



TECHNOLOGY MANAGEMENT.

SPECIFICATION.

**REQUIREMENTS FOR OUTDOOR
ALTERNATING-CURRENT CIRCUIT BREAKERS FOR
TRACTION AND DISTRIBUTION SUBSTATIONS**

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INDEX

SECTION	CONTENTS	PAGE NO
1.0	SCOPE.	3
2.0	STANDARDS.	3
3.0	TENDERING PROCEDURES	3
4.0	APPENDICES	4
5.0	SERVICE CONDITIONS	4
6.0	REQUIREMENTS FOR ALTERNATING CURRENT CIRCUIT BREAKERS.	4
7.0	SPECIAL TOOLS, SERVICING AIDS AND MANUALS AND SPARES LISTS.	8
8.0	TRAINING.	8
9.0	TEST CERTIFICATES.	8
10.0	GUARANTEE AND DEFECTS.	8
11.0	INSPECTION.	8
12.0	PACKAGING AND TRANSPORT	8
	APPENDIX 1	9
	APPENDIX 2	10

1.0 SCOPE

- 1.1 This specification covers Transnet freight rail requirements for the design, manufacture, testing and supply of outdoor Alternating Current (AC) circuit breakers in accordance to SANS 62271-100.
- 1.2 The alternating current circuit breakers shall be suitable rated for nominal phase to phase r.m.s voltages ranging from 22 kV to 220 kV.

2.0 STANDARDS, PUBLICATIONS AND DRAWINGS

2.1 Unless otherwise specified all materials and equipment supplied shall comply with the applicable and latest editions of SANS or Transnet freight rail publication.

2.2 The following publications are referred to in this specification:

2.2.1 SOUTH AFRICAN NATIONAL STANDARDS

- | | | |
|-----------------|---|--|
| SANS 121: | - | Hot-dip Galvanized coatings for fabricated iron or steel articles. |
| SANS 1431: | - | Weldable structural steels. |
| SANS 60529: | - | Degrees of protection provided by enclosures (IP code). |
| SANS 60694: | - | Common Specifications for high-voltage switchgear and controlgear standards. |
| SANS 60815 | - | Guide for the selection of insulators in respect of polluted conditions |
| SANS 62271-100: | - | High Voltage Alternating Current Circuit Breakers. |

2.2.2 TRANSNET FREIGHT RAIL SPECIFICATIONS.

- | | |
|-----------|---|
| CEE.0045: | Painting of Steel Components of Electrical Equipment. |
| CEE.0224: | Drawings, Catalogues, Instruction Manuals and Spares. |

2.2.3 Occupational Health and Safety Act No 85 of 1993.

2.2.4 TRANSNET FREIGHT RAIL DRAWINGS

- | | | |
|---------------|---|---|
| CEE-TBK-0027: | - | Control circuit diagram. No-volt coil protection. |
|---------------|---|---|

2.3 Any items offered in accordance with other standards will be considered at the sole discretion of Transnet freight rail. The tenderer shall supply full details stating where the item differs from these specifications as well as supplying a copy (in English) of the recognised standard specification(s) with which it complies.

3.0 TENDERING PROCEDURE

3.1 Tenderers shall indicate clause-by-clause compliance with this specification as well as the relevant equipment specifications. This shall take the form of a separate document listing all the specifications clause numbers indicating on individual statement of compliance or non-compliance.

3.2 The tenderer shall motivate a statement of non-compliance.

3.3 Tenderers shall complete Appendix 2. " Information to be provided by tenderers".

3.4 Tenderers shall submit detailed technical literature of the current transformers offered together with drawings showing, general constructional details and principal dimensions.

3.5 Any items offered in accordance with other standards will be considered at the sole discretion of Transnet freight rail. The tenderer shall supply full details stating where the item differs from these specifications as well as supplying a copy (in English) of the recognised specification(s) with which it complies.

3.6 Failure to comply with clauses 3.1, 3.2, 3.3, 3.4 and 3.5 could preclude a tenderer from consideration.

4.0 APPENDICES

The following appendices form an integral part of this specification and shall be read in conjunction with it.

