-	x	x [c)]
765	-	-	-	x	x
+/- 533 DC			1800 DC x [d)]		

NOTES

a) Required for Distribution substation applications (HV sub-transmission and MV Distribution networks). Rationalisation of a 3150 A circuit-breaker may be considered, when commercially viable.

b) Required for Transmission substation applications.

c) Same rating shall be applicable to the 550kV rated circuit-breaker requirement

d) For Eskom's +/- 533kV HVDC system requirement, the rated normal current shall be 1800A DC as a minimum. It shall be demonstrated if the circuit-breaker can carry the current of 3300A upon emergency or future requirements.

e) The associated temperature rise limits for the rated normal current given in Table 3 shall be in accordance with SANS 62271-1.

f) 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 a)).

g) 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 Table 4) when carrying rated current shall be stated in schedule B.

3.1.5 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.

3.1.6 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.

3.1.7 Rated duration of short circuit (t_k)

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

Table 4: Standardised rated short circuit-breaking, short-time and peak withstand currents

Nominal system voltage U_n *[kV]*	**Rated short-circuit breaking and short-time (3 sec) withstand current** ***I*SC, *I*k** *[kA (r. m. s.)]*	**Rated peak withstand current** ***I*p** *[kA (peak)]*
6,6 & 11	20 / 25	50 / 62,5
22	20 / 25	50 / 62,5
33	20 / 25 / 31,5	50 / 62,5 / 78,75
44	20 / 25 / 31,5	50 / 62,5 / 78,75
66	20 / 25 / 31,5	50 / 62,5 / 78,75
88	20 / 25 / 31,5	62,5 / 78,75
132	25 / 31,5 / 40	62,5 / 78,75 / 100
220	31,5 / 40 / 50	78,75 / 100 / 125
275	40 / 50	100 / 125
400*)	50 / 63	125 / 157,5
765	50	125
+/- 533 DC **)	20	50

*) - denotes that both 420kV and 550kV rated circuit-breakers are required to meet this criteria

**) - denotes that the +/- 533kV DC rated circuit-breakers are required to meet this minimum criteria. The voltage across open gap is 133.3kV DC

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

a) The rated d.c. supply voltage (U_a) of closing and opening devices and of auxiliary and control circuits shall be 110 V or 220 V. The rated d.c. supply voltage required will be specified in schedule A.

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

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

The rated supply frequency of heaters and other a.c. auxiliary circuits shall be 50 Hz.

3.1.9 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 4. 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.

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

a) The first-pole-to-clear factor $_{(kpp)}$ for circuit-breakers used in systems of nominal voltage up to and including 132 kV shall be 1,5 in accordance with SANS 62271-100, i.e. as applicable to circuit-breakers used in non-effectively earthed systems. For circuit-breakers used in systems of nominal voltage above 132 kV, the first-pole-to-clear factor shall be 1,3 in accordance with SANS 62271-100, i.e. as applicable to circuit-breakers used in effectively earthed systems. The first-pole-to-clear factor shall be stated in schedule B.

NOTE: 44 kV to 132 kV networks are usually solidly earthed. However, in the interests of standardisation, due to the fact that certain 44 kV to 132 kV networks may be non-effectively earthed – a first-pole-to-clear factor of 1,5 is specified.

b) The standard values of prospective transient recovery voltages given in SANS 62271-100 shall apply according to the circuit-breaker class specified in Table 4 for the relevant circuit-breaker application and as defined in SANS 62271-100.

3.1.11 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.

3.1.12 Rated operating sequence for circuit-breakers

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

Three-phase auto-reclosing: O – t – CO – t' – CO (all poles), where t = 0,3 s and t' = 3 min.

NOTE: Preference will be given to circuit-breakers offered with a rated operating sequence where t' = 15s.

b) The following rated operating sequence shall apply to all single-pole operated circuit-breakers intended for rapid auto-reclosing. The rated operating sequence required will be specified in schedule A.

Single-phase auto-reclosing: O (one pole) – t – C (one pole) – O (all poles) – t' – CO (all poles), where t = 0,3 s and t' = 3 min.

NOTE: Preference will be given to circuit-breakers offered with a rated operating sequence where t' = 15s.

c) 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.

O – t – CO – t' – CO (all poles) where t = t' = 3 min.

d) 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.

e) 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.

3.1.13 Characteristics for short-line faults

These characteristics are applicable to class S2 circuit-breakers (refer to Table 4) intended for direct connection to overhead lines in systems with a solidly earthed neutral and all circuit-breakers having a rated voltage of 100 kV and above. They are therefore applicable to all circuit-breakers for use in systems of nominal voltage above 66 kV. Refer to 4.105 of SANS 62271-100 for standardised characteristics for short-line faults.

NOTE: 44 kV to 132 kV networks are usually solidly earthed.

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

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.

3.1.15 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 Table 4 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 very low probability of restrike during capacitive current breaking. In this case, the following requirements are applicable:

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

- the rated capacitor bank switching currents shall be in accordance with the preferred values given in SANS 62271-100. The circuit-breaker class offered, 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
- all circuit-breakers supplied for capacitor-bank switching shall be capable of capacitor switching without the need for controlled opening and/or closing.
- shunt capacitor banks will either be connected to a substation busbar or will form part of another device such as a thyristor switched reactive power (VAr) controller (thyristor controlled reactors).

NOTES

- The backup circuit-breakers in the particular substations may not have adequate capacitive switching capabilities. This means that the circuit-breakers intended for shunt capacitor bank switching will have to be relied upon to satisfactorily and reliably (i.e. with a very low probability of restrike) switch the capacitive currents associated with the shunt capacitor banks.
- The shunt capacitor bank circuit-breaker will be required to switch more than once 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 busbar.
- For the sake of standardisation, preference will be given to general-purpose circuit-breakers offered that are capable of capacitor bank switching duties. However, special-purpose circuit-breakers will be considered.
- Current-limiting reactors will normally be installed by Eskom between the circuit-breaker and the shunt capacitor bank being switched in order to obtain transient currents of manageable proportions for the power capacitor elements as well as the circuit-breaker.
- The use of controlled switching to provide optimal capacitor-bank switching is recommended. Refer to 3.2.18.

3.1.16 Inductive load switching for circuit-breakers

No rating is assigned. Circuit-breakers shall be capable of switching shunt reactors and shall be designed to withstand re-ignitions. Refer to SANS 62271-110 (applicable only to three-phase alternating current circuit-breakers having rated voltages of 52 kV and above). The chopping number of the circuit-breaker offered shall be stated in schedule B.

NOTES

- The use of controlled switching to provide re-ignition-free shunt reactor switching is recommended. Refer to 3.2.18. In the absence of controlled switching, re-ignitions during opening of the contacts cannot be avoided due to the random operation (opening) of the circuit-breaker. By means of controlled opening, all poles of the shunt reactor circuit-breaker can be given a sufficiently long arcing time to ensure re-ignition-free interruption. The use of controlled switching will minimise high magnitude fast-fronted (steep) switching transients created during re-ignition events and will prolong the maintenance intervals of the circuit-breaker.
- Information obtained from tests conducted in accordance with SANS 62271-110, i.e. the circuit-breaker chopping number (used to determine the suppression peak overvoltage factor) and the re-ignition behaviour, can be used to correctly configure the controller.
- The maximum ratings of existing (earthed) shunt reactors are typically 40 MVAr to 50 MVAr at 132 kV, 100 MVAr at 400 kV and 400 MVAr at 765 kV (i.e. 133 MVAr per phase).

3.1.17 Rated time quantities for circuit-breakers

Refer to SANS 62271-100. The rated opening time, break-time, closing time, open-close time, reclosing time, close-open time and pre-insertion time (where applicable) of the circuit-breaker offered shall be stated in schedule B.

3.1.18 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.

3.1.19 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 5 for the specified circuit-breaker application. The circuit-breaker class offered shall be stated in schedule B.

Table 5: Classification of circuit-breakers (SANS 62271-100)

Circuit-breaker	Circuit-breaker application	Circuit-breaker class 3)	Electrical endurance 4)	Re-strike performance during capacitive current breaking (line- and cable- charging)	Mechanical endurance
11 kV, 1600 A, 20 kA[5)]	As per Technical A/B Schedule	S1	E2 [1)]	C1	M1
11 kV, 2500 A, 25 kA[5)]	As per Technical A/B Schedule	S1	E2 [1)]	C1	M1
22 kV, 1600 A, 20 kA[6)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
22 kV, 2500 A, 25 kA[6)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
33 kV, 1600 A, 20 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
33 kV, 2000 A, 25 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
33 kV, 2500 A, 31,5 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
44 kV, 1600 A, 20 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
44 kV, 2000 A, 25 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
44 kV, 2500 A, 31,5 kA[7)]	As per Technical A/B Schedule	S2	E2 [2)]	C2	M2
66 kV, 1600 A, 20 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
66 kV, 2000 A, 25 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
66 kV, 2500 A, 31,5 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
66 kV, 3150 A, 31,5 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
88 kV, 1600 A, 20 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
88 kV, 2000 A, 25 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
88 kV, 2500 A, 31,5 kA	As per Technical A/B Schedule	S2	N/A	C2	M2
132 kV, 1600 A, 25 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
132 kV, 2000 A, 31,5 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
132 kV, 2500 A, 31,5 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
132 kV, 2500 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
132 kV, 3150 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
220 kV, 2500 A, 31,5 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2

Circuit-breaker	Circuit-breaker application	Circuit-breaker class 3)	Electrical endurance 4)	Re-strike performance during capacitive current breaking (line- and cable- charging)	Mechanical endurance
220 kV, 2500 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
220 kV, 3150 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
220 kV, 3150 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
275 kV, 2500 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
275 kV, 3150 A, 40 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
275 kV, 2500 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
275 kV, 3150 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
275 kV, 4000 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
400 kV, 3150 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
400 kV, 3150 A, 63 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
400 kV, 4000 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
400 kV, 4000 A, 63 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
550 kV, 4000 A, 63 kA	As per Technical A/B Schedule	N/A	N/A	C2	M2
765 kV, 3150 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2[8)]	M2
765 kV, 4000 A, 50 kA	As per Technical A/B Schedule	N/A	N/A	C2[8)]	M2
+/- 533kV DC [9)]	As per Technical A/B Schedule	N/A	N/A	C2[8)]	M2

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. Class S2 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. Class S2 circuit-breakers are specified due to the fact that they may be used in systems with direct connection to overhead lines / outdoor busbars without intervening cables. In the case where circuit-breakers are used in cable systems, class S2 circuit-breakers are suitable.
4. Class E1 and E2 circuit-breakers are restricted to distribution circuit-breakers of rated voltage up to and including 52 kV in accordance with SANS 62271-100.
5. Unless otherwise mention on the Technical A/B Schedules, the 11 kV 2500 A circuit-breaker is used for transformer and bus-section applications at 11 kV only. Unless otherwise mention on the Technical A/B Schedules, the 22 kV 1600 A circuit-breaker is for transformer, bus-section and feeder application at 22 kV.
6. The 33 kV 1600 A circuit-breaker is for transformer, bus-section and feeder application at 33 kV.
7. Cable-charging breaking current switching duties are not applicable to 765 kV circuit-breakers.
8. General-purpose circuit-breakers are required for transformer / bus-section / feeder applications.
9. For +/- 533kV HVDC scheme application, the current shall be 1800A DC. It shall be demonstrated if the circuit-breaker does have the capability of carrying up to 3300A for the system emergencies and future requirements.

3.2 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 without 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 3.5.4 and QM-58 specification).

3.2.1 Service conditions

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

i. a minimum ambient air temperature of -10 °C;

ii. a maximum ambient air temperature of +45 °C (refer to 3.1.4 f));

iii. rapid temperature changes. The condensation of water vapour can take place within operating mechanism enclosures and hollow components. The average humidity is 95 %;

iv. wind velocity of 34 m/s (N);

v. solar radiation up to a level of 1 100 W/m^2 (on a clear day at noon);

vi. the circuit-breakers shall be installed up to altitudes of 1 800 m;

NOTE: Due (in part) to the fact that the switchgear and controlgear shall be used up to altitudes of 1800 m AMSL (Above Mean Sea Level), 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"); and
- The class of corrosion characterizing the site severity will be specified in Schedule A in accordance and the details required under clause 3.2.6 shall be supplied with tender documentation.
- seismic activity up to 0,3g.

b) Circuit-breakers for use in systems of nominal voltage up to and including 132 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.

NOTE: 44 kV to 132 kV networks are usually effectively earthed. However, certain 44 kV to 132 kV networks may be non-effectively earthed.

3.2.2 General

Note: Notwithstanding the requirements on 3.2.2.1 below, the Supplier of the switchgear shall respond to the following with the tender documentation:-

- Full maintenance analysis FMECA of the compact switchgear assemblies unit as per Appendix D.
- Response to the Digital secondary plant interface option clauses 3.2.19.1 and 3.21.1 and Appendix C.
- Provide the detailed Factory Failure Rate (FFR) percentage over the period of 5 years.
- Provide information on On Time Delivery (OTD) percentage over the period of 5 years.
- Provide technical response to Non-Conformance (NCR's) percentage over a period of 1 year

3.2.2.1 The following are the requirements for the circuit-breakers:-

a) Outdoor circuit-breakers shall comply with the requirements of SANS 62271-100 and the requirements of this standard. In case of the dead-tank circuit-breakers, it shall also comply with the requirements of SANS 62271-203. Where conflicting requirements exist, the requirements of this standard shall take precedence.

b) Circuit-breakers shall be of the live-tank or dead-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) Dead-tank circuit-breakers shall be supplied with integrated ring-type current transformers (CTs). CTs shall be located at the base of the outdoor bushings.

The compartment/ tank metallic enclosure shall be made of aluminium or aluminium alloys for all standard Eskom requirements, unless the requirement is for coastal application, a different specification metal shall be indicated on the Technical A schedule. Other metals for compartment/ tank metallic enclosures with their corrosion treatment method in accordance with clause 3.2.6 shall be shall be submitted with the tender documentation and will be subject to approval by Eskom.

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 132 kV shall be supplied suitable for a pole-beam support arrangement (two-column support with common base frame). Live-tank circuit-breakers for use in systems of nominal voltage from 132 kV up to and including 400 kV shall be supplied suitable for a three-column support arrangement. It will be specified in schedule A whether circuit-breakers shall be supplied with the steel support structure.

NOTES

- For further information relating to the Supplier's and Eskom's scope of responsibility, refer to Appendix A.
- For live-tank circuit-breakers for use in systems of nominal voltage up to and including 132 kV, the steel common base frame is supplied with the circuit-breaker (refer to c)). The circuit-breakers are supplied without the steel support structure columns (legs). Refer to Table 5 for further information on the standard Eskom support structure drawings.

e) Circuit-breaker operating mechanisms:

- Circuit-breakers shall be either three-pole ("3P") operated (i.e. single operating mechanism) or single-pole ("1P") operated (i.e. three 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. The spring-hydraulic operated mechanisms shall be considered for Dead-tank circuit-breakers with the rated voltages of above 145 kV. The spring-hydraulic operated mechanisms may be accepted for use in the Live-tank circuit-breakers with the rated voltages of 550 kV and 800 kV.

NOTE

i. Other hydraulic operated or pneumatic operated mechanisms will not be accepted for all voltages.

- 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.
- 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.
- When a feeder circuit-breaker is in the closed position and the spring has been charged, it shall be able to "TRIP-CLOSE-TRIP" before the spring needs to be recharged

f) The insulation and/or extinguishing medium of the circuit-breaker shall be either SF6 gas or environmental friendly medium. The type of interrupting and insulation and/or extinguishing medium technology offered shall be stated in schedule B. For SF6 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

i. 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 IEC62271-100.

g) Circuit-breakers shall be designed for minimal maintenance in accordance with the electrical and mechanical endurance class as specified in 5. 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 3.2.23.1).

h) Dead-tank circuit-breakers detailed information on how CT's are accessed for primary injection testing and CT replacement, without having to interfere with the SF6 circuit shall be provided with the tender documentation.

3.2.3 Construction requirements

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 handling and installation;

c) the equipment shall be designed to facilitate construction and maintenance activities for personnel; and

d) SF6 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.

3.2.4 Circuit-breaker operating mechanism enclosure requirements

a) Circuit-breaker operating mechanisms, local control facilities and all parts requiring lubrication shall be protected by weatherproof 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 stainless steel with corrosion protection in accordance with 3.2.6. The use of factory painted aluminium shall be considered if corrosion protection is in accordance with 3.2.6, and no parts exposed. The mechanism enclosures of the exposed aluminium shall not be acceptable.

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.

e) Access to the operating mechanism enclosure(s) shall be through a hinged access door allowing accessibility to components installed in the enclosure (e.g. control levers, push-buttons, MCBs and secondary wiring terminal strips) in accordance with SANS 62271-1.

f) In the case of circuit-breakers for use in systems of nominal voltage up to and including 132 kV, servicing shall be possible from the ground level. In the case of circuit-breakers for use in systems of nominal voltage above 132 kV, where the servicing level may be above ground level, it shall be possible to view all circuit-breaker status indications and make necessary readings from the ground level. Details of special equipment required (including inspection platforms) to fulfil this requirement shall be provided with the tender documentation (refer to 3.2.23.1).

