



TRANSNET
freight rail

A division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

3 KILOVOLTS DC HIGH SPEED CIRCUIT BREAKERS FOR TRACTION SUBSTATIONS

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1.0 SCOPE

This specification covers Transnet Freight Rail's requirements for the supply of 3kV DC, high speed circuit breakers for use on a DC electrified railway systems.

2.0 APPENDICES

The following appendices form an integral part of this specification:-

- 2.1 Appendix 1: List of drawings.
- 2.2 Appendix 2: Schedule of Specific Requirements.
- 2.3 Appendix 3: Technical Data Sheet (specific technical information to be furnished with tenders).
 - 2.3.1 Equipment offered in this appendix shall be supplied in terms of this specification and no changes or substitutes will be allowed without the written consent of Transnet Freight Rail.
 - 2.3.2 Acceptance by Transnet Freight Rail's Technology Management staff of the equipment offered in this appendix, in no way relieves the tenderer of his obligation to fulfil his statement of compliance with this specification.
 - 2.3.3 Transnet Freight Rail reserves the right to subject the material offered to tests and inspection to check compliance with the relevant clauses of this specification and/or the quality/performance claimed by the tenderer, prior to adjudication or at any stage during manufacture.

3.0 STANDARDS AND PUBLICATIONS

- 3.1 The following standard specifications (latest edition) are referred to in this document:

3.1.1 INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC 60947-2: Switchgear and Control gear

3.1.2 TRANSNET FREIGHT RAIL

CEE 0227: The design and manufacture of a modular 3kV DC, 2000A circuit breaker cell and truck for use on a 3kV DC traction system

BBB 0041: Preparation of drawings for Transnet Freight Rail Infrastructure.

BBD5994: Technical Documentation Management Policy

3.2 DEFINITIONS

All technical terms used in this specification shall have the definitions as per IEC 60947-2 section 2.

4.0 METHOD OF TENDERING

- 4.1 Tenderers shall indicate clause by clause compliance with the specification. This shall take the form of a separate document listing all the specifications clause numbers indicating the individual statement of compliance or non-compliance. This document can be used by tenderers to elaborate on their response to a clause.
- 4.2 A statement of non-compliance shall be motivated by the tenderer.

- 4.3 Tenderers shall submit descriptive literature consisting of detailed technical specifications, general constructional details and principal dimensions, together with clear illustrations of the equipment offered.
- 4.4 The Schedule of Requirements, Quantities and Prices, Appendix 1 to this specification shall be fully completed by Tenderers.
- 4.5 Failure to comply with clauses 4.1, 4.2, 4.3 and 4.4 could preclude a tender from consideration.

5.0 SERVICE CONDITIONS

The circuit breakers shall be designed and rated for operation under the following service conditions:

5.1 Atmospheric service conditions.

Altitude:	0 to 1800 m above sea level
Ambient temperature:	-10°C to +55°C.
Relative humidity:	10% to 90%
Lightning conditions:	15 Ground flashes per square kilometre per annum.
Pollution:	Heavily salt laden or polluted with smoke from industrial sources

5.2 Mechanical service conditions.

The substations in which the breakers are to be installed are situated next to the railway lines and the breakers will therefore be subjected to vibration.

5.3 Electrical service conditions.

- 5.3.1 The circuit breakers are required for the switching and protection of overhead track circuits, the rail being the negative return.
- 5.3.2 The system voltage is nominally 3.15kV DC, but varies during normal operation between 2,4kV and 3,9kV.
- 5.3.3 For the purpose of surge and lightning protection to the substation equipment, a 4 micro Farad capacitor is connected between the positive cable termination and negative rail. A Zinc Oxide surge arrester, having a residual voltage of 13kV, is also connected between the positive cable termination and earth mat.
- 5.3.4 The breakers are fed from sub- or tie-station busbars and calibrated to protect sections of overhead track equipment to which they are connected. Sub- and tie-stations are unattended but remote controlled.
- 5.3.5 Circuit conditions under which track breakers operate vary over a wide range. The following information is considered typical:
- 5.3.5.1 Substation spacing: On open lines it varies from 10 to 25 km, whilst in heavily loaded, multi track areas it varies from 3 to 10 km.
- 5.3.5.2 Substation capacity: The installed capacities vary from 3MW to 12MW, with individual rectifier capacities varying from 3MW to 6MW.