4.1 Appendix 1 - "Schedule of Requirements".

This appendix details the specific requirements for this application.

4.2 Appendix 2 - "Information to be provided by tenderers".

This appendix calls for specific technical information to be furnished by tenderers.

5.0 SERVICE CONDITIONS.

The current circuit breaker shall be designed to operate under the following conditions.

5.1 ATMOSPHERIC CONDITIONS

5.1.1	Altitude:	0 to 1800m above sea level.
	Ambient temperature:	-5°C to +45 °C.
	Relative humidity:	10% to 90%
	Lightning Conditions:	12 ground flashes per square kilometre per annum.
	Pollution:	Heavily salt laden or polluted with smoke from industrial sources.

5.2 ELECTRICAL CONDITIONS

5.2.1 Supply voltage: The incoming AC voltage can vary $\pm 5\%$ of the nominal system r.m.s voltage.

5.2.2 Frequency: Frequency of the supply voltage is 50 ± 2.5 Hz.

6.0 REQUIREMENTS FOR ALTERNATING CURRENT CIRCUIT BREAKERS.

6.1 The AC circuit breakers shall be designed, manufactured and tested in accordance with the requirements of specifications SANS 62271-100 and SANS 60694.

6.2 The circuit breakers shall be of the outdoor type suitable for operation under the nominal phase to phase voltages or phase to neutral voltages specified in Appendix 1.

6.3 The insulating medium of the primary circuit breakers shall be SF6 gas or vacuum, depending on the supply voltage. (Refer to Appendix 1)

6.3.1 Vacuum circuit breakers may be used for voltages ranging from 22 kV up to 33 kV

6.4 The AC circuit breakers used on Transnet freight rail may be the single, double or triple pole type.

6.4.1 Double or triple pole type circuit breakers shall be ganged operated.

6.5 The circuit breakers shall be rated at the highest r.m.s. voltage for equipment operating at the nominal system voltage specified in Appendix 1.

6.6 The minimum rupturing capacities for the respective voltages and current ratings for the circuit breakers shall be in accordance to the SANS 62271-100. The rated short-circuit breaking current shall be at least 20kA.

6.7 The circuit breakers shall be rated for a continuous current of at least 1250 Ampere

6.8 The circuit breakers shall have a first pole to clear factor of 1.5.

6.9 The circuit breakers shall have a making time not greater than 1 second.

6.10 The circuit breakers shall be capable of twice rupturing the specified fault current at the specified voltages, with a one minute interval between operations and then shall be in a condition to be closed and carry the rated current without it being necessary to inspect or make adjustments.