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

h) 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

i) 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 3.2.1.

j) 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.

k) 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.

l) 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. In the latter case, the conductors shall be kept as short as possible and the earthing terminal on the operating mechanism enclosure shall be located towards the top of the enclosure housing. Earthing conductors shall be manufactured using galvanised steel. A 30 mm long, Ø25 mm (min) metallic boss, with an M12 thread throughout and welded to the equipment shall be used for all external earthing conductor fastenings. The boss shall be fitted with a M12 x 25 mm long setscrew, washer and spring washer. The boss and the setscrew on the enclosure shall be stainless steel of grades 304 and 316, respectively, unless otherwise approved by Eskom. The boss and the setscrew on the circuit-breaker steel support structure (e.g. the common base frame or the steel column support) shall be galvanised steel.

NOTES: The use of copper or aluminium is considered to present a theft risk and will not be accepted if metal is visually exposed. Such method shall meet clause 3.2.6. The proposal to prevent visual exposure shall be presented to Eskom for approval with the tender documentation.

m) Operating mechanism enclosures shall make provision for the entry of Eskom control cabling from below. Refer to 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 below, unless otherwise approved by Eskom.

NOTE The use of plug-in type cable is not acceptable. Eskom prefers the normal gland plate and terminations made on terminals.

n) 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.

NOTES

- The use of aluminium cable racking is considered to present a theft risk and will not be accepted.
- Where Eskom support structure legs are provided, no provision is made for securing or mounting inter-pole cable racking on the legs - requiring the (armoured) inter-pole cabling to be buried in the ground in accordance with 240-56030489, unless otherwise approved by Eskom.
- The use of plastic material cable ties shall not be accepted.

o) Upper surfaces of enclosures shall be shaped or sloped to prevent the accumulation of water.

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) A gauze-covered drain hole with a minimum diameter of 25 mm and having no internal rim or ledge that is likely to obstruct drainage shall be provided at the lowest point of the operating mechanism enclosure.

r) Suitable lifting eyes shall be provided at the top of the operating mechanism enclosure. 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.

s) 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.

t) All circuit-breakers shall be fitted with a mechanical trip facility which does not require any voltage to operate and must be located inside the mechanism enclosure. It shall be clearly marked with warning labels.

3.2.5 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 3.2.23.1):

- "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) can be assumed to 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) If specified in schedule A, the steel support structure and/or concrete foundation shall be designed by the manufacturer. A drawing showing the steel support structure and concrete foundation design details shall be provided with the tender documentation (refer to 3.2.23.1) and the drawing number(s) shall be stated in schedule B.

The steel support shall be designed according to the following requirements (if part of the supply):

- Steel shall be in accordance with SANS 1431
- Steel shall be Grade 350W
- Steel shall be hot-dip galvanised in accordance with SANS 121
- Welding shall conform to the requirements of SANS 10044.
- Welds shall be seal welded.

- Steelwork shall be fabricated, erected and leveled to a tolerance of ±1.5mm.
- Bolts and nuts shall be in accordance with SANS 1700:5.
- Bolts and nuts shall be Grade 8.8.
- Bolts, nuts and washers shall be hot-dip galvanised in accordance with SANS 121.
- Holes shall have diameter of 18mm for M16 bolts.
- All works shall comply with the requirements of SANS 1200

c) In the case of live-tank circuit-breakers for use in systems of nominal voltage up to and including 132 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.

d) Unless it is specified in schedule A that the steel support structure and/or concrete foundation is to be designed by the manufacturer, the circuit-breaker shall be designed to interface with the standard Eskom steel support structure and/or concrete foundation in accordance with the drawings specified in Table 5.

e) If specified in schedule A, in the case of circuit-breakers for use in systems of nominal voltage up to and including 33 kV, galvanised steel surge arrester mounting brackets shall be provided and fitted adjacent to each circuit-breaker 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 for mounting the surge arrester. Each surge arrester mounting bracket shall be designed with a suitable clearance to accommodate a surge arrester having a 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 surface shall not be painted.

NOTE: Surge arrester mounting brackets may only be required for medium-voltage applications.

Table 6: Eskom standard civil design drawings for outdoor live-tank circuit-breaker steel support structures and concrete foundations

System voltage *[kV]*	**Steel support structure drawing number (live-tank circuit- breakers)**	**Concrete foundation drawing number (live-tank circuit- breakers)**
11, 22 and 33	TBA[1)]	TBA[1)]
44 and 66	D-DT-5200-2	D-DT-5201
88 and 132	D-DT-5200-2	D-DT-5200-1
220 and 275	0.54/7479-0-0	0.54/7471-0-0
400	0.54/7479-0-0	0.54/7472-0-0
765	TBA[1)]	TBA[1)]
+/- 533 DC	TBA[1)]	TBA[1)]

NOTES
1. Standardised drawings are not (yet) available.
2. These drawings shall be applicable to equipment with the higher rated voltages

3.2.6 Corrosion protection and lubrication

a) All exposed metal shall be protected against corrosion in accordance with DSP 34-1658 for outdoor “high” to “very high” ‘C4’ and ‘C5’ (i.e. marine) corrosivity rating environments.

b) The minimum detailed specification (“DS”) for all exposed metal in accordance with DSP 34-1658 shall be “DS-11” (3CR12), ‘DS-18 (Stainless steel) and ‘DS-13” (Hot-dip galvanised).

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 DSP 34-1658) offered by the manufacturer for the following components shall be stated in schedule B. Details shall be provided with the tender documentation (refer to 3.2.23.1):

- enclosures;
- nuts, bolts, studs and washers;
- structural steel (i.e. common base frame, support structure legs, etc.); and
- other exposed metal (excluding main terminals).

- The detailed material and Corrosion Protection Information in accordance with the Table 6 below whall be provided by the Supplier with the tender documentation the information on each supplied live-tank circuit-breaker and dead-tank circuit-breaker type as specified below:-

Table 7: 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 bracket*
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 Zincfix*
Bi-metallic corrosion prevention		*Coat both sides*
Crevice corrosion prevention		*Seal with crevice with Zincfix*
Item or part weight in Kilogram		*7kg*
Field experience		*Equipment used at coast in USA*
Remarks/General comments		*Debris, scratches and indentation have been removed prior to galvanising.*

d) The behavior of lubricants that are exposed to air, SF6 gas and its arcing products 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 3.2.23.1) 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 3.2.23.1) of the measures taken to prevent flange corrosion. 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: Circuit-breaker operating mechanism enclosure heaters

i. 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.

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

iii. The electrical supply for heaters shall be single-phase 230 V a.c.

iv. 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. In the case of circuit-breakers for use in systems of nominal voltage above 132 kV, heater fail alarm circuits shall be wired to terminals in accordance with 0.54/07529 and 0.54/8557.

3.2.7 Terminal requirements

a) Main (HV) terminals

i. 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 specifically;

ii. an 8 hole (2 x 4 hole pattern) aluminium flat pad with a 50 mm pitch (distance between holes) and having a minimum thickness of 20 mm. The diameter of the holes shall be 14 mm (M12).

NOTE: For the 220 kV and above circuit-breakers, an 9 hole aluminium flat pad with a 40 mm pitch having a minimum thickness of 20mm shall be acceptable. The diameter of the holes shall be 14 mm (M12).

iii. The arrangement of the HV main terminals shall be such that they can be removed without interfering with the integrity of the circuit-breaker.

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.

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

Details of the circuit-breaker HV main terminals and earthing shall be provided on the general arrangement drawings as described in 3.2.23.1.

3.2.8 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 6.

Table 8: Minimum electrical working clearances

System voltage *(kV]*	**Working clearance** *(mm]*
11 and 22	2 820
33	2 930
44 and 66	3 270
88 and 132	3 950
220	4 350
275	4 850
400	5 700
765	8 000
+/- 533 DC	Supplier to comply as per **NOTE**
NOTE: The working clearance is calculated by summating the height of a person with his/her arm in an extended upward position (i.e. 1800 + 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) Pressure relief devices shall be orientated so as not to pose any hazard to personnel or adjacent equipment. Details of pressure relief devices offered shall be provided with the tender documentation.

e) In the case of dead-tank circuit-breakers, the requirements for internal faults (internal arc) and pressure relief devices shall be in accordance with SANS 62271-203. The Supplier shall provide details with the tender documentation (refer to 3.2.23.1) regarding the time during which an arc due to an internal fault up to a given value of short-circuit current will cause no external effects. The definition of this time shall be based on test results or an acknowledged calculation procedure. Refer to clause D.1 of SANS 62271- 203. The duration of current without burn-through for different values of the short-circuit current may be estimated from an acknowledged calculation procedure.

3.2.9 Insulation requirements

a) Hollow insulators

- The insulator material shall be ceramic or 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 ceramic type shall be in accordance with the requirements of SANS 62155 and SANS 60815-2.
- Insulators of the silicone rubber composite type shall be in accordance with the requirements of SANS 61462 and SANS 60815-3.

- Only for items in which it is requested in the technical schedules, KIPTS (Koeberg Insulation Pollution Test Site) certificates must be supplied for Medium ("c"), Heavy ('d") to Very heavy ('e") site pollution severity (SPS). The KIPTS test facility limitation is currently (2014) up to 132kV. Therefore the test requirement is split according to nominal system voltage level as follows:
  - o $U_n \leq$ 132kV: For insulators for applications up to nominal system voltages of 132kV (i.e. lightning Impulse withstand up to and including 550kV), the Eskom KIPTS "Natural aging and pollution performance test" is to be conducted in place of the IEC 60507 artificial pollution test. The test shall be according to Eskom procedures 240-56062328 and 240-56030420. The test commencement date and test duration shall be as defined in 240-56030420.
  - o $U_n >$ 132kV: For insulators for applications with nominal voltages greater than 132kV (i.e. lightning impulse withstand greater than 550kV), the results from the test on 132kV insulator will be extrapolated to longer insulators having the same design in addition to performing the IEC 60507 artificial pollution test.

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:-
  - o 34,7 mm/kV for "c - medium" site pollution severity (SPS) class;
  - o 43,3 mm/kV for "d - heavy" site pollution severity (SPS) class; and
  - o 53,7 mm/kV for "e - very heavy" site pollution severity (SPS) class.

NOTE: 34,7 mm/kV, 43,3 mm/kV and 53,7 mm/kV corresponds to a previous specific creepage distance (SCD) of 20 mm/kV, 25 mm/kV and 31 mm/kV respectively.

- 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:
  - i. for 11 kV: 600 mm[1)]; and
  - ii. for 22 kV: 400 mm; and
  - iii. 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.
- Eskom reserves the right to call for clearances greater than those already successfully proven by dielectric tests.

d) phase-to-phase and phase-to-earth clearances, measured by the taut-string method, shall be stated in schedule B.

3.2.10 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 SF6 circuit-breakers, pressure gauges (compensated for temperature and responding to SF6 gas density) shall be provided. These devices shall be sheltered from the elements to ensure that the reading provided is correct and to prevent ageing of the device, and this requirement shall apply to all circuit-breaker types with other insulation and/or extinguishing medium.

g) All indicating devices 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.

3.2.11 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 insulation and/or extinguishing medium inside of the circuit-breaker.

NOTE: The warning label for the mechanical trip facility shall be displayed.

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, fuses, 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 stick-on labels, double sided tape or glue is accepted, unless otherwise approved by Eskom.

3.2.12 Requirements for sulphur hexafluoride (SF6) gas (where applicable)

NOTE: Requirements below, where applicable, shall be fulfilled by the Supplier for all circuit-breakers that are using environmental friendly insulation and/or extinguishing medium. Furthermore, the Supplier shall provide additional specific details.

a) SF6 gas used as an insulation and/or extinguishing medium shall comply with the requirements of IEC 60376.

b) When installation is called for, SF6 circuit-breakers shall be filled with new SF6 gas at the rated normal pressure. All SF6 circuit-breakers shall be factory filled with new SF6 gas at the rated transportation pressure. This shall be applicable to other environmental friendly insulation and/or extinguishing medium.

c) The maximum SF6 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.

d) A certificate guaranteeing SF6 purity to IEC 60376 shall be supplied with the circuit-breaker. Upon filling and testing the circuit-breaker, a SF6 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:

- SF6 content (purity) - not less than 98%
- Dew-point (humidity/ moisture content) maximum, at rated filling pressure and +20°C – at commissioning shall not be above -10 °C. When equipment is in service it shall not exceed the critical limit of -5 °C.

NOTE: As the reference unit, in accordance with SANS NRS 087:2008 clause E.1.1 the volume concentration of the moisture contained in a gas shall be expressed in microliters per litre (µL/L).

e) The following requirements are applicable to SF6 gas-filled circuit-breaker filling and pressure monitoring (also the other environmental friendly insulation and/or extinguishing medium):

- In the case of circuit-breakers for use in systems of nominal voltage up to and including 132 kV, gas filling/evacuation points with DILO DN8 connections shall be provided.
- In the case of circuit-breakers for use in systems of nominal voltage from 220 kV up to and including 765 kV, gas filling/evacuation points with DILO DN20 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 i.e. 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), etc.
- The type of gauge utilised shall be designed such as to prevent any corrosion of moving parts and contacts inside the gauge.

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

- 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 3.2.23.1).
- 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 preferably 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 insulation and/or extinguishing medium 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 3.2.23.1).
- Electrical interlocks and alarms provided by the gas density monitoring device shall be in accordance with 240-56030489.

f) The management of SF6 gas shall be in accordance with NRS 087.

3.2.13 Current transformers (CTs) for dead-tank circuit-breakers

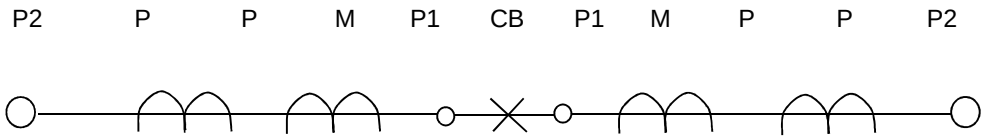
a) Current transformers (CTs) shall be of the integrated ring-type, manufactured and tested in accordance with IEC 61869-1, SANS 60044-1 (IEC 61869-2), SANS 60044-6 and NRS 029 (IEC 61869-6).

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) It shall be possible to remove and replace the ring-type CTs without dismantling the circuit-breaker bushing. The method to perform this shall be provided with tender documentation.

e) Specific requirements for dead-tank circuit-breaker CT's:-



No of CORE (As per Schedule A) **No of CORE (As per Schedule A)**

NOTE: P1 and P2 are indicating the dead-tank circuit-breaker's HV bushings main terminal and plug-in point

Figure 1: Typical arrangement of the CTs on the dead-tank circuit-breaker

3.2.13.1 Cores and class for CT's on dead-tank circuit-breakers

For Feeder bays, Coupler bays and Transformer bays CT's on dead-tank circuit-breakers

i. 765kV CT's:

Number of CT cores: 4 x Protection class TPY; 2 x Metering class 0.2

Table 9: 765kV ratios for multi ratio (MR) and fixed metering current transformers

Nominal ratio	Proposed Tapping points on secondary windings	Ratios available	Burden capability VA	Accuracy class	Ratio
3200/1	800/800/1200/400	3200/2800/2400/2000/1600/1200/800/400/1	10	0,2	800/1
800/1*	Fixed	800/1	10	0.2	800/1

NOTE: The asterisk (*) on the nominal ratio denotes that it is requirement for the 765kV Reactor Dead-tank circuit-breakers

Table 10: 765kV ratios for multi ratio (MR) and fixed protection current transformers

Nominal ratio	Proposed Tapping points on secondary windings	Ratios available	Maximum secondary winding resistance at 75°C(1)	Class	Eal	Double duty cycle
3200/1	800/800/1200/400	3200/2800/2400/2000/1600/1200/800/400/1	12.8	TPY	2000	C-O-C-O
800/1*	Fixed	800/1	12.8	TPY	2000	C-O-C-O

NOTE: The asterisk (*) on the ratio denotes that it is the requirement for the 765kV Reactor Dead-tank circuit-breakers

Table 11: Values where TPY cores are used on dead-tank circuit-breakers

	Unit	765kV CT	400kV CT in Trfr Bay
Current transformer class		TPY	TPY
Number of Protection cores		4	2
Rated primary current (Ipn)	A	3150	3150
Rated secondary current	A	2	2
Rated frequency	Hz	50	50
System voltage and insulation level	kV	765	400
System voltage and insulation level	kV	1550	1050
Ith (Ipsc)	kA	50 for 1 sec	50 for 1 sec
Idyn	kA	127.5	127.5
Ratio to which specified data applies	-	3200/1 (MR)	3200/1 (MR)
Alf (Symmetrical short circuit)	-	20	20
Kssc (Asymmetrical short circuit)	-	15	15
Tp	msec	100	100

	Unit	765kV CT	400kV CT in Trfr Bay
DC Component	%	55	55
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	100	100
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	40	40
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	500	500
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	100	100
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	40	40
Rb	Ω	12	12

- CT requirements for Shunt Reactor bays: Number of CT cores:

Dead-tank circuit-breaker CT's:2 x Protection class TPY (fixed 800/1) and 1 x Metering class 0.5 @ 800/1 5VA

Table 12: Values for the 765kV Reactor dead-tank circuit-breaker

	Unit	Dead-tank CB CT
Current transformer class		TPY
Rated primary current (Ipn)	A	800
Rated secondary current	A	2
Rated frequency	Hz	50
System voltage	kV	765
Insulation level	kV	1550
Ith (Ipsc)	kA	50 for 1 sec
Idyn	kA	127.5
Ratio to which specified data applies	-	800/1 (Fixed)
Alf (Symmetrical short circuit)	-	20
Kssc (Asymmetrical short circuit)	-	15
Tp	msec	100
DC Component	%	55
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	100
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	40
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	500
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	100
Duty cycle: Single: t', t'al; Double: t', t'al, tfr, t", t"al	msec	40
Rb	Ω	12

ii. 220kV – 400kV CT's:

Number of CT cores: 2 x Protection class TPS; 2 x Bus Zone class TPS; 2 x Metering class 0.2

NOTE: The 400kV dead-tank circuit-breaker used on the 765kV transformer bay on the 400kV side shall have the core requirements: 2 x Protection class TPY; 2 x Bus Zone class TPS; 2 x Metering class 0.2

iii. 132kV CT's:

Number of CT cores: 2 x Protection; 2 x Bus Zone; 2 x Metering.