5.3.6 The substation has the following overload ratings:

200 percent for 30 minutes

Short circuit proof for 200 milliseconds.

5.3.7 Typical fault conditions.

	Fault near sub	Fault remote from sub.
Prospective current	50kA	10kA
Time constant	10ms	45ms

5.3.8 All substations on a section normally work in parallel.

5.3.9 The breakers will be fitted with single shot 20 second interval auto reclosing relays. The breakers will be remote controlled, permitting re-closures to be attempted from remote at approximately 2 minute intervals.

6.0 LIFE CYCLE COST

6.1 The cost of the high speed circuit breaker is not the only deciding factor when purchasing high speed circuit breakers. Life cycle cost will be taken into account when evaluating the offers made.

6.2 The life cycle cost will be based on maintenance history in Transnet Freight Rail. The following information shall be submitted by the tenderer.

6.2.1 A separate quotation for the recommended spares Transnet Freight Rail should acquire for normal maintenance purposes to cover expected requirements for a five year operating period, per 20 breakers purchased, indicating the price per item.

6.2.2 A separate quotation for any special tools required, for the maintenance of breakers.

6.2.3 A separate quotation for any other items required, to adapt the breakers to fit into Transnet Freight Rail's system.

6.2.4 A prescribed average maintenance requirement in man-hours per year per high speed circuit breaker, over a 25 year period.

6.3 The recommended quantity of spares and prescribed man-hours per year shall be based on 30 overload and fault trips per month per breaker. It is estimated that an average of 10 percent of all trips are due to faults.

7.0 DRAWINGS, INSTRUCTIONS AND CATALOGUES

7.1 Tenderers shall include in their tenders for the supply of operating and maintenance instruction manuals and drawings to enable the erection, maintenance, repair and adjustment of the breakers to be carried out.

7.1.1 The preparation of the drawings shall be in accordance with Transnet Freight Rail's specification BBB 0041.

7.1.2 The catalogues, instruction manuals and spares lists shall be in accordance with Transnet Freight Rail's technical documentation policy BBD5449.

7.1.3 One copy of the instruction manual must be supplied for every 4 breakers supplied, plus a further 10 copies.

- 7.2 Tenderers shall also include in their tenders for the supply of spare parts catalogues. These catalogues must contain detailed illustrations and descriptions, and suitably indexed pages reflecting:
- 7.2.1 Illustration item numbers, complete description of items including coil winding data and material, manufacturer's item numbers and Transnet Freight Rail stores item number (left blank).
- 7.2.2 One copy of the catalogue must be supplied for every 10 breakers supplied, plus a further 10 copies.
- 7.3 Proof copies of the drawings, instruction manuals and spare parts catalogues shall be submitted by the successful tenderer for approval as soon as possible after the business has been placed to enable the final copies to be supplied at the commencement of delivery of the breakers.
- 7.4 The successful tenderer shall supply Transnet Freight Rail with one complete set of detailed manufacturing drawings and specifications of all consumable items, i.e. of all coils, main and arcing contacts, arc chutes - and components, etc.

8.0 TECHNICAL REQUIREMENTS

8.1 GENERAL

- 8.1.1 The breakers shall have a minimum continuous rating of 2 000A and shall be suitable for operation under the service conditions described in clause 5.0.
- 8.1.2 The breakers shall be capable of clearing a prospective short circuit current of 50kA with a time constant of 10ms, 4 times in succession with time intervals of 20s, 60s and 120s between applications. It shall then still be capable of normal service without attention.
- 8.1.3 Consideration will only be given to those types of breakers which have been proved to operate satisfactorily on a 3kV DC traction system, under conditions comparable with those encountered on Transnet Freight Rail. Tenderers shall furnish full details (Appendix 3) in regard to experience, viz. approximate number of breakers of tendered design manufactured to date, dates of supply and where installed.
- 8.1.4 The breakers shall be mounted horizontally on the standard rack out type truck provided by Transnet Freight Rail to drawings referred to in Appendix 1 of this specification or in a modular circuit breaker cell as per specification CEE 0227.
- 8.1.5 The overall dimensions of a breaker, complete with arc chute, when mounted on this truck shall be such as to afford clear passage of the truck into the standard breaker cell, leading dimensions of which are indicated on the drawings.
- 8.1.6 The breakers shall operate satisfactorily in buildings where the roof details are as follows:
- 8.1.6.1 Concrete roof: minimum height 2,6m.
- 8.1.6.2 Roof consisting of steel members supporting Mica material/Asbestos free or metal sheeting: minimum height 3,25m.
- 8.1.7 All parts shall be interchangeable between breakers.
- 8.1.8 The breaker and arc chute shall be designed to require the minimum maintenance. The minimum maintenance interval shall be 250 trips at a trip setting of 4 000A at 3,2kV. Of these trips 10 percent may be fault trips.