- 6.11 The circuit breaker shall be electrically operated from a nominal 110 Volt DC control voltage unless otherwise specified in Appendix 1.
- 6.12 It shall be possible to close the circuit breaker only when the control voltage is above 85% of the nominal voltage. The circuit breaker shall trip automatically when the control voltage falls below 70% of the nominal voltage.
- 6.13 The circuit breaker shall have a motor wound spring operating mechanism.
- 6.14 The operating mechanism shall be provided with shunt release for both opening and closing.
- 6.15 Pneumatic, hydraulic or gas control for tripping and closing the primary circuit breakers are not acceptable.
- 6.16 The operating mechanism shall be so designed so that the breaker may be closed manually from ground level by means of a suitable detachable handle.
- 6.17 The operating mechanism shall be constructed of non-ferrous material.
- 6.18 The operating springs shall recharge automatically after the completion of a closing operation.
- 6.19 The circuit breaker shall be of the trip-free type.
- 6.20 A visual mechanical indicating device shall be provided to indicate the state of the spring and shall be inscribed "Spring Charged" when the mechanism is in the condition to close the circuit breaker and "Spring Free" when it is in any other condition.
- 6.20.1 One pair of normally open and normally closed contacts shall be provided for the indication circuitry to the substation control panel for indication of the "Spring Charged" and "Spring Discharged" conditions.
- 6.21 Auxiliary contacts shall be provided for operation in conjunction with the protection and other auxiliary circuits specified. At least one spare pair of normally open and one spare pair of normally closed contacts shall be provided.
- 6.22 Circuit breaker control switches shall be provided on the circuit breaker mechanism. They shall return automatically to the neutral position when the handle is released after being turned to either the "close" or "trip" positions.
- 6.23 Local/Remote selector switches shall be provided on the circuit breaker mechanism and shall be of the two-position type. The switch shall have no "off" or "neutral" position.
- 6.23.1 Provision shall be made that when the circuit breaker is switched to the local position, the protection and trip circuitry to the circuit breaker shall not in any way be by-passed.
- 6.24 Mechanical operation shall be provided on the circuit breaker for any closing or trip release, which is normally electrically operated.
- 6.25 The circuit breaker shall be provided with a no volt coil with a mechanical latching mechanism, which will trip, lockout and inhibit the circuit breaker from closing when the no volt coil is de-energised. Refer to Transnet Freight Rail's drawing No. CEE-TBK-27 which forms part of this specification, for details of the control circuitry for the no volt protection.
- 6.25.1 The no volt coil circuitry with its associated mechanical latching mechanism shall operate separately from the trip coil circuitry.
- 6.26 A counter shall be provided on the circuit breaker to indicate the total number of operations of the breaker.
- 6.27 Tenderers shall advise the number of circuit breaker operations under full load and fault conditions, after which maintenance and/or measurement of contact wear is recommended.
- 6.28 The circuit breaker operating mechanism including its controls and relays shall be housed in a metal enclosure.
- 6.29 The enclosure housing shall be manufactured from stainless steel or hot dipped galvanised steel.
- 6.30 The coating of the enclosure if galvanised shall comply with the requirements of Transnet freight rail's specification CEE.0045.
- 6.31 The degree of protection of the enclosure shall be in accordance with SANS 60529 and shall be IP 55.

- 6.32 Provision shall be made for the enclosure to be pad-lockable.
- 6.33 The enclosure shall be provided with a gland plate for bottom entry of the control cables.
- 6.34 VACUUM CIRCUIT BREAKERS.**
- 6.34.1 Vacuum switching devices shall be evacuated and sealed in accordance with the latest technology and accepted practice.
- 6.34.2 The pre striking and chopping current shall be kept below 5 amperes. Tenderers shall give full details regarding these characteristics.
- 6.34.3 Where vacuum circuit breakers are specified in Appendix 1 they shall be either of the motor wound spring operating mechanism or magnetic actuator operating mechanism type.
- 6.35 SULPHUR HEXAFLUORIDE CIRCUIT BREAKERS. (SF6)**
- 6.35.1 The SF6 circuit breaker shall be fitted with a pressure gauge/densimeter to monitor the gas pressure.
- 6.35.2 The pressure gauge/densimeter circuit shall be provided with a minimum of two sets of contacts for alarm and indication for the substation's annunciator or flag circuit.
- 6.35.3 The supplier shall wire the SF6 circuit breaker local control circuit, such that in the event of a gas leakage or drop in gas pressure, the SF6 circuit breaker will trip and lockout.
- 6.35.4 A set of normally closed contacts shall be provided in the circuit breaker mechanism control box for the low gas trip circuitry.
- 6.35.5 The SF6 circuit breaker shall trip and lockout before the minimum safe SF6 gas pressure is reached.
- 6.35.6 In terms of the Occupational Health and Safety Act No 85 of 1993. Code 1704 (pressure vessels) the successful tenderer shall furnish a certificate of manufacture complying with the terms of the Act for the circuit breakers.

6.36 INSULATION LEVELS, CREEPAGE DISTANCES AND CLEARANCES

6.36.1 INSULATION LEVELS

The rated insulation levels of the AC circuit breakers shall comply with the requirements specified in Table 1.

- 6.36.1.1 Table 1 lists the nominal system voltages present on Transnet freight rail and the required insulation levels as specified in accordance with SANS 1019.