NOTE: Class as per NRS 029 and 240-56062864 Table 2.

3.2.13.2 Magnetizing curves

Details of magnetizing curves (on a log-scale) for the dead-tank circuit-breakers CT's shall be provided for the TPY cores with tender documentation. The other cores' magnetizing curves shall be provided upon Eskom request.

3.2.14 Switching surge control (where applicable)

a) In order to reduce complexity, circuit-breakers that require auxiliary devices in the main circuit (e.g. pre-insertion closing resistors or inductors for switching surge control during no-load transmission line switching) may be considered for use in systems of nominal voltage 765 kV and will be subject to approval by Eskom. Information required for the selection of an appropriate resistance for the pre-insertion closing resistor will be provided by Eskom with the tender documentation.

NOTE: The inclusion of pre-insertion resistors may impact on the mechanical endurance class of the circuit-breaker (e.g. reduce the number of mechanical operations from 10 000 (M2) to 2 000 (M1) operations). This should be considered when evaluating various alternative solutions.

b) 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 (refer to 3.2.18) and/or the application of metal oxide surge arresters connected in parallel with the circuit-breaker interrupters.

NOTE: The electronic controller shall be IEC61850 protocol compliant.

3.2.15 Grading capacitors (where applicable)

a) Where grading capacitors are required for the distribution of voltage stresses across the interrupters of circuit-breakers having two or more interrupting units in series, this shall be stated in schedule B together with the capacitance (in pF) per interrupting unit, the type of insulation material e.g. oil/paper and the manufacturer and type.

b) The Supplier shall provide details with the tender documentation (refer to 3.2.23.1) of how to verify the condition of grading capacitors during the life of the circuit-breaker. The grading capacitors are required to last for the lifetime of the circuit-breaker without maintenance.

3.2.16 Extreme asymmetrical short-circuit interrupting capability (where applicable)

If required, the capability of the circuit-breaker to interrupt short-circuit currents with a higher degree of asymmetry than required by the SANS 62271-100 standard will be specified by Eskom in schedule A. Details will be provided with the tender documentation. Such capability shall be demonstrated by tests or calculations that show that the influence of the arc voltage will produce a current zero within the normal arcing time of the circuit-breaker.

NOTE: Circuit-breakers typically placed on the high-voltage side of large generator step-up transformers may experience short-circuit currents that may, due to the extreme asymmetry of the short-circuit current, not have a current zero for a number of cycles, preventing interruption of the current. In such circumstances, the duty of the circuit-breaker can be eased, for example, by delaying its opening. Alternatively, it may be proven by tests or calculations that the arc voltage of the circuit-breaker is high enough to damp the d.c. component of the current so much that a current zero will occur.

3.2.17 Requirements for simultaneity of poles during single closing and single opening operations

a) All interrupters in a pole and in all three poles of the circuit-breaker shall operate simultaneously on opening and closing – including infrequent operation and under extreme temperature conditions. Contact synchronism shall be retained within rated values during the expected maintenance intervals of the circuit-breakers. The expected degree of synchronism shall be in accordance with SANS 62271-100 and therefore as follows:

- the time interval between contact touch for all poles of the circuit-breaker shall not exceed 5 ms (a quarter of a cycle of rated frequency);
- the time interval between contact touch for interrupters in the same pole shall not exceed 3,3 ms (a sixth of a cycle of rated frequency);
- where applicable, the time interval between contact touch for individual pre-insertion closing resistors shall not exceed 10 ms (a half of a cycle of rated frequency); and
- where applicable, the time interval between contact touch for individual pre-insertion closing resistors in the same pole (series connected) shall not exceed 6,6 ms (a third of a cycle of rated frequency);
- the time interval between contact separation for all poles of the circuit-breaker shall not exceed 3,3 ms (a sixth of a cycle of rated frequency); and
- the time interval between contact separation for interrupters in the same pole shall not exceed 2,5 ms (an eighth of a cycle of rated frequency);

b) Refer to 5.101.1 of SANS 62271-302 for general guidance for circuit-breakers intended for operation with intentionally non-simultaneous poles (controlled switching - refer to 3.2.18).

3.2.18 Controlled switching

NOTES

- For switching of shunt capacitor banks, shunt reactors and power transformers, circuit-breakers supplied may be required to perform controlled (point-on-wave) switching duties. The Supplier shall provide all accessories and cabling required for the point-on-wave relay.
- SANS 62271-302 provides guidance on the design, construction, specification and testing of circuit-breakers with intentional non-simultaneous pole operation which are excluded from the scope of SANS 62271-100. Circuit-breakers with intentional non-simultaneous pole operation are mainly used for the implementation of controlled switching.
- The Supplier shall provide proof that the controlled switching device (point-on-wave) is compliant to IEC61850 protocol with the Tender documentation.
- The controller and its associated circuitry are to be provided as a separate contract item.
- The controller and its associated circuitry are located at a remote location in the control room associated with the particular circuit-breaker.
- Mechanically staggered poles used for controlled switching applications will not be accepted due to the limitation placed on the circuit-breaker mechanical endurance, unless otherwise accepted by Eskom.

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 3.2.23.1). 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.

c) The Supplier shall provide details with the tender documentation (refer to 3.2.23.1) regarding the mechanical characteristics of the circuit-breaker which affect the mechanical operating time, e.g. influence of ambient temperature, substation d.c. control voltage, standing time, operating pressure, contact wear. The cause of deviations in operating times shall be indicated in all cases, e.g. arising in the operating coil/latch assembly, energy storage device, etc.

d) The Supplier shall provide details with the tender documentation (refer to 3.2.23.1) of the circuit-breaker dielectric characteristic – as a function of time (closing) and as a function of SF6 gas filling pressure up to the maximum rated design pressure. The Supplier shall also supply the upper and lower limits of the dielectric characteristic which can be expected over the service life of the circuit-breaker. The critical arcing time window shall be indicated for re-ignition-free shunt-reactor switching. For controlled closing of shunt capacitor banks as well as for controlled opening of shunt reactors, a tolerance of less than ± 1 ms is required as a function of the above mentioned parameters. If special measures are required to maintain operating times within these limits, this shall be stated with the tender documentation.

3.2.18.1 Additional requirements for the point-on-wave controller for digital secondary plant interface option

The point-on-wave switching controller shall form an additional Process Interface Unit (PIU) in the digital secondary plant interface to the switchgear as per clause 3.2.21.1.

The point-on-wave switching controller shall implement the IEC 61850 logical node CPOW – Control Point-on-wave switching.

3.2.19 Pole discordance (PD) or phase discrepancy

NOTES

- A pole discordance (PD) or phase discrepancy condition is when one or more poles of a single-pole operated circuit-breaker (i.e. "1P") do not perform an operation in harmony with the other poles.
- The PD timer and its associated circuitry are to be provided as a separate contract item.
- This timer will receive its signal from a combination of normally-open and normally-closed auxiliary switch contacts.
- The PD timer and its associated circuitry are located on the control panel at a remote location in the control room associated with the particular circuit-breaker.

a) If a pole discordance condition persists for at least 100 ms, then the control circuitry associated with the circuit-breaker shall immediately initiate a trip command to all poles. The duration for which the discordance condition persists before tripping all poles, shall be controlled using a settable timer.

b) In order to determine the correct settings for this timer, the Supplier shall provide the following information with the tender documentation (refer to 3.2.23.1) about the timing events (with tolerances) between:

- main contact timing and the auxiliary contacts timing of the same pole for both opening and closing operations;
- main contact timing and the auxiliary contacts timing between all poles for both opening and closing operations assuming the open and close command is received simultaneously by all poles; and
- designation of auxiliary contacts (required for future testing);

c) In the case of single-pole auto-reclosing, where an intentional PD will exist for times in excess of 1 000 ms, the control circuitry shall deliberately permit this condition.

3.2.20 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 132 kV, the circuit-breaker auxiliary and control circuit wiring interface shall be in accordance with D-DT-5407. In the case of circuit-breakers for use in systems of nominal voltage above 132 kV, the wiring interface shall be in accordance with 0.54/07529 (Live-tank circuit-breakers) and 0.54/8557 (Dead-tank circuit-breakers).These schematics shall be applicable to equipment with the higher rated voltages.

c) A removable 3 mm thick brass or aluminium 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 tinned copper earthing bar with M6 fasteners or 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 d.c. 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

- Switchgear shall only be required to operate at one d.c. 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 d.c. or 220 V d.c. as specified in schedule A.
- A readily available d.c. supply voltage "conversion kit" may be required by Eskom from the Supplier in order to convert the circuit-breaker operating mechanism from 110 V to 220 V d.c. or vice versa. Refer to 0.

3.2.20.1 Requirements for the digital secondary plant interface option

An option shall be provided for a digital interface to the auxiliary and control circuits based on IEC 61850 [25] GOOSE Messaging. The digital interface shall be applicable to binary controls and binary status signals. Analogue instrument transformer signals (where applicable) shall be retained, that is implementation of IEC 61850 Sampled Measured Values is not required. The digital interface shall be achieved via Intelligent Electronic Devices (IEDs) to be referred to herein as Process Interface Units (PIUs).

The digital interface shall be an add-on option to the standard wiring interface of the switchgear, and shall be installed within the mechanism box, or in an additional bolt-on enclosure which shall be provided. The mechanism box/enclosure shall also be able to accommodate the point-on-wave closing controller. All wiring between the PIUs and the interface terminal strips shall be provided.

The digital interface shall be in accordance with SANS 62271-3 [25]. In particular:

a) The PIUs shall be specified to conformance class b (“including the services required to implement the complete IEC 61850 series’ data model with self-descriptive capabilities”) or higher.

b) The ACSI basic conformance shall include B11 (Server side of Two Party Application Association), B31 (GSE Publisher side) and B32 (GSE Subscriber side).

c) The total processing delay of the communication device (t_1) for trip and close signals for primary switchgear rated above 145kV shall be less than or equal to 7 ms. The processing delay for all other signals shall be less than or equal to 12 ms.

Two physically separate PIUs shall be provided. Separate auxiliary DC power supplies shall be provided by the Purchaser for each PIU. Each PIU shall be provided with all status and alarm contacts relating to the switchgear and the additional alarms indicated below. The "Main" PIU shall control the main tripping coil. The "Main 2"/"Back-up" PIU shall control the back-up tripping coil. Both PIUs shall have control over the closing coil by means of a dedicated DC supply (via the point on wave closing controller where applied).

The functions specified for a specific PIU may be distributed amongst multiple devices, but the physical separation of the main (1) and back-up/main 2 PIUs shall be retained.

PIUs shall be specified in accordance with Eskom Standard [28] 240-6465228. In particular, the devices:

a) Shall be rated for operating over the temperature range -25°C to +70°C (Section 3.1.1) without forced cooling.
b) Shall be equipped with a multi-session fibre optic Ethernet port in accordance with Section 3.16. Alternatively, separate optical Ethernet ports may be provided for IEC 61850 [25] communication and remote engineering access.

Tenderers shall complete the Schedules A&B of Eskom Standard 240-6465228 [28] which have been tailored for PIU devices.

The PIU hardware design shall allow for the unplugging of all interface wiring without the need to disconnect individual wires. Pre-wired test plugs shall be available for the input and output wiring, allowing the normal interface wiring plugs to be substituted by testing plugs for test purposes (i.e. to connect the PIU inputs and outputs to a secondary injection test set). All plugs shall be keyed so as to avoid replacement into the incorrect sockets. Keying of plugs shall be user settable and re-settable.

The PIUs shall support the following minimum sets of logical nodes in accordance with IEC 61850-7-4 and Eskom Standard 240-42066934 [27]. The PIUs shall support sufficient instances of the logical nodes and binary inputs and output contacts for the intended application.

a) LPHD – System: Physical device
b) CSWI – Control: Switch controller (circuit-breaker, disconnectors, earthing switches)
c) SCBR – Supervision and monitoring: circuit-breaker monitoring
d) SIMG – Supervision and monitoring: insulation medium supervision (gas) and/or SIML – Supervision and monitoring: insulation medium supervision (liquid) as applicable
e) SSWI - Supervision and monitoring: circuit-switch monitoring (for integral disconnectors and/or earthing switches)
f) XCBR – Switchgear: Circuit breaker
g) XSWI – Switchgear: Circuit switch (for integral disconnectors and/or earthing switches)

The digital interface IEDs shall have sufficient binary inputs and Logical Nodes for the assimilation and communication of the following additional alarms:

a) Main/Back-up DC supply fail (cross reporting by the main and back-up IEDs)
b) Closing DC supply fail
c) Motor DC supply fail
d) Main/Back-up IED unhealthy (cross reporting by the main and back-up IEDs)
e) Point-on-wave device unhealthy
f) Spring charged

The IEC 61850 Protocol Implementation Extra Information (PIXIT) requirements for the GSE Model and the Time Synch Model and the Technical Issue Conformance (TICS) requirements shall be in accordance with Eskom Standard [29] 240-68107841.

It shall be possible to place the digital interface IEDs in a test mode whereby output contact operation is blocked, yet information regarding attempted contact operation is made available via (preferably) IEC 61850 Edition 2 test mode (see IEC 61850-7-1 Section 7.8.4) and/or an engineering personal computer that is temporarily connected to the network. Simulation of binary inputs shall be supported.

3.2.21 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 b))

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

- Trip-coil rated voltage, current, d.c. resistance (at 20 ^{0}C)
- Close-coil rated voltage, current, d.c. resistance (at 20 ^{0}C)
- Motor rated voltage and current (starting peak current and nominal running current)

NOTE: These values shall be the nominal values (with tolerances) according to the routine test parameters.

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 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 3.2.12 f (requirement for labels). The method used shall be stated in schedule B. The nameplate material offered shall be stated in schedule B.

e) Where applicable, 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. The details on the nameplates shall be in accordance with NRS 029.

f) The actual ratings to which the circuit-breaker has been type-tested (and not merely the values specified) shall be displayed.

3.2.22 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. racking handle, spring charging handle, etc.). A full list of operating tools shall be provided with the tender documentation (refer to 3.2.23.1). 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 minor maintenance shall be supplied with the tender documentation (refer to 3.2.23.1). Where applicable, the following tools are required for minor maintenance:

- slow operating device(s);
- hoses and fittings for draining and filling with SF6 gas or other insulation and/or extinguishing medium; and

- other tools which may be required (e.g. contact alignment tools, insulation and/or extinguishing medium density meter checking device).

d) 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 3.2.23.1).

e) A full list of spares required for maintenance shall be provided with the tender documentation (refer to 3.2.23.1).

f) 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.

3.2.23 Documentation requirements

3.2.23.1 The documentation to be submitted with tender documentation

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

a) 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;

b) a full set of general arrangement (GA) drawings showing the following minimum information:

i. 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;

ii. a descriptive title of the drawing (e.g. "400 kV 3150 A 1-pole Operated Circuit-breaker General Arrangement");

iii. 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.;

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

v. 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);

vi. details of the main earthing terminal and operating mechanism enclosure earthing terminal;

vii. 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;

viii. any special trenches or steelwork required between phases;

ix. the steel support structure dimensioned outline and general arrangement;

x. the steel support structure label mounting holes;

xi. in the case where the steel support structure is designed by the manufacturer, the steel support structure earthing terminal;

xii. the concrete foundation dimensioned outline, design detail and general arrangement;

xiii. 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;

xiv. maximum torque required for the foundation holding down bolt nuts used to secure the support structure base plate (Nm);

xv. static and dynamic forces (loads), centre of gravity - refer to a).

xvi. relative location of circuit-breaker poles, base frame, operating mechanism enclosure(s), grading capacitors (where applicable) and closing resistors (where applicable);

xvii. location of all enclosure doors and handles;

xviii. location and annotation of control facilities (gas filling/evacuation points, SF6 density monitoring device with its environmental protection shelter/cover, etc.);

xix. location and layout of LV control cable gland plates;

xx. insulation and/or extinguishing pressure and quantity requirements; and

xxi. location of nameplate on circuit-breaker;

c) 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.;

d) drawings showing the generic layout of all the nameplates (circuit-breaker, operating device(s), CTs) in accordance with 3.2.21. 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;

e) generic auxiliary and control circuit schematic wiring diagrams for the circuit-breaker. 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;

f) 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;

g) full list of spares required for maintenance (refer to e) and section 3.5.1)

h) full list of operating tools (refer to a));

i) detailed list of standard tools required for minor maintenance (refer to c));

j) detailed list of additional specialised tools for major (specialised) maintenance (refer to d));

k) full list summary of type-tests as well as copies of type test reports and/ or certificates (refer to 3.3.1.2);

l) generic routine test certificates for the circuit-breaker (refer to 3.3.1.2);

m) transport, storage, installation, operating and maintenance manuals (refer to section 9);

n) training material (refer to section 10); and

o) generic quality inspection and test plan (QITP)

p) the submission, where applicable, of the following additional information:

i. premature failures experienced in service of similar design circuit-breakers supplied elsewhere by the manufacturer, together with the recommended modifications (refer to g));

ii. where applicable, details of any special equipment required to view all circuit-breaker status indications and make necessary readings from the ground level (refer to f));

iii. details of corrosion protection and lubricants offered (refer to d));

iv. measures taken to prevent flange corrosion (refer to e));

v. where applicable (i.e. dead-tank circuit-breakers), details of the internal arc behaviour of the circuit-breaker (refer to d))

vi. details of the arrangements offered to maintain insulation and/or extinguishing medium pressure in the system when the circuit-breaker or a pole is removed or replaced (refer to e) point 11);

vii. details of all insulation and/or extinguishing medium pressure devices, including drawings, manufacturer's specifications, performance and test data, details of production tests and a quality control programme (refer to e) point 16);

viii. information on how to verify the condition of grading capacitors during circuit-breaker life (refer to 3.2.15);

ix. information required for controlled switching (refer to 3.2.18);

x. information about the timing events for PD timers (refer to a));

xi. quality control plans indicating all inspection hold points (refer to c));

xii. details of equipment requiring maintenance during storage (refer to a));

xiii. a written commitment from the Supplier regarding the submission of the maintenance DVD (refer to 3.5.2); and

xiv. spares availability philosophy (refer to 3.5.3.2).