8.2 INSULATION

- 8.2.1 The minimum clearance distance in air that shall apply from the 3kV DC circuit to the auxiliary circuits and to the steel base shall be 100mm. Alternatively, double insulation or barriers shall be provided.
- 8.2.2 The insulation between the 3kV DC circuit and (a) the auxiliary circuits and (b) the steel base shall be capable of withstanding a test voltage of 10,5kV (rms) 50Hz for one minute.
- 8.2.3 All low voltage auxiliary equipment shall be capable of withstanding a test voltage of 2kV (rms) 50Hz for one minute.
- 8.2.4 The circuit breaker shall be able to withstand the following 50Hz test voltages for 60 seconds between the open main contacts:
 - 8.2.4.1 With the arc chute removed: 10,5kV (rms).
 - 8.2.4.2 With the arc chute in its working position: 5,4kV (rms).
- 8.2.5 Full particulars of the insulation, including the class, shall be supplied.

8.3 CIRCUIT BREAKER

- 8.3.1 The circuit breaker shall be of the trip free type.
- 8.3.2 The method of closing, latching and the trip free feature shall be described in detail, with the use of drawings and sketches.
- 8.3.3 In the event of circuit breakers being offered that use mechanical latching (to be de-latched), the tenderer shall ensure that the circuit breakers will not malfunction to open due to the mechanical latching mechanism not operating correctly. Such mechanisms shall be suitably protected from dust or fragments from the arc chutes or contacts which can affect their satisfactory operation.
- 8.3.4 Main contacts, which are not self-cleaning, shall be of material which will not oxidise when the breakers are open or closed for lengthy periods.
- 8.3.5 Main contacts (or arcing contacts, if fitted) shall be tipped with material with a high resistance to arc erosion, welding and sticking.
- 8.3.6 Arcing contacts (if fitted) and main contacts shall be accessible for inspection and maintenance and shall be designed to facilitate any necessary adjustments and renewal.
- 8.3.7 The temperature rise limit of main contacts (if made of copper) shall not exceed 45 degrees Celsius while passing the continuous rated current.
- 8.3.8 It shall **not** be possible to close the breaker manually.
- 8.3.9 The breakers shall be designed to prevent dust or fragments from the arc chutes or contacts from affecting their satisfactory operation.
- 8.3.10 All adjustments shall be such that they can be easily effected. The need for special tools should be avoided.
- 8.3.11 Tenderers shall furnish full details of all adjustments which can be made, particularly of the main contact alignment and pressure, and where applicable of pole face and toggle mechanism.
- 8.3.12 In an event of circuit breaker not being able to trip with low voltage/over voltage tripping indirect tripping shall be provided.

- 8.3.13 The circuit breaker shall be able to operate as a normal contactor in the event of other relays such as DC feeder protection relays instructing it to open under fault conditions. There shall be no delay in clearing an Arc under these conditions. If required the circuit breaker shall be provided with an indirect tripping mechanisms.

8.4 CALIBRATION

- 8.4.1 The breakers may be either uni- or bi-directional tripping. Tenderers shall state what type is offered; giving details of the calibration ranges for both the forward and reverse current tripping.
- 8.4.2 A scale plate, indicating the maximum and minimum trip settings and at least five intermediate graduations shall be provided on each breaker at the calibration adjustment position.
- 8.4.3 The calibration range for the forward direction shall be from 2 000A to 5 000A.
- 8.4.4 The calibration range for the reverse direction (if reverse tripping is possible) shall be at least the same as that of the forward direction.
- 8.4.5 Tenderers shall indicate clearly the means whereby the above calibration ranges are provided.
- 8.4.6 The stability at any particular setting shall be such that the current required to trip the breaker shall not vary by more than 2 percent below or above the set calibrated value when calibration is checked under similar conditions.
- 8.4.7 The breaker design shall incorporate features to ensure that the breakers can be closed satisfactorily on to a steady (residual) load of not less than 60 percent of any particular calibration setting.