Highest phase-to-phase r.m.s voltage for equipment. (U_m)	Nominal system phase-to-phase r.m.s. voltage	Rated lightning impulse withstand voltage peak.	Rated short duration power- frequency withstand r.m.s voltage.
24 kV	22 kV	150kV	50 kV
36 kV	33 kV	200 kV	70 kV
52 kV	44 kV	250 kV	95 kV
72,5 kV	66 kV	350 kV	140 kV
100 kV	88kV	380 kV 450 kV	150 kV 185 kV
145 kV	132 kV	550 kV 650kV	230 kV 275 kV
245 kV	220 kV	850 kV 950 kV	360 kV 395 kV

Insulation levels for highest voltage for equipment $U_m < 100$ kV are based on an earth fault factor equal to $\sqrt{3}$ and for $U_m > 100$ kV an earth fault factor equal to $0,8\sqrt{3}$.
Where more than one insulation level is given per voltage system, the higher level is appropriate for equipment where the earth fault factor is greater than 1,4

TABLE 1: Standard Voltages and insulation levels in accordance with SANS 1019:2008 [1]

6.36.1.2. For the 25 kV and 50kV single phase ac traction systems the ac high voltage circuit breakers shall be designed to the following nominal system phase to phase r.m.s voltages and withstand insulation levels:

- For the 25 kV (phase to earth) ac traction systems the ac high voltage circuit breakers current transformer shall be rated for a nominal system phase to phase r.m.s voltage of at least 44 kV and designed to withstand the required insulation level for that nominal system voltage.
- For the 50 kV (phase to earth) ac traction systems the ac high voltage circuit breakers shall be rated for a nominal system phase to phase r.m.s voltage of at least 88 kV and designed to withstand the required insulation level for that nominal system voltage.

6.36.2 CREEPAGE DISTANCES

6.36.2.1 The standard creepage distance between phase and earth shall be in accordance with table ii of SANS 60815.

6.36.2.2 For coastal areas and very heavy polluted inland areas the standard creepage distance shall be the very heavy polluted level, i.e. 31mm/kV of the highest r.m.s phase to phase voltage U_m for equipment.

6.36.2.3 For inland areas the standard creepage distance shall be the heavy polluted level, i.e. 25mm/kV of the highest r.m.s phase to phase voltage U_m for equipment.

6.36.3 CLEARANCES

6.36.3.1 The following minimum safety outdoor earth clearances shall be maintained between any live conductor or metal and earthed metal: -

Highest phase to phase r.m.s voltage for equipment.	24kV	36kV	48kV	72kV	100kV	145kV	245kV
Outdoor distance	320mm	430mm	540mm	770mm	1000mm	1450mm	1850mm

6.36.3.2 The following minimum safety clearances shall be maintained between any live conductor or metal and ground surface level: -

Highest phase to phase r.m.s voltage for equipment.	24kV	36kV	48kV	72.5kV	100kV	145kV	245kV
Nominal phase to phase r.m.s system voltage	22kV	33kV	44kV	66kV	88Kv	132kV	220kV
Within security fence. (Restricted access way)	2820mm	2930mm	3040mm	3270mm	3500mm	3950mm	4350mm
Outside security fence but within Transnet freight rail's reserve	5200mm	5300mm	5400mm	5700mm	5900mm	6300mm	6700mm
Outside Transnet freight rail's reserve	5500mm	5500mm	5500mm	5700mm	5900mm	6300mm	6700mm

6.37 SUPPORT STEELWORK.

- 6.37.1 The circuit breaker shall be provided with its own support steelwork, which shall be hot-dip galvanised in accordance with specification SANS 121 and shall comply to requirements of SANS 1431: for weldable structural steels.
- 6.37.2 Support steelwork exposed to a high pollution/corrosive atmosphere shall be painted in accordance with specification CEE.0045.

7.0 SPECIAL TOOLS, SERVICING AIDS AND MANUALS AND SPARES LISTS.

- 7.1 The tenderers shall submit a separate offer for special tools and servicing aids necessary for the servicing and maintenance of SF6 circuit breakers.
- 7.2 Three copies of instruction/maintenance manuals, spares list's and wiring diagrams of the circuit breakers in accordance with Transnet freight rail's specification CEE.0224. shall be supplied upon delivery.