3.2.23.2 The documentation to be delivered with each circuit-breaker

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

a) an auxiliary and control circuit schematic wiring diagram of the circuit-breaker;

b) a complete set of routine test certificates;

c) a commissioning and hand-over test sheet; and

d) one set of transport, storage, installation, operating and maintenance manuals.

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.

3.2.23.3 Storage of supplied documents

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.

3.2.23.4 Documents to be supplied upon awarding or contract

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

a) circuit-breaker analyser data required for condition monitoring (refer to 3.5.5);

b) detailed scope of works (job plan) for each type of prescribed maintenance intervention;

c) detailed work instructions (task manual) for each type of prescribed maintenance intervention; and

d) detailed works reports (check sheet) for each type of prescribed maintenance intervention.

e) quality inspection and test plan (QITP) in accordance with QM-58 clause 6c and Appendix I.

3.2.24 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 QM-58 how to handle preservation.

c) Durable waterproof packaging shall prevent damage to the circuit-breaker components during transportation and storage on site and shall be such that suitable ventilation is allowed in order to minimise condensation.

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 d.c. control voltage; specific creepage; “1P” or “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.

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) Fork-lift 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 a.c. 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 a.c. 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.

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.

3.3 Tests

3.3.1 General

a) Manufacturer's testing capabilities

The manufacturer shall be fully responsible for performing or having performed all the required 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 testing.

3.3.1.1 Witnessing of tests

Eskom reserves the right to be present at any of the 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 8 weeks.

Eskom shall be notified as soon as possible of all test failures and corrective measures. 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.

3.3.1.2 Test certificates and reports

a) Type test reports and/or certificates together with each complete summary of type test (in English) shall be supplied with the tender documentation (refer to 3.2.23.1). The type test reports and/or certificates and the summary of type tests shall be in both printed copy and in electronic Portable Document Format (PDF). The type test reports shall be in electronic Portable Document Format (PDF).

i. The type test certificate which is the proof of official accreditation shall have the official signatures of the accredited test laboratory where the type-tests were performed which is responsible for its validity and contents. The type test certificate shall contain a record of series of type-tests carried out strictly in accordance with the IEC standard. It shall contain essential drawings and the equipment tested.

ii. Where the Supplier and OEM are using the type test certificate and type test report beyond that particular equipment that was type tested, to indicate that the other equipment types with their different ratings are covered by the type test certificate and type test report, a separate official signed off letter on the company's letterhead shall be supplied by the Supplier with the tender documentation. This letter shall clearly state all particular tests and the tested parameters that are extrapolated form the type test certificate and type test report.

iii. The summary list of type-tests indicating the following:-

- The type test performed,
- The IEC standard it was type tested on,
- The type test report document number;
- The date of type test performed
- The Test Facility where the type test was performed, the Test facility accreditation authority.

b) Generic routine test certificates/reports shall be supplied with the tender documentation (refer to 3.2.23.1) in electronic format (pdf). 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

3.3.2 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 and shall include the following tests:

- equipment insulation level (SANS 62271-100 6.2); dry lightning impulse withstand voltage test (BIL or LIWL) (SANS 60137 8.3) (for bushings on the dead-tank circuit-breaker);
- Dry power frequency withstand level voltage tests (PFWL) (SANS 62271-100), (SANS 60137 8; 9.3 & 8.1) (for bushings on the dead-tank circuit-breaker);
- Wet power frequency voltage withstand level (PFWL) test (SANS 62271-100), (SANS 60137 8; 9.3 & 8.1) for all bushing < 300kV (for bushings on the dead-tank circuit-breaker);
- dry switching impulse withstand level voltage test (SIWL) (SANS 62271-100), for bushings rated for U_r ≥ 300kV (SANS 60137 8.4) (for dead-tank circuit-breaker);
- wet switching impulse withstand test (SIL) for bushings rated for U_r ≥ 300kV (SANS 60137 8.4) (for dead-tank circuit-breaker);
- temperature rise and measurement of resistance of circuits (SANS 62271-100 6.5 & 6.4); temperature rise test (SANS 60137 8.7) (for bushings on the dead-tank circuit-breaker);
- 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); verification of thermal short-time withstand current (SANS 60137 8.8) (for bushings on the dead-tank circuit-breaker);
- critical current tests (where applicable) (SANS 62271-100 6.107);
- single-phase tests (for Un >_ 66 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 >_ 66 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 >_ 66 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);
- radio interference voltage tests (for Un >_ 132 kV) (SANS 62271-100 6.3);
- verification of the protection (IP coding) (SANS 62271-100 6.7) and, in the case of dead-tank circuit-breakers, verification of the protection (IP coding and mechanical impact test) (SANS 62271-203 6.7);
- tightness test (SANS 62271-100 6.8 / SANS 62271-203 6.8 (for dead-tank circuit-breakers));
- EMC tests (SANS 62271-100 6.9) - where applicable; (SANS 60137 8.6) (for bushings on the dead-tank circuit-breaker);
- X-radiation test procedures for vacuum interrupters (SANS 62271-100) - where applicable;
- static terminal load tests (for Un >_ 66 kV) (SANS 62271-100 6.101.6);
- cantilever load withstand test (SANS60137 8.9) (for bushings on dead-tank circuit-breakers);
- additional tests on auxiliary and control circuits (SANS 62271-100 6.10);
- proof tests for enclosures (compartment/ metallic tank) (for dead-tank circuit-breakers) (SANS 62271-203 6.103);
- internal pressure test on gas-filled, gas-insulated and gas-impregnated bushings (SANS 60137 8.11) (for dead-tank circuit-breaker);
- test under conditions of arcing due to an internal fault (for dead-tank circuit-breakers) (SANS 62271-203 6.105);
- insulator tests (for dead-tank circuit-breakers) (SANS 62271-203 6.106); and
- corrosion test on earthing connections (for dead-tank circuit-breakers) (SANS 62271-203 6.107).
- all type-tests applicable to CT's (for dead-tank circuit-breaker);

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);
- dry power frequency withstand voltage tests for bushings (SANS 60137 8 & 9.3) (for dead-tank circuit-breaker);
- measurement of dielectric dissipation factor (tan δ) and capacitance at ambient temperature (SANS 60137 8 & 9.1) (for dead-tank circuit-breaker);

- measurement of partial discharge quantity (SANS 60137 8 & 9.4) (for dead-tank circuit-breaker);
- 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 7.1).

- measurement of the resistance of the main circuit (SANS 62271-100 7.3);
- tightness test (SANS 62271-100 7.4 / SANS 62271-203 7.4 (for dead-tank circuit-breakers)); (SANS 60137 9.8) (for bushings of the dead-tank circuit-breaker);
- design and visual checks (SANS 62271-100 7.5 / SANS 62271-203 (for dead-tank circuit-breakers) / SANS 60137 (for bushings on dead-tank circuit-breakers));
- pressure tests of enclosures (for dead-tank circuit-breakers) (SANS 62271-203 7.101); and
- Internal pressure test on gas-filled, gas-insulated and gas-impregnated bushings (SANS 60137 9.6) (for dead-tank circuit-breaker);
- mechanical operating tests on circuit-breaker (SANS 62271-100 7.101).
- all factory routine tests applicable to CT's (for dead-tank circuit-breaker);

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) Only for items in which it is requested in the technical schedules, KIPTS (Koeberg Insulation Pollution Test Site) certificates must be supplied for Medium ('c'), Heavy ('d') to Very heavy ('e') site pollution severity (SPS). The KIPTS test facility limitation is currently (2014) up to 132kV. Therefore the test requirement is split according to nominal system voltage level as follows:

- o $U_n \leq 132kV$: For insulators for applications up to nominal system voltages of 132kV (i.e. lightning Impulse withstand up to and including 550kV), the Eskom KIPTS "Natural aging and pollution performance test" is to be conducted in place of the IEC 60507 artificial pollution test. The test shall be according to Eskom procedures 240-56062328 and 240-56030420. The test commencement date and test duration shall be as defined in 240-56030420.
- o $U_n > 132kV$: For insulators for applications with nominal voltages greater than 132kV (i.e. lightning impulse withstand greater than 550kV), the results from the test on 132kV insulator will be extrapolated to longer insulators having the same design in addition to performing the IEC 60507 artificial pollution test.

h) Where applicable, CTs shall be tested in accordance with SANS 60044-1 or NRS 029, as applicable.

i) Insulators of the ceramic type shall be tested in accordance with SANS 62155 and SANS 60815-2.

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

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

a) Commissioning checks and a test programme (as determined by the manufacturer) 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 and trip II. 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)
- the average speed on opening (in m/s)

g) For the measurement of the steady-state contact resistance of the main circuit, a d.c. 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 pQ and the resolution shall be at least 1 pQ.

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 3.4.7.2 for further information on the pre-commissioning test report.

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

3.4.1 General

a) The manufacturing, transport, storage, installation and pre-commissioning of switchgear and controlgear, 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 3.2.23.1).

3.4.2 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 3.2.23.1), 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 8 weeks.

d) 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.

e) 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.

3.4.3 Conditions during transportation

NOTE: Refer to DST_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 mounted. Refer to l) for the requirements for non-resettable impact recorders.

c) The supplier shall demonstrate - either by testing or through previous satisfactory experience - that 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.

d) If the design of the equipment is mature, and the equipment has previously been shipped under similar conditions, the above tests may be waived at Eskom's discretion.

3.4.4 Transportation and off-loading

a) Refer to 3.2.23.4 for the requirements for packaging for transportation and storage.

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.

3.4.5 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 3.2.23.1) 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 k)) shall be provided to enable Eskom to supply power to the heaters.

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 3.2.23.1). 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.

3.4.6 Installation

a) Unless otherwise specified and agreed (e.g. where OEM certified training and/or supervision is provided), the Supplier 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, leveling of the switchgear, filling of gas (other insulation and/or extinguishing medium), where applicable.

c) For each type of circuit-breaker, the installation instructions provided by the supplier (refer to 3.2.23.1) 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:
  - i. the total mass of the equipment, inclusive of insulation and/or extinguishing medium;
  - ii. the mass of insulation and/or extinguishing medium; and
  - iii. 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 controlgear has been installed and all the interfacing connections have been completed. These instructions shall include the following:
  - i. procedures for carrying out any adjustment that may be necessary to achieve correct operation;
  - ii. recommendations for any relevant measurements that should be made and recorded to help with future maintenance decisions; and
  - iii. 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 a.c. power supplies cannot be made available to the Supplier for installation and pre commissioning purposes, the Supplier shall be responsible for providing his own a.c. power supply (e.g. generator) for the installation and pre-commissioning of switchgear.

3.4.7 Pre-commissioning

3.4.7.1 Testing of each circuit-breaker after installation

Each circuit-breaker shall be tested after installation in accordance with 3.3.3. 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 d.c. power supplies, test equipment and suitably qualified and accredited personnel shall be provided by the Supplier.

NOTES

a) For reasons of compatibility with Eskom's on-site test equipment, one of the following types of equipment shall be used to measure/record the time quantities and travel characteristics:

- Elcon - SA10 Instrument, Sweden
- Programma Elektrik AB - TM 1600 or TM 1800 Instrument, Sweden.

b) The software used shall be compatible with any one of the above instruments, and will be specified when ordering the circuit-breaker. The choice may depend on where the circuit-breaker will be used.

3.4.7.2 Pre-commissioning test report

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

3.4.7.2.1 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 that is on the OEM instruction manual and/or test protocol shall be incorporated by the Supplier on this report, e.g. “Activate anti-condensation heaters”;

b) within three 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 CD 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.

3.4.7.2.2 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 substation and section;
- circuit-breaker identification and application;
- date of commissioning; and
- date and time of testing/measuring.

3.4.7.2.3 Clear copies attached to the official report

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.

3.4.7.3 The switchgear and controlgear shall be subject to a final inspection by Eskom

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

3.4.7.4 Final inspection to hand-over

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.

3.4.8 Safety related data (where applicable)

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

3.4.9 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.

3.4.10 After sales technical support

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

3.5 Inspection and maintenance

3.5.1 General

The effectiveness of maintenance depends mainly on the way instructions are prepared by the OEM and implemented by Eskom. The Supplier shall supply maintenance information in the form of maintenance manuals, full maintenance analysis FMECA as per Appendix D, OEM test plan/ speed calculation datum points (for closing and opening circuit-breaker operation) field service bulletins and Digital Video Disk (DVD) material covering the following aspects:

a) Extent and frequency of maintenance:

For this purpose, the following factors shall be considered:

i. switching operations (accumulated switching amperage);

ii. total 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);

iii. environmental conditions;

iv. measurement and diagnostic tests for condition monitoring ; and

v. full maintenance analysis FMECA as per Appendix D.

b) Scope of work to be performed:

It shall include the following:

i. recommended place for the maintenance work (indoor, outdoor, in factory, on-site, etc.);

ii. procedures for inspection, diagnostic tests, examination overhaul;

iii. reference to drawings;

iv. reference to part numbers or standard kit of parts;

v. tools required, including special equipment or tools;

vi. precautions to be observed (e.g. cleanliness and possible effects of harmful arcing by-products);

vii. lubrication procedures; and

viii. cleaning materials.

c) Graphical information:

Detailed drawings and sketches of the circuit-breaker components, with clear identification (part number and description) of assemblies, sub-assemblies and essential components. Expanded detail drawings, which indicate the relative position of components in assemblies and subassemblies, are expected as a preferred illustration method. Graphs and similar means of portraying important information shall also be included.

d) Specified operational values:

Values and tolerances pertaining to which, when exceeded, make corrective action necessary, for example:

i. pressure levels (where applicable);

ii. operating times and contact velocities;

iii. resistance of the main current carrying circuits;

iv. insulation and/or extinguishing medium characteristics (e.g. the SF6 purity, dew point, acidity, etc.);

v. quantities and quality of gas;

vi. grading capacitor condition;

vii. contact condition (including contact dimensions);

viii. torque settings for fasteners; and

ix. important dimensions.

e) Specifications for materials:

This includes warnings of known non-compatibility of materials.

i. fluid; and

ii. cleaning and degreasing agents.

f) Tools, lifting and access equipment:

A list of standard and specialised tools shall be provided with description of their application and associated part number.

Tests after the maintenance work: All tests shall be clearly described and shall include the parameters to be observed.

g) Spare parts:

Description, reference number, quantities and advice for storage.

h) Time estimates:

Estimated time required to carry out maintenance activities.

i) Detailed information:

This relates to the recommended makes and types of transducers (linear or rotary) to facilitate the measurement of travel curves. Such transducers (as well as the brackets, fittings and so forth that are needed to apply them on the circuit-breaker) are part of the special maintenance tools for the circuit-breaker. The manual shall show clearly how the transducer, together with any brackets, fittings, etc, shall be mounted and applied on the circuit-breaker.

3.5.2 Maintenance DVD

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 DVD format. A written commitment from the Supplier regarding the submission of the DVD shall be provided with the tender documentation (refer to 3.2.23.1). The actual DVD shall be supplied upon awarding of the contract following approval of the maintenance manual by Eskom. Copies of the DVD shall be issued to the contract manager and relevant technical specialists.

The DVD shall provide a record of the maintenance requirements and procedures for the equipment supplied. The DVD 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 DVD will show how such maintenance is achieved.

The DVD 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 DVD 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 DVD's or if consolidated into a single DVD, there shall be adequate indexing to permit quick access to the desired section. For each piece of equipment requiring maintenance, the DVD 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 disassembly steps, including any marking of positions required prior to disassembly, any discharging of pressure and/or stored energy;
- the disassembly, 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; and
- some trouble-shooting methods if the required tolerances are not achieved.

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.

3.5.3 Spares

3.5.3.1 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 (refer to e)) together with prices in the pricing schedules for the circuit-breakers concerned.

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.

3.5.3.2 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 controlgear.

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;
- SF6 density monitoring devices (If applicable, other insulation and/or extinguishing medium); and
- contactors and relays.

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:

- 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 3.2.23.1).

3.5.3.3 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.

3.5.3.4 Packaging, preservation and storage of spares

Refer to QM-58 how 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.

3.5.3.5 D.C. supply voltage conversion kits

D.C. 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 d.c. to 220 V d.c. or from 220 V d.c. to 110 V d.c. Refer to a).

3.5.4 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.

3.5.5 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 SF6 gas or other insulation and/or extinguishing medium density, the instrumentation for which will provide information enabling early warning of insulation and/or extinguishing medium leaks and planned outages for refilling or repairs;
- analyser for SF6 gas quality and decomposition products (with alarms); and
- continuous monitoring, recording and alarm signalling 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 Supplier and 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.

3.6 Manuals

3.6.1 General

Transport, storage, installation (erection), operation and maintenance information shall be submitted in the form of manuals (refer to 3.2.23.1 and 3.2.23.2). These manuals shall be in English and provided in the following formats:

- hard copy A4 form; and
- electronic copy (pdf) form copied onto an appropriate medium such as Compact Disc (CD).

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

3.6.2 Content

The instruction manual(s) shall cover transport, storage, installation, operation and maintenance and shall fulfil the following requirements:

- 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, minor and major 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, compounds and so on shall be listed.

One set of sample manuals shall be supplied to Eskom with the tender documentation (refer to 3.2.23.1) for approval. After approval, the requisite number of manuals shall be supplied.

Qualified personnel will install, operate, maintain and repair the equipment with the aid of the manufacturer's instruction manuals and DVD aids. The manuals shall contain at least the following information (where applicable):

General

- 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.

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.

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 DVD to supplement installation information given in the installation manual. This visual information may be provided separately or may form part of the maintenance DVD required.

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.

Inspection and maintenance

- the maintenance manual shall contain the typical contents as described in 3.5.

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 SF6 gas products shall be described; and
- trouble-shooting procedures shall be provided.

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 3.2.23.

3.7 Training

The Supplier shall provide first-hand training of an international standard on the supplied equipment by OEM accredited instructors for the duration of the contract.

Refer to [35] 240-56065202 for the switchgear training requirements from original equipment manufacturers. The supplier shall provide with the tender documentations, the detailed training programme in accordance with this training standard [35].

3.8 Safety, health, environment and quality

Refer to 240-56063765 for Eskom's health and safety management requirements for Suppliers. Refer to QM-58 for Eskom's quality management requirements for Suppliers.

All facets of this tender must comply with Occupation Health and Safety Act (OHS Act) No 85 of 1993 – Construction and Electrical Machinery Regulations.

4. Authorisation

This document has been seen and accepted by:

Name & Surname	Designation
	Rev 1 Document Approved by TDAC ROD 27 February 2013
	Rev 2 Document Approved by SCOT for HV Plant
Bheki Ntshangase	Senior Manager PDE HV Plant
Bheki Ntshangase	Plant Equipment SC Chairperson
Jabulani Cebekhulu	AIS Care Group Convener
Andre Marais	HV/ EHV GIS/ MTS Care Group Convener
Tjaart van der Berg	Transmission Switchgear Task Team Convener
Ajith Persadh	Distribution Switchgear Care Group
Sarel Pretorius	GIS Work group Convener
Naresh Rampersad	Transmission HV Plant Manager's Forum – Switchgear representative
Monde Bala	Senior Manager Limpopo OU - Maintenance and Operation & Distribution Plant Management Forum

5. Revisions

Date	Rev	Compiler	Remarks
Sept 2015	6	S. Nkosi	Final Document for Authorisation Reviewed clauses:- 1 and 2.1.1 – included the special requirement – traction and HVDC requirements; 2.2.1 – updated list of references by including – Note; [1] – added Bushing standard; [55] – added Technical evaluation criteria standard; 3.1.1; 3.1.2; 3.1.4; 3.1.7; 3.1.19, 3.2.5 and 3.2.8 – included HVDC requirements; 3.2.2 Note – updated by adding FFR, OTD and NCR's; 3.2.2.1 a) – included SANS 62271-203 for DTCB; c) – included the compartment/ tank metallic enclosure details; e) – energy storage device details updated; i) – added 3.2.6 – revised c) to include old f) with table 6. removed f) 3.2.23.1 k) – revised to align with 3.3.1.3 a) requirement; 3.3.1.2 a) – paragraph revised and introduced i., ii and iii.; 3.3.2 b) – included type-tests requirements for the bushings, CT's and the compartment/ metallic tank on DTCB; d) included routine test requirements for bushings and CT's on DTCB; 3.4.7.2.1 a) – included OEM instruction manual and/or protocol; 3.7 – revised; Annex A clause A.1 a) – updated with the reference to the Technical Evaluation Criteria and inclusion of i.;
June 2014	5	S. Nkosi	3.3.2 g) and 3.2.10 a) – Reviewed clauses on KIPTS

Date	Rev	Compiler	Remarks
May 2014	4	S. Nkosi	Reviewed clauses:- 2.1.1 – introduced maintenance analysis FMECA and digital secondary interface option 2.2 – updated list of references 3.1.1 a) revised the Note 3.1.2 included 44kV and 88kV requirements 3.1.4 included 1600A and 2000A requirements 3.1.7 included 20kA, 25kA, 31.5kA and 40kA 3.1.19 updated the classification table 3.2.1 and 3.2.6 – aligned to DSP 34-1658 3.2.2 Note – introduced FMECA and the option of the digital secondary plant interface 3.2.2.1 – new numbering 3.2.10 b – updated SPS class and included SCD of 25 mm/kV 3.2.19.1 and 3.2.21.1 – the option of the digital secondary plant interface 3.5 – included FMECA requirements 3.8 – updated number of Safety standard Appendix A.3 changed to Appendix B Appendix C – new digital secondary plant interface option Technical schedules A & B Appendix D – Maintenance analysis and templates 6 – revised the list
Aug 2013	3	S. Nkosi	Reviewed clauses:- 2.2.1; Table 4; 3.2.8 a – ii NOTE; 3.2.14; Appendix C; Document number changed to 240-56063756
July 2013	2	S. Nkosi	Final Document for Authorisation Updated all references from “this specification” to “this standard”; Included special requirements and designs that offer environmental friendliness. Reviewed clauses:- 1; 2.1.1; 2.2; 2.2.1; 2.5; 2.7; 3; 3.1.2 Table 1; 3.1.4 a); Table 2; 3.2.1; 3.2.2 a), f), e), g); 3.2.4 b), n), l, t); 3.2.5 b, Table 5; 3.2.6 e), Table 6; Deleted – 3.3 to 3.5 old numbering; 3.2.7 d); 3.2.8 a), b), Deleted – old a) – iii; 3.2.11 f); 3.2.12 a), c), f); 3.2.13 Note, a, b, d, e; 3.2.14 a) to f); 3.2.15 b); 3.2.16 a); 3.2.19 Notes; 3.2.21 b), c); 3.2.22 d), e); 3.2.23 c); 3.2.24.1 a), b) – xx, o), p) – vi – vii; 3.2.24.2; 3.2.24.3; 3.2.24.4, e), b) 3.2.25, a), b); 3.3.1 a); 3.4.2 b); 3.4.3, Note, a); 3.4.4; 3.4.5, d), e); 3.4.6 b), c – i -ii; 3.4.7 b); 3.4.7.2; 3.4.7.2.1 a); 3.5.1 d); 3.5.3.4; 3.5.4; 3.5.5; 3.6.2; 3.8; 6; A.1 a), b), g), o), q); A2 a)
May 2013	1	J. Cebekhulu	Final Document for Publication
Nov 2012	0	J. Cebekhulu	Draft document for Review created from 32-1166

6. Development team

The following people were involved in the development of this as well as previous revisions of this standard. The original document was compiled by Transmission and Distribution switchgear specialists.

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- Tjaart van der Berg — Tx (Northern Grid)

7. Acknowledgements

The Compiler acknowledges the contributions to this revision from Technology, Distribution and Transmission and Quality.

Annex A – Appendix A – Supplier and Eskom responsibilities

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

A.1 Supplier's responsibilities

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

a) upon submission of a tender, the submission of a complete set of technical documents as required by this standard (refer to clause 3.2.23 for documentation requirements), this shall be in paper print, Adobe PDF copy and all the technical schedules A and B shall also be submitted in a copy of the Microsoft Excel format.. The tender shall state clearly all deviations (if any) in the Deviation Schedule and in schedule B (if applicable). Deviations will be evaluated by Eskom and the outcome will be communicated, in writing, to the Tenderer;

   i. The Supplier shall also read the [55] Technical Evaluation Criteria standard 240-46425564 with this document and supply all the information with the technical submission in order for the technical documentation to be evaluated by Eskom. Failing to provide information called by this standard and the [55] Technical Evaluation Criteria standard 240-46425564 shall render the technical submission disqualified for technical evaluation.

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 a.c. power supply), the supply of an a.c. 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) where applicable, the first filling of the insulation and/or extinguishing medium to the OEM's rated value;

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

q) 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;

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

s) any modifications required during the circuit-breaker service life; and

t) any other responsibilities as specified in this document.

A.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;

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.

Annex B – Appendix B – Technical Schedule A & B (Generic)
TECHNICAL SCHEDULES A & B FOR 6,6 kV to 765 kV OUTDOOR CIRCUIT-BREAKERS
SAP: _____ BKR LT/ DT ___kV ____A ___kA _P ___VDC Creepage (BIL) Spacing

Schedule A: Purchasers specific requirements
Schedule B: Guarantees and technical particulars of equipment offered

1	2	3		4	5
Item	**Clause of 240-56063756**	**Description**		**Schedule A**	**Schedule B**
1		**Item and system description** BKR LT/ DT ___kV ____A ___kA _P ___VDC Creepage (BIL) Spacing			
1.1		• SAP No		_____	xxxxxxxxxx
1.2		• Buyers Guide Drawing		Eskom Drwg Number/ N/A	xxxxxxxxxx
1.3		• Circuit-breaker application		Transformer/Bus/Line/ Cable/Shunt Cap/ Traction/Shunt Reactor/Gen Synchronising on HV busbar (____mm phase spacing)	xxxxxxxxxx
1.4		• Nominal system voltage (U_n)	kV	_____	xxxxxxxxxx
1.5		• System voltage range	pu	0,9 to 1,1	xxxxxxxxxx
1.6		• System earthing (effective/non effective) ([*1] - *non-effective when to be used on 88kV and below)*		Effective/ Non-effective	xxxxxxxxxx
2		**Ratings**			
2.1		• Rated voltage (U_r)	kV	_____	
2.2		• Number of phases on system		3	
2.3		• Rated short-duration power-frequency withstand voltage (U_d)	kV	_____	
2.4		• Rated peak lightning impulse withstand voltage (U_p)	kV	_____	
2.5		• Rated frequency (f_r)	Hz	50	
2.6		• Rated normal current (I_r) - main circuit	A	_____	
2.7		• Calculated maximum continuous current - main circuit @ 40 ^{0}C ambient	A	xxxxxxxxxx	
2.8		• Calculated maximum continuous current - main circuit @ 45 ^{0}C ambient	A	xxxxxxxxxx	

2.9		• Maximum allowable temperature of main contacts (refer to Table 3 of SANS 62271-1)	^{O}C	xxxxxxxxxx	
2.10		• Measured temperature rise (highest) of main contacts @ rated current (type test)	K	xxxxxxxxxx	
2.11		• Maximum allowable temperature of bolted or equiv connections (refer to Table 3 of SANS 62271-1)	^{O}C	xxxxxxxxxx	
2.12		• Measured temperature rise (highest) of bolted or equiv connections @ rated current (type test)	K	xxxxxxxxxx	
2.13		• Maximum allowable temperature of terminals for the connection to external conductors (refer to Table 3 of SANS 62271-1)	^{O}C	xxxxxxxxxx	
2.14		• Measured temperature rise (highest) of terminals for the connection to external conductors @ rated current (type test)	K	xxxxxxxxxx	
2.15		• Rated short-time withstand current (I_k and I_{ke})	kA	_____	
2.16		• Rated peak withstand current (I_p and I_{pe})	kA	_____	
2.17		• Rated duration of short circuit (t_k)	s	3	
2.18		• Rated d.c. supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)	V	_____	
2.19		• Rated a.c. supply voltage of heaters and other a.c. auxiliary circuits (U_a)	V	230	
2.20		• Rated supply frequency of closing and opening devices and of auxiliary and control circuits	Hz	d.c.	
2.21		• Rated supply frequency of heaters and other a.c. auxiliary circuits	Hz	50	
2.22		• Rated short-circuit breaking current (I_{SC}) of circuit-breaker	kA	_____	
2.23		• Factor by which the 100 % symmetrical and asymmetrical single-phase rated short-circuit breaking current exceeds the three-phase rating	pu	_____	
2.24		• Circuit-breaker class		xxxxxxxxxx	
2.25		• First-pole-to-clear factor (k_{pp}) for circuit-breaker		_____	
2.26		• Standard values of TRV related to the rated short-circuit breaking current (SANS 62271-100)		SANS 62271-100 Table 5	
2.27		• Rated short-circuit making current of circuit-breaker	kA	_____	
2.28		• Rated operating sequence for circuit-breaker		O-0,3s-CO-3m-CO/ O(1 pole)-0,3s-C(1 pole)-O(all poles)-3m-CO(all poles)	
2.29		• Minimum resting time following rated operating sequence	min	xxxxxxxxxx	

2.30		• Characteristics for short-line faults		SANS 62271-100 4.105 for Class S2 circuit-breakers only	
2.31		• Rated out-of-phase making and breaking current for circuit-breakers	kA	xxxxxxxxxx	
2.32		• Classification of circuit-breaker according to its restrike performance (line- and cable-charging breaking current)		Class C2	
2.33		• Rated capacitive switching currents for circuit-breaker - line-charging breaking current	A	_____	
2.34		• Rated capacitive switching currents for circuit-breaker - cable-charging breaking current	A	_____	
2.35		• Classification of circuit-breaker according to its restrike performance (capacitor bank switching)		Class C2	
2.36		• Rated capacitive switching currents for circuit-breaker - single & back-to-back capacitor bank breaking current (I_{sb} & I_{bb})	A	_____	
2.37		• Frequency of the inrush current (f_{bi})	Hz	_____	
2.38		• Rated capacitive switching currents for circuit-breaker - back-to-back capacitor bank inrush making current	kA	_____	
2.39		• Chopping number of the circuit-breaker	λ	xxxxxxxxxx	
2.40		• Rated opening time for circuit-breaker	ms	xxxxxxxxxx	
2.41		• Rated break-time for circuit-breaker (max 60ms for U_n ≤ 132kV; max 50ms for U_n >132kV)	ms	shall not exceed 60 (Un ≤ 132kV) / 50 (Un >132kV)	
2.42		• Rated closing time for circuit-breaker	ms	xxxxxxxxxx	
2.43		• Rated open-close time for circuit-breaker	ms	xxxxxxxxxx	
2.44		• Rated reclosing time for circuit-breaker	ms	xxxxxxxxxx	
2.45		• Rated close-open time for circuit-breaker	ms	xxxxxxxxxx	
2.46		• Rated pre-insertion time for circuit-breaker	ms	7±1	
2.47		• Circuit-breaker mechanical endurance class		Class M2	
2.48		• Number of mechanical operations for circuit-breaker		_____	
2.49		• Classification of circuit-breakers as a function of electrical endurance		_____	
		□			
3		**Service conditions**			
3.1		• Location (indoors/outdoors)		Outdoors	
3.2		• Ambient air temperature range	°C	-10 to +40	
3.3		• Solar radiation	W/m^2	1100	
3.4		• Altitude (amsl)	m	1800	
3.5		• Class of pollution (SANS 60815-1:2009)		Very heavy ('e')	
3.6		• Average humidity	%	95	
3.7		• Wind speed (velocity)	m/s	34	
3.8		• Condensation and precipitations		Yes	