8.0 TRAINING.

- 8.1 The tenderer shall submit details with the tender of the training courses, which will be conducted by the supplier for the training of Transnet freight rail maintenance staff in the operation and maintenance of the circuit breaker. The courses shall include theoretical as well as practical tuition. The date and venue of this training course shall be arranged with the maintenance manager of the depot. The cost of the training shall be quoted for separately.

9.0 TEST CERTIFICATES.

- 9.1 The manufacture shall make available type test certificates for the equipment (as specified in SANS 62271-100 when required. Routine test certificates shall be supplied with each circuit breaker.

10.0 GUARANTEE AND DEFECTS.

- 10.1 The contractor shall guarantee the satisfactory operation of the circuit breaker supplied and accept liability for maker's defects, which may appear in design, materials and workmanship.
- 10.2 The guarantee period shall expire after: -
A period of 12 months commencing on the date of energising of the circuit breaker.
- 10.3 Any specific type of fault occurring three times within the guarantee period and which cannot be proven to be due to other faulty equipment not forming part of this contract, shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the maintenance manager of the depot and at the cost of the Supplier. If urgent repairs have to be carried out by Transnet freight rail staff to maintain supply during the guarantee period the supplier shall inspect such repairs to ensure that the guarantee period is not affected and should they be covered by the guarantee, reimburse Transnet freight rail the cost of material and labour.

11.0 INSPECTION.

- 11.1 Transnet freight rail reserves the right to carry out inspection and any tests on the equipment at the works of the supplier/ manufacture.
- 11.2 Arrangements must be made timeously for such inspections to be carried out before delivery of the equipment to the client.

12.0 PACKAGING AND TRANSPORT.

- 12.1 The tenderer shall ensure that the equipment be packed in such a manner that it will be protected during handling and transport.
- 12.2 The tenderer shall provide transport for the delivery of the equipment to the site where required.

13.0 BIBLIOGRAPHY

- [1] SANS 1019: 2008. Edition 2.5

END

SCHEDULE OF REQUIREMENTS
(To be completed by client)

1.0 SYSTEM DETAIL

- 1.1 AC Circuit Breakers: _____ substation/location.
- 1.2 Pollution level: Heavy _____ Very Heavy _____
- 1.2 Quantity of AC Circuit Breakers. _____
- 1.1 Nominal phase to phase voltage for 3 phase system: _____ kV.
- 1.2 Nominal phase to neutral voltage for single phase systems: _____ kV.
- 1.3 Frequency: _____ Hz
- 1.4 Circuit breaker control DC voltage: _____ V
- 1.5 Circuit breakers to be used for the following:
- 3 kV DC Traction substations. Yes/No
 - Distribution substations. Yes/No
 - 25 kV AC Traction substations. Yes/No
 - 50 kV AC Traction substation. Yes/No

DETAIL OF AC CIRCUIT BREAKERS.

- 2.0 Type of circuit breakers required:
- Vacuum: Yes / No
- Gas (SF6): Yes / No _____
- 2.2 Number of circuit breakers required: _____
- 2.3 Number of poles: _____
- 2.4 Rated Voltage: _____ kV
- 2.5 Rated short-circuit breaking current: _____ kA
- 2.6 Rated normal current: _____ Ampere.

END

TECHNICAL DATA SHEET
(To be completed by tenderer)

DETAIL OF CIRCUIT BREAKER

- 1.1 Make and manufacturer _____
- 1.2 Rated Voltage _____ kV.
(Highest rated voltage for equipment)
- 1.3 Rated Insulation level _____ kV.
(Rated lightning withstand Voltage)
- 1.4 Number of Poles: _____
- 1.6 Rated short circuit breaking current _____ kA.
- 1.7 Rated normal current: _____ Ampere.
- 1.6 Breaker operating time:
- 1.6.1 Closing: _____ ms.
- 1.6.2 Opening: _____ ms.
- 1.7 Number of operations after which breaker contact maintenance / measurement is required:
- 1.7.1 Under full load conditions _____
- 1.7.2 Under fault conditions _____
- 1.8 First Pole to Clear Factor _____
- 1.9 DC control voltage: _____ V