3.9		• Seismic activity	g	0,3	
4		**General**			
4.1		• Circuit-breaker compliant to SANS 62271-100		Yes	
4.2		• Circuit-breaker design (live-tank / dead-tank)		Dead-tank/ Live-tank	
4.3		• Circuit-breaker manufacturer		xxxxxxxxxx	
4.4		• Circuit-breaker country of origin		xxxxxxxxxx	
4.5		• Circuit-breaker model/type designation		xxxxxxxxxx	
4.6		• Circuit-breaker total mass	kg	xxxxxxxxxx	
4.7		• CTs required		Yes/ N/A	
4.8		- CT manufacturer		N/A	
4.9		- CT country of origin		N/A	
4.10		• Support structure design		xxxxxxxxxx	
4.11		- Steel support structure to be supplied with circuit-breaker	Y/N	No/ Yes	
4.12		- Circuit-breaker pole operation		3-pole operated (3P)/ 1-pole operated (1P)	
4.13		- Stored energy operation for circuit-breaker mechanism		Yes	
4.14		- Energy storage device (*spring-hydraulic shall be considered for DTCB U_r >145kV and LTCB U_r ≥ 550kV and 800kV)		Spring/ (as per note*)	
		NOTE: When a feeder circuit-breaker is in the closed position and the spring has been charged, it shall be able to "TRIP-CLOSE-TRIP" before the spring needs to be recharged		Yes	
4.15		- Manual and motorised spring charging		Yes	
4.16		- Manual and electric energy release		Yes	
4.17		- Mechanical energy stored in charged spring	kJ	xxxxxxxxxx	
4.18		- Mechanical device provided to prevent over-charging of the closing spring for manual and motor charging		Yes	
4.19		- Safe conditions produced in the case of failure to latch		Yes	
4.20		- Circuit-breaker insulation and/or extinguishing medium		SF6/Enviro-friendly	
4.21		- Type of interrupter design (puffer, self-blast, etc.)		xxxxxxxxxx	
4.22		- Configuration of moving contacts (single, double or triple motion)		xxxxxxxxxx	
4.23		- Minimim expected life-span of circuit-breaker	years	> 40	
5		**Construction requirements**			
		• Design and layout of the circuit-breaker :			
5.1		- standardised circuit-breaker elements to maximise interchageability	Y/N	Yes	

5.2		- modular, pre-assembled elements shall be designed to facilitate handling and installation	Y/N	Yes	
5.3		- designed to facilitate ease of construction and maintenance	Y/N	Yes	
5.4		- Filter material housing located to provide easy access during maintenance	Y/N	Yes	
6		**Circuit-breaker operating mechanism enclosure requirements**			
6.1		• Operating mechanisms, local control facilities and all parts requiring lubrication protected by weatherproof enclosures	Y/N	Yes	
6.2		- degree of protection for enclosures containing exposed bearings, auxiliary switches, motors and other electrical devices	IP	IP 55	
6.3		- degree of protection for all open areas in the circuit-breaker common base frame as well as externally mounted indicating devices (where applicable)	IP	IP 2X	
6.4		- degree of protection for all other enclosures	IP	IP 54	
6.5		• Operating mechanism enclosure, handles and fixings material		3CR12 stainless steel/ Painted aluminium	
6.6		• Operating mechanism enclosure corrosion protection in accordance with 5.6 of DSP 34-1658	Y/N	Yes	
6.7		• Operating mechanism enclosures arranged to facilitate easy access from all sides	Y/N	Yes	
6.8		- all fastenings compliant with 240-56063756	Y/N	Yes	
6.9		• Circuit-breaker designed for operation from the front of the operating mechanism enclosure	Y/N	Yes	
6.10		• Access to the operating mechanism controls, terminals strips etc. provided through hinged front access door	Y/N	Yes	
6.11		• Maximum height to top of mechanism allows servircing from ground ($U_n \leq 132$kV) or viewing indications and reading from ground ($U_n >132$kV)	Y/N	2000	
6.12		• Front access door secured with a heavy-duty locking mechanism	Y/N	Yes	
6.13		• Padlocking facility shackle diameter	mm	6	
6.14		• Front access door equipped with travel stop	Y/N	Yes	
6.15		• Rigid, corrosion resistant documentation pocket provided on inside of front access door, securely attached no protrusion through door	Y/N	Yes	
6.16		• Facilites provided for securing operating tools on inside of front access door	Y/N	Yes	

6.17		• Earthing of operating mechanism enclosure in accordance with 240-56063756	mm	Yes	
6.18		• Provision for bottom/ below entry of all control cabling into operating mechanism enclosure	Y/N	Yes	
6.19		• Metallic cable racking provided for inter-pole cabling?	Y/N	No	
6.20		• Upper surfaces of enclosure shaped/sloped to prevent the accumulation of water	Y/N	Yes	
6.21		• Gasket material offered		Neoprene / Heavy-duty foam-plastic	
6.22		• Gauze-covered drain hole provided (> 25 mm)	Y/N	Yes	
6.23		• Enclosure lifting eyes provided		Top	
6.24		• Enclosure colour		Light grey (G29)	
6.25		• Mechanical trip facility located inside mechanism enclosure	Y/N	Yes	
7		**Circuit-breaker supporting structure**			
		• Mechanical loads and parameters relating to the design of the circuit-breaker support structure and foundation			
7.1		- “static” dead weight of the circuit-breaker	N	xxxxxxxxxx	
7.2		- rated “static” terminal force F_{shA} of the circuit-breaker due to connected conductors	N	xxxxxxxxxx	
7.3		- rated “static” terminal force F_{shB} of the circuit-breaker due to connected conductors	N	xxxxxxxxxx	
7.4		- rated “static” terminal force F_{sv} of the circuit-breaker due to connected conductors	N	xxxxxxxxxx	
7.5		- “dynamic” horizontal force exerted during operation on the foundation	N	xxxxxxxxxx	
7.6		- “dynamic” vertical force exerted during operation on the foundation	N	xxxxxxxxxx	
7.7		- “dynamic” moment (torque) exerted during operation about the foundation	Nm	xxxxxxxxxx	
7.8		- “dynamic” horizontal force exerted between circuit-breaker poles (centre phase interrupter chamber) during a rated (terminal fault) short-circuit	N	xxxxxxxxxx	
7.9		- wind force (load) exerted on the circuit-breaker	N	xxxxxxxxxx	
7.10		- maximum torque required for the foundation holding down bolt nuts	Nm	xxxxxxxxxx	
7.11		• Circuit-breaker steel support structure to be designed by manufacturer	Y/N	Yes/ No	
7.12		• Circuit-breaker concrete foundation to be designed by manufacturer	Y/N	Yes/ No	
7.13		• Common base frame supplied with circuit-breaker ($U_n \leq 132$ kV)	Y / N / N/A	Yes/ N/ N/A	

7.14		• Circuit-breaker designed to interface with the standard Eskom steel support structure	Y/N	Yes/ No	
7.15		• Circuit-breaker support structure designed to interface with the standard Eskom concrete foundation	Y/N	Yes/ No	
7.16		• Circuit-breaker steel support structure drawing (240-56063756 Table 5)		Esk Drwg Number/ TBA	
7.17		• Circuit-breaker concrete foundation drawing (240-56063756 Table 5)		Esk Drwg Number/ TBA	
7.18		• Surge arrester mounting brackets supplied and fitted ($U_n \leq 33$ kV)	Y/N	Yes/ No	
8		**Corrosion protection and lubrication**			
8.1		• Corrosion specification		DSP 34-1658	
8.2		• Corrosivity rating of environment		"high" to "very high"	xxxxxxxxxx
8.3		• Minimum detailed specification number for exposed metal	DS	DS-11	xxxxxxxxxx
8.4		- Equivalent detailed specification number offered for operating mechanism enclosures	DS	xxxxxxxxxx	
8.5		- Equivalent detailed specification number offered for all bolts, nuts and washers	DS	xxxxxxxxxx	
8.6		- Equivalent detailed specification number offered for all structural steel	DS	xxxxxxxxxx	
8.7		- Equivalent detailed specification number offered for all other exposed metal (excluding main terminals)	DS	xxxxxxxxxx	
8.8		• Details of lubricants provided with tender documentation	Y/N	Yes	
8.9		• Details of flange arrangements, treatments to prevent flange corrosion provided with tender		Yes	
8.10		• Material and Corrosion Protection Information Table 6 on the 240-56063756 standard completed	Y/N	Yes	
9		**Circuit-breaker operating mechanism enclosure heaters**			
9.1		• Heater size offered (≥220kV use 0.54/07529)	Watt	100	
9.2		• Heater control circuit specification (240-56030489 and Eskom standard wiring drawing)		Eskom Drwg Number and 240-56030489	
9.3		• Heater maintains dew-point higher than ambient temperature, constantly circulates air to all parts of enclosure	Y/N	Yes	
10		**Terminal requirements**			
10.1		• HV main terminal type		Flat pad	
10.2		• Flat pad details:			
10.3		- Number of holes and pitch	mm	8 x 50/ 9 x 40	

10.4		- Thickness (min)	mm	20	
10.5		- Material		Aluminium	
10.6		• Main HV terminals shall be in accordance with SANS 62271-301	Y/N	Yes	
10.7		• HV main terminals removable without interfering with operation of circuit-breaker	Y/N	Yes	
10.8		• Details of main HV terminals shown on the GA	Y/N	Yes	
10.9		• Earthing terminals		N/A	
10.10		• Details of earthing terminals shown on the GA	Y/N	Yes	
10.11		- Circuit-breaker earthed to main substation grid through support structure and foundation holding down bolts	Y/N	Yes	
10.12		- Earthing of circuit-breaker via steel support structure and foundation holding down bolts	Y/N	Yes	
10.13		- Additional conductor provided between the circuit-breaker and the support structure	Y/N	Yes/ No	
10.14		- Material (preferably not exposed)	Cu/ Al	Yes/ No	
10.15		- Additional Ø18 mm hole provided at bottom of steel support structure (if part of supply)		N/A	
11		**Safety clearances and personnel safety**			
11.1		• Live parts isolated by means of elevation	Y/N	Yes	
11.2		• Minimum electrical working clearance (240-56063756 Table 6)	mm	_____	
11.3		• Distance from lowest part of any high-voltage insulation above ground	mm	2500	
11.4		• Type of pressure relief devices provided		xxxxxxxxxx	
12		**Insulation requirements**			
		• Hollow insulators			
12.1		- Insulator material		Ceramic DILO fitting/ Silicone rubber composite	
12.2		- Insulator manufacturer		xxxxxxxxxx	
12.3		- Ceramic type insulators in accordance with SANS 62155 and SANS 60815-2	Y/N	Yes	
12.4		- Silicone rubber composite type insulators in accordance with SANS 61462 and SANS 60815-3	Y/N	Yes	
12.5		- Circuit-breaker tested at KIPTS	Y/N	No	
		• Minimum insulation creepage distances (SANS 60815-1)			
12.6		- Minimum external unified specific creepage distance (USCD)	mm/kV	_____	
		• Clearances in air			

12.7		- Phase to phase clearance in air	mm	xxxxxxxxxx	
12.8		- Phase to earth clearance in air	mm	xxxxxxxxxx	
13		**Position / status indication**			
		• Circuit-breaker position indication			
13.1		- Position indication to SANS 62271-1	Y/N	Yes	
13.2		- Position indication visible with operating mechanism enclosure front access door closed	Y/N	Yes	
13.3		- Closed position: “I” in white lettering on a red background	Y/N	Yes	
13.4		- Open position: “O” in white lettering on a green background	Y/N	Yes	
13.5		- Lettering (symbol) size (min)	mm	30	
		• Closing spring status indication			
13.6		- Status indicated by "SPRING CHARGED" and "SPRING DISCHARGED"	Y/N	Yes	
13.7		- Lettering size (min)	mm	15	
13.8		• Type of non-resettable circuit-breaker operation counter offered		Mechanical / electrical	
13.9		• Pressure gauge provided (compensated for temperature and responding to insulation and/or extinguishing medium density) - where applicable	Y/N	Yes	
13.10		• Pressure gauge sheltered from the elements - where applicable	Y/N	Yes	
14		**Labels**			
		• Operating labels			
14.1		- Instructions for tripping (“TO TRIP”) and closing (“TO CLOSE”) the circuit-breaker	Y/N	Yes	
14.2		- Instructions for charging closing springs (“TO CHARGE SPRING”)	Y/N	Yes	
14.3		• Actuator(s) for local opening and closing of the circuit-breaker labelled in accordance with 240-56063756. NOTE The trip/close actuator colour differ from IEC 60073	Y/N	Yes	
14.4		• Warning labels for manual operation; mechanical trip facility; interval between repeated CO's at testing	Y/N	Yes	
		• Function labels			
14.5		- Function labels provided to identify all LV (secondary) control equipment	Y/N	Yes	
14.6		- Function label text height (min)	mm	5	
14.7		• Labels manufactured to 240-56062515	Y/N	Yes	
15		**Requirements for SF_6 gas (where applicable)** NOTE The Supplier shall provide details of other environmental friendly insulation and/or extinguishing			

		medium if applicable			
15.1		• SF_6 in accordance with IEC 60376	Y/N	Yes	
15.2		• The maximum SF_6 gas leakage rate (NB: provide details if other enviro-friendly insulation and/or extinguishing medium)	%	0,5 / year	
		• SF_6 gas purity			
15.3		- SF_6 content	%	>98	
15.4		- Dew point at rated filling pressure (max) (at +20°C)	°C & µL/L	>-10	
		• SF_6 gas-filled circuit-breaker filling and pressure monitoring			
15.5		- central gas/filling evacuation point connection provided		DILO DN8/ DILO DN20	
15.6		- height of gas filling/evacuation point above ground (max)	mm	2400	
15.7		- gas filling point and the gas pressure gauge separated	Y/N	Yes	
15.8		- dial type gauge responding to Density and indicating pressure compensated for temperature provided	Y/N	Yes	
15.9		- Density monitoring device (density switch) contact requirements		Eskom Drwg Number	
15.10		- Density monitoring device suitable for outdoor operation	Y/N	Yes	
15.11		- method/system used to prevent corrosion of moving parts and contacts		xxxxxxxxxx	
15.12		- Density monitoring device shielded against direct sunshine	Y/N	Yes	
15.13		- non-return valves fitted on all DN8/DN20 fittings and pipe work to allow removal of poles and/or density monitoring device while maintaining system pressure	Y/N	Yes	
15.14		- details of arrangement offered supplied with tender documentation	Y/N	Yes	
15.15		- pipe work material		Cu	
15.16		- separate/common filling/evacuating and density monitoring point per pole provided		Separate	
15.17		- type of electrical connections to the density-monitoring device		xxxxxxxxxx	
15.18		- cabling protected using compression glands/grommets	Y/N	Yes	
15.19		- details of all pressure devices provided with tender documentation	Y/N	Yes	
15.20		- Density monitoring device electrical interlocks and alarm requirements		Eskom Drwg Number and 240-56030489	
15.21		• Management of SF_6 gas in accordance with NRS 087	Y/N	Yes	
16		**Current Transformers**			

16.1		• Type of CT design		N/A/ Ring-type	
16.2		• CT specification		N/A/ CT Standard/ Specific per sub	
16.3		• Number of cores		N/A/ CT Standard/ Specific per sub	
16.4		• CT specification (drawing number)		Eskom Drwg Number	
16.5		• Rated short-time withstand current - magnitude	kA	N/A	
		□ Rated short-time withstand current - duration	s	N/A	
16.6		• Position relative to the circuit-breaker		N/A/ both sides (per side 1P, 1BZ, 1M)	
16.7		• Terminal numbering and wiring interface (drawing number)		N/A	
		• Protection current transformers:			
16.8		□ a) cores		N/A/ CT Standard/ Specific per sub	
16.9		□ b) class		N/A/ CT Standard/ Specific per sub	
16.10		□ c) ratios	A	N/A/ CT Standard/ Specific per sub	
		• Bus-zone current transformers:			
16.11		□ a) cores		N/A/ CT Standard/ Specific per sub	
16.12		□ b) class		N/A/ CT Standard/ Specific per sub	
16.13		□ c) ratios	A	N/A/ CT Standard/ Specific per sub	
		• Measurement current transformers:			
16.14		□ a) cores		N/A/ CT Standard/ Specific per sub	
16.15		□ b) class		N/A/ CT Standard/ Specific per sub	
16.16		□ c) burden	VA	N/A/ CT Standard/ Specific per sub	
16.17		□ d) ratios	A	N/A/ CT Standard/ Specific per sub	
16.18		• Details of the calculated magnetising curves provided on a log-scale	Y/N	Yes	
16.19		• Details of protection against mechanical damage and fixing method provided	Y/N	Yes	
16.20		• Ring-type CTs interchangeable without dismantling the bushing, this method provided with tender documentation		N/A	
		□			
17		**Switching surge control (where applicable)**			
17.1		• Pre-insertion closing resistor if offered (provide Close, Open and Pre-insetion times)		Closing, 7±1	
17.2		• Pre-insertion closing resistor resistance	Ω	ca 300 - 350	

17.3		• Electronic controller offered for switching of cap banks, reactor banks and transformers (Provide Manufacturer & Type, IEC 61850 protocol compliancy)	Y/N	Yes	
17.4		• Metal oxide surge arresters offered		xxxxxxxxxx	
18		**Grading capacitors (where applicable)**			
18.1		• Grading capacitors if offered (provide insulation material e.g. oil/paper) (Provide Manufacturer & Type)		xxxxxxxxxx	
18.2		• Grading capacitor capacitance	pF	xxxxxxxxxx	
18.3		• Details of how to verify condition of grading capacitors during the life of the circuit-breaker provided with the tender documentation	Y/N	Yes (where applicable)	
19		**Extreme asymmetrical short-circuit interrupting capability (where applicable)**			
19.1		• Circuit-breaker required to interrupt short-circuit currents with a higher degree of asymmetry than required by SANS 62271-100	Y/N	xxxxxxxxxx	
19.2		• Proof of higher asymmetrical interrupting capability provided with tender documentation	Y/N	Yes (where applicable)	
20		**Requirements for simultaneity of poles during single closing and single opening operations**			
20.1		• Contact synchronism retained within rated values during the expected maintenance interval of circuit-breaker	Y/N	Yes	
20.2		- time interval between contact touch for all poles of the circuit-breaker	ms	< 5	
20.3		- time interval between contact touch for interrupters in the same pole	ms	< 3.3	
20.4		- time interval between contact touch for individual closing resistors - where applicable	ms	< 10	
20.5		- time interval between contact touch for individual closing resistors in the same pole (series connected) - where applicable	ms	< 6,6	
20.6		- time interval between contact separation for all poles of the circuit-breaker	ms	< 2.5	
20.7		- time interval between contact separation for interrupters in the same pole	ms	< 1	
21		**Controlled switching**			

21.1		• All information and details provided with the tender documentation (Controller is IEC61850 protocol compliant)	Y/N	Yes	
22		**Pole discordance (PD) or phase discrepancy**			
22.1		• All information and details provided with the tender documentation	Y/N	Yes	

23		**Auxiliary and control circuits**			
23.1		• Auxiliary and control circuit requirements (≥220kV use 0.54/07529 (Live-tank CB's) & 0.54/8557 (Dead-tank CB's))		Eskom Drwg Number and 240-56030489	
		• Auxiliary power supplies:			
23.2		- Provision		On site by Eskom	
23.3		- Peak power requirement (max)	VA	xxxxxxxxxx	
23.4		- Standby power requirements	VA	xxxxxxxxxx	
		• Circuit-breaker spring-charging motor control circuit (per mechanism):			
23.5		- d.c. supply voltage range of operation	%	85 to 110	
23.6		- d.c. current (peak starting)	A	< 30	
23.7		- d.c. current (max continuous)	A	< 10	
23.8		- total time taken to charge spring	s	< 10	
23.9		- method offered for protection against continual motor running (over-run)		xxxxxxxxxx	
23.10		- automatic charging of closing spring		Yes	
23.11		- number of spare contacts of SLS provided (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		Eskom Drwg Number	
		• Circuit-breaker closing control circuit (per mechanism):			
23.12		- d.c. supply voltage range of operation	%	85 to 110	
23.13		- d.c. power (peak)	W	≤ 500	
23.14		- number of close coils required		1	
23.15		- close coil current	A	xxxxxxxxxx	
23.16		- close coil resitance @ 20^0C	Ω	xxxxxxxxxx	
		• Circuit-breaker tripping control circuit (per mechanism):			
23.17		- d.c. supply voltage range of operation	%	70 to 110	
23.18		- d.c. power (peak)	W	≤ 500	
23.19		- number of trip coils required		2	
23.20		- physically and electrically separate trip control circuits		Yes	
23.21		- trip circuit supervision		Yes	
23.22		- trip coils rated to carry 20mA d.c. continuously		Yes	
23.23		- trip coil current	A	xxxxxxxxxx	
23.24		- trip coil resitance @ 20^0C	Ω	xxxxxxxxxx	
23.25		• Circuit-breaker equipped with anti-pumping circuitry		Yes	
23.26		• d.c. isolation switch provided		Yes	
23.27		• Circuit-breaker control circuit interlocks specification		Eskom Drwg Number and 240-56030489	
23.28		• Circuit-breaker alarm circuits wiring specification (≥220kV use 0.54/07529)		Eskom Drwg Number and 240-56030489	
		• Auxiliary contacts provided (spare for Eskom			

		use):			
		□ Duty rating			
23.29		□ - a.c. and d.c. supply current	A	10	
23.30		□ - N/O and N/C contact reference positions (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		Circuit-breaker opened, spring discharged, gas low, relay coils de-energised	
		□ Low insulation and/or extinguishing medium alarm			
23.31		□ - N/O		0	
23.32		□ - N/C		2	
		□ Low insulation and/or extinguishing medium block contacts			
23.33		□ - N/O		0	
23.34		□ - N/C		2	
		□ Spare circuit-breaker auxiliary switch contacts (per mechanism) (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))			
23.35		□ - N/O		4	
23.36		□ - N/C		4	
		□ Spare circuit-breaker spring limit switch contacts (per mechanism) (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))			
23.37		□ - N/O		3	
23.38		□ - N/C		3	
		• Terminal blocks and terminal strips:			
23.39		□ - Number of spare terminals provided		≥ 6	
23.40		□ - Terminal blocks to DSP 34-253, screw clamp, spring-loaded insertion type (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		Yes	
23.41		□ - Terminal block width offered (above 132kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))	mm	≥ 8	
23.42		□ - Make of terminal block offered (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		xxxxxxxxxx	
23.43		• Lugs (insulated hook blade type)		Crimped	
23.44		• Earth sliding link types/equivalents (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		Weidmuller TVP SAKA 10	
23.45		• Trunking provided on both sides of each terminal strip		Yes	
23.46		• 'Fine-tooth' trunking tooth width	mm	6,1	
23.47		• Trunking size	mm	60 x 60	
		• Wiring size:			
23.48		□ - CT and motor control circuit wires	mm^2	2,5	
23.49		□ - Control and other auxiliary wires	mm^2	1,5	
23.50		□ - Minimum number of strands		7	
		• Wiring colour:			

23.51		- CT wires		red/white/blue/black	
23.52		- Earth wires		green/yellow	
23.53		- All other wires		grey	
23.54	•	Wiring identification		Ferruling	
23.55	•	Terminal strips numbered and designated as per drawing (≥220kV use 0.54/07529)		Eskom Drwg Number	
	•	LV MCBs:			
23.56		- MCBs to SANS 60947-2 and IEC 60898		Yes	
23.57		- Make and type offered		xxxxxxxxxx	
23.58		- I_{CU}	A	xxxxxxxxxx	
23.59		- I_{CS}	A	xxxxxxxxxx	
23.60		- Utilisation category (SANS 60947-2)		'A'	
23.61		- Max service voltage	V	xxxxxxxxxx	
23.62		- d.c. MCB rated voltage	V	≥ 250	
23.63		- Pollution degree (SANS 60947-2)		≥ 3	
23.64		- Suitable for isolation (SANS 60947-2)		Yes	
23.65		- Protection curve (SANS 60947-2 / IEC 60898)		'C'	
23.66		- Location		Mechanism enclosure	
23.67	•	Circuit-breaker auxiliary and control circuit wiring interface (drawing number) (≥220kV use 0.54/07529 (LTCB's) & 0.54/8557 (DTCB's))		Eskom Drwg Number	
23.68	•	Bottom entry removable brass/aluminium LV gland plates provided (minimum area 200 x 100 mm; thickness 3mm)	Y/N	Yes	
23.69	•	Terminal strips shall be arranged in a vertical orientation (with minimum 150mm distance to gland plate)	Y/N	Yes	
23.70	•	Earthing point inside mechanism enclosure provided, allows 10 spare secondary control cable cores	Y/N	Yes	
24		**Nameplates**			
	•	Nameplates provided for the following:			
24.1		- circuit-breaker (SANS 62271-100)	Y/N	Yes	
24.2		- circuit-breaker operating mechanism (SANS 62271-100)	Y/N	Yes	
24.2		- CT (NRS 029)	Y/N	N/A	
24.3	•	Method used to attach nameplates (riveted or screwed on)		xxxxxxxxxx	
24.4	•	Nameplate material offered (engraved aluminium or stainless steel)		xxxxxxxxxx	
24.5	•	Duplicate nameplates provided for CTs on inside of operating mechanism enclosure front access door	Y/N	N/A	

25		**Tools and spares**			
		• Tools to be supplied with circuit-breaker (minimum requirements):			
25.1	☐	- full set of operating tools (Has the list on separate sheet been provided?)	Sets	1 set per circuit-breaker	
25.2	☐	- tools fitted on inside of the front access door	Y/N	Yes	
25.3		• Standard tools available for minor maintenance (Has the list on separate sheet been provided?)	Y/N	Yes	
25.4		• Specialised tools available for major maintenance purposes (Has the list on separate sheet been provided?)	Y/N	Yes	
25.5		• Spares available for maintenance (Has the list on separate sheet been provided?)	Y/N	Yes	
25.6	☐	Written letter, in case of design obsolescence has been provided?	Y/N	Yes	
26		**Documentation** **Note: All tender documentation to be provided in electronic format.**			
		• Documentation to be supplied with tender:			
26.1	☐	- GA drawing (provide drawing number on separate sheet provided)	Sets	1	
26.2	☐	- Drawing of all insulators used in the circuit-breaker (provide drawing number on separate sheet provided)	Sets	1	
26.3	☐	- Generic layout of nameplates (provide drawing number on separate sheet provided)	Sets	1	
26.4	☐	- Generic auxiliary and control circuit schematic wiring diagram (provide drawing number on separate sheet provided)	Sets	1	
26.5	☐	- GA drawing of the operating mechanism enclosure	Sets	1	
26.6	☐	- list of spare parts with prices for each circuit-breaker offered (provide list on separate sheet provided)	Sets	1	
26.7	☐	- list of all operating tools for each circuit-breaker offered (Has the list on separate sheet been provided?)	Sets	1	
26.8	☐	- list of all standard minor maintenance tools for each circuit-breaker offered (Has the list on separate sheet been provided?)	Sets	1	
26.9	☐	- list of all specialised major maintenance tools for each circuit-breaker offered (Has the list on separate sheet been provided?)	Sets	1	

26.10		- full list as well as copies of type test certificates and reports (Has the report numbers on separate sheet been provided?)	Sets	1	
26.11		- generic routine test certificates for each circuit-breaker	Sets	1	
26.12		- transport, storage, installation, operating and maintenance manuals	Sets	1	
26.13		- training material	Sets	1	
26.14		- generic quality inspection and test plan (QITP)	Sets	1	
26.15		- all other relevant additional information requested	Sets	1	
		• Documentation to be supplied with each circuit-breaker:			
26.16		- Schematic wiring diagram for circuit-breaker	Sets	1	
26.17		- Complete set of routine test certificates for circuit-breaker	Sets	1	
26.18		- Commissioning and hand-over test sheet	Sets	1	
26.19		- Transport, storage, installation, operating and maintenance manuals	Sets	1	
26.20		• Submission of documentation requested upon awarding of contract	Y/N	Yes	
26.21		• Units used in Republic of South Africa		In tender/offer	
26.22		• Project reference list, service to Eskom		In tender/offer	
27		**Packaging requirements**			
27.1		• Each individual circuit-breaker unit packed	Y/N	Yes	
27.2		• Containers (e.g. wooden crates) suitable for transport and storage over long periods (for up to 18 months) (NB: preservation requirements in QM-58)	Y/N	Yes	
27.3		• Durable waterproof packaging designed to prevent damage to components during transportation and storage on site	Y/N	Yes	
27.4		• Suitable ventilation provided to minimise condensation	Y/N	Yes	
27.5		• Packaging able to withstand impact loadings of at least 18 kN	Y/N	Yes	
27.6		• Each crate clearly and sequentially marked	Y/N	Yes	
27.7		• Each container/crate clearly marked with a durable label using an indelible font with all specified information in 240-56063756	Y/N	Yes	
27.8		• Exposed shafts, bearings and machined surfaces treated with a temporary anti-corrosive coating	Y/N	Yes	
27.9		• Loose components or components that are subject to damage from exposure to dust or water packed in hermetically sealed plastic bags	Y/N	Yes	
27.10		• All components clearly marked	Y/N	Yes	

27.11		• Fork-lift lifting points provided on the packaging - where applicable	Y/N	Yes	
27.12		• External temporary 230 V a.c. connection point for the heater circuit provided	Y/N	Yes	
27.13		• Non-resettable impact recorder/detector provided	Y/N	Yes	
27.14		• Circuit-breaker transported with a positive gas pressure of maximum 150 kPa - where applicable	Y/N	Yes	
27.15		• Copy of the BOM shall be provided with the delivery note	Y/N	Yes	
28		**Miscellaneous**			
		• General			
28.1		• Test equipment used for pre-commissioning in accordance with 240-56063756	Y/N	Yes	
28.2		• Written commitment to provide Inspection and maintenance DVD has been provided with tender docs	Y/N	Yes	
28.3		• Required period for spares availability	Years	25 years after discontinuation of switchgear	
28.4		Availability of trip coils, close coils, spring charging motors, density monitoring devices, contactors & relays	Hours	12	
28.5		• Specification sheets, speed calculation points, travel curve values shall be provided at contract awarding	Y/N	Yes	
29		**Training Requirements**			
29.1		• Training offered in accordance with 240-56065202	Y/N	Yes	

SIGNATURES

Supplier	Name (Print)	Sign	Date
Factory	Name (Print)	Sign	Date
Eskom	Name (Print)	Sign	Date

Annex C – Appendix C - TECHNICAL SCHEDULES A & B for PIUs in accordance with EST 240-64685228

Requirements per specific IED

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

3	**Requirements (per specific IED)**	Unit	Schedule A	Schedule B
-	IED Type		Switchgear PIU	
3.2	**Hardware and Firmware**			
3.2.1	**Manufacturer type designation**			
a	Model number		Specify	
b	Hardware version		Specify	
c	Firmware version		Specify	
3.4	**Input energising current (CT inputs)**			
3.4.1	Number of three phase CT inputs		N/A	
3.4.2	Number of three phase CT inputs with Neutral input		N/A	
3.4.3	Number of single phase/neutral CT inputs		N/A	
3.4.4	Number of Sensitive Earth Fault CT inputs		N/A	
3.5	**Input energising voltage (VT inputs)**			
3.5.1	Number of three phase VT inputs		N/A	
3.5.2	Number of single phase VT inputs		N/A	
3.6	**DC Auxiliary energising voltage**			
3.6.1	Nominal DC voltage (ordering option per application)	V	110 or 220	
3.7	**DC Binary inputs**			
3.7.1	Number of binary inputs (Nominal voltage)		Specify	
3.7.2	Number of binary inputs (48V)		N/A	
3.7.3	Number of binary inputs (24V)		N/A	
3.8	**Binary Outputs (output contacts)**			
3.8.1	Number of high-break output contacts		Specify	
3.8.2	Number of standard output contacts		Specify	
3.9	**Analogue transducer inputs and outputs**			
3.9.1	Number of analogue transducer inputs		N/A	
3.9.2	Number of analogue transducer outputs		N/A	
3.10	**Indications**			
3.10.1	Number of LED indications		Specify	
3.11	**Display**			
3.12	**Push buttons**			
3.12.1	Number of integrated push buttons		Specify	
3.16	**Communication ports and protocols**			
3.16.2	Number of fibre optic Ethernet ports (rear)		Specify	
3.16.3	Number of copper Ethernet ports (rear)		N/A	
3.17	**Event recording and oscillography**			
3.17.1	Oscillographic recorder No. analogue channels		N/A	

3.17.2	Oscillographic recorder No. digital channels		N/A	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Requirements per IED product family

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

3	Requirements (per IED family)	Unit	Schedule A	Schedule B
-	Manufacturer product family/series name		Specify	
3.1	**Environmental conditions**			
	Requirements as per specification		Noted	
3.2	**Hardware and Firmware**			
	Requirements as per specification		Noted	
3.2.11	IEDs shall not employ any method of forced cooling.		Comply	
3.2.13	Support of IEC 61850 Logical Node LPHD as per [37] 240-42066934. Attributes serial number, model name/number and location shall be supported.		Comply	
3.2.14	Provision of a self supervision function as per specification		Comply	
3.3	**Global ratings**			
3.3.1	Nominal frequency	Hz	N/A	
3.3.1	Required operating range	Hz	N/A	
3.4	**Input energising current (CT inputs)**			
3.4.1a	Nominal current: Phase, Earth Fault	A	N/A	
3.4.1b	Nominal current: Sensitive Earth Fault (where applicable)	A	N/A	
3.4.2	Saturation current (linear) rating	I_{Nom}	N/A	
3.4.3a	Continuous overload	A	N/A	
3.4.3b	Short time overload: 1 second	A	N/A	
3.4.4	Burden per phase at I_{Nom}	VA	N/A	
3.4.5	Details provided on hardware and software filtering		N/A	
3.5	**Input energising voltage (VT inputs)**			
3.5.1a	Nominal voltage (phase-to-phase)	V	N/A	
3.5.1b	Nominal voltage (phase-to-neutral)	V	N/A	
3.5.2a	Continuous overload	V_{Nom}	N/A	
3.5.2b	Short time overload: 3 second	V_{Nom}	N/A	
3.5.3	Burden per phase at V_{Nom}	VA	N/A	
3.5.4	Details provided on hardware and software filtering		N/A	
3.6	**DC Auxiliary energising voltage**			
3.6.1	Nominal DC voltage (as per circuit-breaker ordering option)	V_{DC}	110 or 220	
3.6.2	Operating range	V_{Nom}	0.8 to 1.2	
3.6.3	Quescent burden	W	≤ 50	

3.6.100	Additional burden per energised opto input	W	Specify	
3.6.101	Additional burden per energised output contact	W	Specify	
3.6.102	Power up time	s	Specify	
3.7	**DC Binary inputs**			
3.7.1	Nominal voltage (V_{Nom})	V_{DC}	As per (3.5a)	
3.7.2	Nominal voltage (V_{Nom}) - special inputs (where applicable)	V_{DC}	N/A	
3.7.3	Requirements as per specification		Noted	
3.7.4a	Pick-up threshold range	V_{Nom}	0.70 to 0.80	
3.7.4b	Reset threshold range	V_{Nom}	0.60 to 0.70	
3.7.5	Pick-up time with AC/contact bounce rejection	ms	< 10	
3.8	**Output contacts**			
3.8.1(a)	**High-break contacts**			
i	Make and carry for 200ms at 250 Vdc	A	30	
ii	Carry for 1s at 250 Vdc	A	10	
iii	Carry continuously at 250 Vdc	A	5	
iv	Break (inductive L/R = 40ms) at 250V dc	A	10	
v	Duty cycle		3 ops in 3 sec	
vi	Durability: operations under load		> 10 000	
vii	Operate time	ms	Specify	
3.8.1(b)	**Standard contacts**			
i	Make and carry for 200ms at 250 Vdc	A	30	
ii	Carry for 1s at 250 Vdc	A	10	
iii	Carry continuously at 250 Vdc	A	5	
iv	Break (inductive L/R = 40ms) at 250V dc	A	0.2	
v	Durability: operations under load		> 10 000	
vi	Operate time	ms	Specify	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Requirements per IED product family (continued)

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

3.9	**Analogue transducer inputs and outputs**			
3.9.2	Signal type		N/A	
3.9.3	Maximum output current	I_{Nom}	N/A	
3.9.4	Maximum load on outputs	Ohm	N/A	
3.9.5	Response time to 0 - 100% step change		N/A	
3.9.6	Maximum full scale error	%	N/A	
3.10	**Indications**			
3.10.2	Indications provided by		LED, LCD text	
3.10.3	Colours supported		Tricolour: R,Gr,Amber	
3.10.4	Indications visible by default (without manual intervention)		Comply	
3.10.5	Alarm reset types supported:			

a	Follow		Yes	
b	Latching, manual reset		N/A	
c	Latching, manual/auto reset		N/A	
3.10.6	Resettable via external HMI and via the IED front panel		N/A	
3.10.7	Lamp test function as per specification		N/A	
3.11	**Display**			
3.11.1	On-board back-lit display provided		Specify	
3.11.2	Display life as per IED design life		Yes (where provided)	
3.11.3	Is a screen saver feature required/provided to achieve design life?		Specify	
3.11.4	Default display of analogues as per specification		N/A	
3.11.5	Display of multiple sets of analogue data (as required)		N/A	
3.11.6a	Mimic provided		N/A	
3.11.6b	Can mimic be hidden		N/A	
3.12	**Push buttons**			
	Requirements as per specification		N/A	
3.12.5	Actuating principles		N/A	
3.12.6	Guards provided, or double action operation		N/A	
3.12.7	Identification of circuit-breaker controls		N/A	
3.13	**Programmable logic**			
3.13.1	Support for logical gates: AND, OR, NOT, timers, flip-flops, counters		N/A	
3.13.2	Flip-flop and counter states are stored in non-volatile memory		N/A	
3.13.3	Virtual outputs (internal variables) are provided		N/A	
3.14	**Setting groups**			
3.14.1	Number of settings groups		N/A	
3.14.2	Settings groups activated by MMS and via binary input		N/A	
3.15	**Security**			
3.15.2	Levels of role based access supported		≥ 3	
3.15.3	Password settable via rear Ethernet port		Yes	
3.15.4	Password length	Char	≥ 16	
3.15.5	Support for numeric, alpha and special characters		Yes	
3.15.6	Support detection and reporting of changes as per specification		Yes	
3.16	**Communication ports and protocols**			
3.16.1	**Communication ports**			
1	Front port			
a	Port type		Ethernet, USB, RS 232	
b	Protocol		Specify	
2	Rear ports			
a	Fibre optic communication type		100BaseFX (1300nm)	

b	Fibre optic cable type		50/125µm or 62.5/125µm MM	
c	Fibre optic connectors		LC (pref) or ST	
d	Optical budget	dB	Specify	
3	One multi-session or two separate ports provided		Yes	
4	Independently settable IP addresses for each port		Yes	
3.16.2	**Communication protocol**			
1	IEC 61850 supported as standard.		Yes	
3a	Protocol for remote engineering access		Specify	
3a	Remote Access protocol conforms to 240-64038621		Yes	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Requirements per IED product family (continued)

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

3.17	**Real time clock and Time synchronisation**			
	Requirements as per specification		Noted	
3.17.1	Real time clock provided, suitable for 30 year IED operation		Yes	
3.17.2	Time drift per day (unsynchronised)	s	<2	
3.17.5	Clock back-up energy storage device			
a	Type (e.g. battery, capacitor)		Specify	
b	If battery, minimum lifespan	yrs	10	
c	If battery, replaceable without soldering		Yes	
3.17.7	Time synchronisation provided by		SNTP or PTP	
3.17.8	SNTP guaranteed accuracy	ms	< 10	
3.17.10	Support for local time offsetting from UTC		Yes	
3.18	**Event recorder and Oscillography**			
	Requirements as per specification		N/A	
3.18.2	Event recorder storage capacity	events	N/A	
3.18.5	Oscillography analogue signal sampling rate	kHz	N/A	
3.18.6	Oscillography digital signal sampling rate	kHz	N/A	
3.18.7	Settable oscillography recording length	s	N/A	
3.18.8	Total oscillogrpahy recording time stored	s	N/A	
3.18.10	Oscillography recorded analogue values		N/A	
3.18.11	COMTRADE file format supported		N/A	
3.18.12	Recordings time stamped, non-voltatile storage		N/A	
3.19	**Software**			
3.19.1	**Software package**			
	Requirements as per specification		Noted	
-	Software name		Specify	
-	Software version number		Specify	

3	Software backwards compatible with Eskom's installed base?		Yes	
4	Corporate software licence provided		Yes	
5	Software costs (if any) to be recovered via IED sales		Noted	
6	Eskom may copy and distribute software for Eskom use		Yes	
11	Software compatibility with Microsoft Windows		XP and 7	
12	Software requires PC administrator rights to operate		No	
3.19.2	**Software functions**			
1	All listed functions supported		Yes	
3.19.3	**Setting file data exchange**			
2	Bi-directional exchange of settings with Microsoft Excel.		Yes	
4	Open source setting file format for exchange		ASCII; *.xml; *.xls; *.csv; *.xrio; *.mdb	
6	All application-specific changes via device settings		Yes	
7	All settings and configurations uploadable to front and rear ports		Yes	
3.19.4	**Event recording and oscillography data exchange**			
1	Protocols supported		MMS file services (pref), HTTPS, FTP	
3.20	**IED simulation models**			
3.20.1a	Models available		Yes	
3.20.1b	Model format (pref: DigSilent PowerFactory)		Specify	
3.21	**Documentation**			
	Requirements as per specification		Noted	
3.21.2	Manuals reflect specific model numbers and firmware offered		Yes	
3.21.3	Manuals available in English		Yes	
3.21.6	Manuals available in searchable *.pdf format		Yes	
3.21.8	Microsoft Excel settings sheet provided		Yes	
3.21.10	Settings guideline provided		Yes	
3.22	**Design life & in-service experience**			
3.22.1	IED design life	yrs	> 20	
3.22.2	Operating record and in service history provided		Yes	
3.22.3	Details of improvements made in last 3 years provided		Yes	
3.22.4c	IED in-service experience as of tender closing	eq.yrs	> 50	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Requirements per IED product family (concluded)

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

3.23	**Marking, labelling and packaging**			

	Requirements as per specification		Noted	
3.23.2	LED/push button labels slide behind clear screen		Yes	
3.24	**Spares**			
3.25	**Repairs**			
3.25.1	Repair turn around time		Specify	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Type Tests per IED product family

Schedule A: Purchasers specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

4.1	**General**				**Schedule A**	**Schedule B**
4.1.4	Type testing laboratory				Specify	
4.1.4	SANS/ILAC accreditation of laboratory				Specify	
4.2	**Type Tests (per IED product family)**					
	Test	**Standard**	**Ports***	**Compliance criteria**		
-	Manufacturer product family/series name				Specify	
4.2.1	**Product Safety**					
1(a)	Dielectric withstand	IEC 60255-5	-	2kV r.m.s. 50Hz for 1 minute between all terminals to case earth, 1kV across contacts.	Comply	
1(b)	Insulation resistance	IEC 60255-5	-	Insulation resistance greater than 20MΩ when measured at 500Vd.c.	Comply	
1(c)	Electrical impulse (1.2/50µs)	IEC 60255-5	-	5kV 1.2/50µs waveform, 0.5J	Comply	
2	Enclosure protection	SANS 60529	ENC	Protected against ingress of dust particles, dripping water.	IP41 (front panel)	
				Protected against access to hazardous parts with the back of a hand.	IP1X (rear)	
4.2.2	**Environmental specifications**					
1	Cold	IEC 60068-2-1	-	16 hours at -25°C (LCD screen operative)	-25°C Test Ad	
2	Dry Heat	IEC 60068-2-2	-	16 hours tolerance at +55°C/+70°C (control room / outdoor application)	+55°C / +70°C Test Bd	
3	Cyclic Temperature and Humidity	IEC 60068-2-30	-	25°C and 95% relative humidity/ 55°C and 95% relative humidity, 12 + 12 hour cycle	+55°C Test Db	

4	Vibration	IEC 60255-21-1	-	Response: 1g, 10 - 150Hz, 1 sweep, energised. Contacts should not close for longer than 2ms.	Class 2 Response	
			-	Endurance: 1g 10 – 150Hz, 20 sweeps, un-energised. Contacts should not close for longer than 2ms.	Class 1 Endurance	
5	Shock	IEC 60255-21-2	-	Response: 5g, 11ms, 3 pulses in each direction, energised	Class 1 Response	
			-	Withstand: 15g, 11ms, 3 pulses in each direction, un-energised	Class 1 Withstand	
6	Bump	IEC 60255-21-2	-	10g, 16ms, 1000 pulses un-energised.	Class 1	
7	Seismic	IEC 60255-21-3	-	Test method A (single axis sine sweep test) 1 – 35Hz, 1 sweep.	Class 1	

TECHNICAL SCHEDULES A & B FOR SWITCHGEAR PIUs IN ACCORDANCE WITH EST 240-64685228

Type Tests per IED product family (concluded)

4.2.3	**Immunity Specifications**					
Note: Refer to IEC 60255-26 for an overview of electromagnetic compatibility requirements.						
1(a) - (c)	Voltage dips, interruption, gradial start-up/shut-down	IEC 60255-11	PS	50ms interruption has no effect on operation No maloperation for 5s interruption. No maloperation for decaying DC over 60s, rising over 60s.	Comply	
1(d)	AC ripple	IEC602 55-11	PS	Device shall function correctly with 12% 100Hz ac signal superimposed on the d.c. supply.	Comply	
4.2.3	**Immunity Specifications (Continued)**					
2	Power frequency magnetic field	SANS 61000-4-8	ENC	100A/m continuous, 1000A/m 1-3s, 50Hz	Class 5	
3	1MHz oscillatory waves	IEC602 55-22-1 or SANS 61000-4-18	PS, IO	2.5kV CM, 1kV DM, 2s total test duration, 6 – 10 bursts at 400Hz repetition.	Class 3	
			COM	1kV CM, 0kV DM, 2s total test duration, 6 – 10 bursts at 400Hz repetition.		

4	Electrostatic Discharge	IEC 60255-22-2 or SANS 61000-4-2	ENC	6kV Contact Discharge, 8kV Air Discharge	Class 3	
5	Radiated Radio Frequency field	IEC 60255-22-3 or	ENC	10V/m unmod r.m.s., 80% AM (1kHz), 80MHz – 1GHz, 1.4 – 2.7 GHz	-	
		SANS 61000-4-3			Class 3	
6	Fast Transient	IEC 60255-22-4	PS, IO, E	2kV, 5kHz	Class B	
			COM	1kV, 5kHz		
7	Surge	IEC 60255-22-5 or		1,2/50µs (8/20µs) voltage (current) surge:	-	
			PS, IO	0,5; 1; 2 kV line to earth, 0,5; 1 kV line to line		
			COM	0,5; 1 kV line to earth		
		SANS 61000-4-5	PS, IO	2kV	Class 3	
8	Induced Radio Frequency field	IEC 60255-22-6 or	PS, COM, IO, E	10Vrms, 150kHz – 80MHz	-	
		SANS 61000-4-6			Class 3	
9	Power Frequency immunity	IEC 60255-22-7	IO	AC voltages applied to D.C. inputs: 150V r.m.s. DM, 300V r.m.s. CM	Class A	
4.2.4	**Emission Specifications**					
Note: Refer to IEC 60255-26 for an overview of electromagnetic compatibility requirements.						
1	Conducted emission	IEC 60255-25	PS	0,15 – 0,5 MHz: 79dB(µV) quasi peak, 66dB(µV) ave.	-	
				0,5 – 30 MHz: 73dB(µV) quasi peak, 60dB(µV) ave.		
2	Radiated emission	IEC 60255-25	ENC	30 – 230 MHz: 40dB(µV) quasi peak at 10m	-	
				230 – 1000 MHz: 47dB(µV) quasi peak at 10m		

* Immunity and Emission tests are applicable to specific "ports" of the Equipment Under Test:-

COM: (Rear) communication ports; E: Earth terminal; ENC: Device enclosure; IO: Inputs/Outputs; PS: Power Supply

CM = Common Mode, DM = Differential Mode.

Annex D – Maintenance Analysis

Below is the table with the FMECA required details that shall be completed and submitted with the tender documentation by the supplier. This shall have the headings of each column as shown below.

The supplier shall provide the details of the maintenance analysis (Table 1A: FMECA sheet) to indicate the reasoning as to the identified maintenance activities and logistics requirements. Note that a criticality assessment may have to be included for each Functional Importance, Health, Usage or Environment row that is included in Table: Maintenance Requirements Definition, if the Consequence or Probability is dependent on these. The supplier shall complete the shaded areas.

The supplier shall also complete the shaded areas of the maintenance requirements definition (Table 1B). The maintenance requirements are defined based on the activities identified from the FMECA and RCM (if included) and taking criteria, associated with the actual functional location, into consideration. This results in several possible maintenance requirement permutations, one of which will be selected by the maintenance function for any item of plant, and from which a consolidated maintenance plan can then be developed.

Table D.1: FMECA Worksheet

FMEA									Criticality (Risk) Assessment																				Outcome
Ref	Function / item	Failure mode	Failure mechanism / cause	Failure effects: Local	Failure effects: Next Higher	Failure effects: End	Detection method	Compensating provisions	Usage, Environment and Health	High / Harsh / Good				Low / Harsh / Good				High / Mild / Good				Low / Mild / Good				High / Harsh / Poor				Low / Harsh / Poor				High / Mild / Poor				Low / Mild / Poor				Maintenance Determination / Recommendation
									Functional Importance	Critical	Significant	Economic	Run to failure	Critical	Significant	Economic	Run to failure	Critical	Significant	Economic	Run to failure	Critical	Significant	Economic	Run to failure	Critical	Significant	Economic	Run to failure	Critical	Significant	Economic	Run to failure	Critical	Significant	Economic	Run to failure	Critical	Significant	Economic	Run to failure	
1.1	Pressure sensor, number XYZ	No output	Mechanical or electrical damage	No pressure input to analogue-to-digital converter	Control system inhibits start-up sequence	No effect	Control system start-up test function	Visual alarm on operator console/ redundant sensor	Probability[1]	D				C				D				B				C				B				C				A				None
									Consequence[2]																																		
									Risk[3]																																		
1.2	Pressure sensor, number XYZ	Out of range output	Electrical damage	Out of range pressure input to analogue-to-digital	Control system initiates shutdown sequence	Over-pressure of vessel possible	Control system continuous test function	Visual and audible alarm on operator console	Probability[1]	E				E				E				E				E				E				E				E				
									Consequence[2]																																		
									Risk[3]																																		
1.3	Pressure sensor, number XYZ	Inaccurate output	Electrical damage	Inaccurate pressure input to analogue-to-digital converter	Incorrect control of pressure system	Over or under-pressure of vessel possible	None	None	Probability[1]																																		
									Consequence[2]																																		
									Risk[3]																																		

Table D.2: Maintenance Requirements Definition

Equipment Class:		Breaker																															
Equipment Sub Class:		SF6																															
Equipment Sub Class Family:		ABC																															
Trigger Modifiers		**Options**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
	Functional Importance	Critical																									X	X	X	X	X	X	X	X
		Significant																	X	X	X	X	X	X	X	X								
		Economic									X	X	X	X	X	X	X	X																
		Run to fail	X	X	X	X	X	X	X	X																								
	Usage / Duty Cycle	High			X	X			X	X			X	X			X	X			X	X			X	X			X	X		X	X
		Low	X	X			X	X			X	X			X	X			X	X			X	X			X	X			X		
	Environment	Harsh		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X	
		Mild	X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		
	Health	Very Good / Good	X	X	X	X					X	X	X	X					X	X	X	X					X	X	X	X				
		Fair / Poor / Very Poor					X	X	X	X					X	X	X	X					X	X	X	X					X	X	X	X

Key	
1M	One monthly
6M	Once every six months
1Y	Once every year
2Y	Once every two years
3Y	Once every three years
4Y	Once every four years

Maintenance Tasks	**FMECA Ref No**	**Trigger [1] (Time and/or Condition)**	**Outage Y/N**	**Manual Y/N**	**Maintenance Activities**
Condition Monitoring					
Inspection or Test Task 1...n					
Preventive Maintenance based on Time					
Maintenance Task 1...n					
Preventive Maintenance based on Condition					
Maintenance Task 1...n					
Corrective Maintenance:					
Maintenance Task 1...n					
Statutory Maintenance					
Maintenance Task 1...n					