8.5 ARC CHUTES

- 8.5.1 Arc chutes manufactured from asbestos cement shall not be accepted. Arc chutes made of low maintenance materials are preferred. Tenderers shall specify what materials are used.
- 8.5.2 Transnet Freight Rail would prefer an offer of an arc chute incorporating a removable metal splitter plate design.
- 8.5.3 Materials used in arc chutes must be of a type that is easily cleaned.
- 8.5.4 The arc chutes shall be constructed as to render the contacts easily accessible by removal of separate parts of the arc chutes as a unit.
- 8.5.5 Tenderers shall submit full details of the principles of operation of the arc chute, as well as sketches and drawings of the various components and assemblies. Details of the maintenance and repairs that can/should be done, and at what intervals, shall also be furnished.

8.6 AUXILIARY CONTACTS

- 8.6.1 Auxiliary contacts for operating in conjunction with the indication and control circuits shall be located well clear of the arc chutes and main contacts.
- 8.6.2 The auxiliary contacts shall be of robust construction and tipped with silver or other suitable material.
- 8.6.3 At least six auxiliary contacts which close ('a' contacts) and six auxiliary contacts which open ('b' contacts) when the breaker closes shall be provided and mounted on each breaker.

- 8.6.4 A robust, dust tight, non-metallic non-flammable cover for the auxiliary contacts shall be provided on each breaker to prevent ionised air from the 3kV DC circuit or dust causing flashovers or tracking. Hard plastic covers are not acceptable.

8.7 CONTROL CIRCUITRY

- 8.7.1 The circuit breaker shall be operated either with DC Feeder Protection relay or with Auto Re-closure relay.
- 8.7.2 Drawings BBF1337, BBF1338, CEE-TBP-35, 39, 40, 41, 42 and 44 reflect the control schematic diagram of circuit breakers in use at present.
- 8.7.3 The DC feeder protection relays being used shall be in accordance to specification BBG0894.
- 8.7.4 The closing and control circuits are supplied from 110V DC battery under constant trickle charge. The equipment shall be capable of satisfactory continuous operation at any voltage between the limits of 90V and 140V.
- 8.7.5 In order to ensure constant calibration, the holding coil is normally supplied from a separate constant 110V DC source.
- 8.7.6 The circuit breakers shall be suitable for operation from the above stated supplies.
- 8.7.7 The remote control equipment (DC feeder protection or Auto re-closure relays), control relays, indication lights, control switches and reclosing relays shown on drawings CEE-TBP-35 and 39 will be provided by Transnet Freight Rail.
- 8.7.8 All other items of equipment required to enable the breakers to operate correctly, without any alterations to the standard wiring circuitry provided by Transnet Freight Rail, shall be included in the tenderer offers.
- 8.7.9 The design of the breakers and control circuitry shall be such that the breakers shall "fail to safety", particularly on loss of the low voltage control supplies.

8.8 TESTS AND OSCILLOGRAMS

- 8.8.1 Short circuit tests shall be carried out on breakers connected to a 3kV DC system with similar fault currents to that which is specified in clause 5.3.7 and oscillograms thereof shall be submitted with the tenderers offers. For the purpose of the test the breakers shall be calibrated at 4 500A.
- 8.8.2 The following shall be clearly indicated on the oscillogram traces:
- 8.8.2.1 Commencement of short circuit.
- 8.8.2.2 Opening time, i.e. time from the application of the short circuit to initial opening of the arc breaking contacts.
- 8.8.2.3 Arcing time.
- 8.8.2.4 Arc voltage (Transient recovery voltage).
- 8.8.2.5 Rate of rise of current.
- 8.8.2.6 Prospective peak current.

9.0 TESTS BY TRANSNET FREIGHT RAIL AND TYPE TEST CERTIFICATES

- 9.1 Transnet Freight Rail reserves the right to test a circuit breaker, selected at random, for compliance with any or all of the following clauses.
- 9.1.1 Fault clearing test, clause 8.1.2.

- 9.1.2 A maintenance interval test (an in service test), clause 8.1.8.
- 9.1.3 Insulation tests, clause 8.2.2 to 8.2.5.
- 9.1.4 Temperature rise of the main contacts, clause 8.3.7.
- 9.1.5 Stability of calibration, clause 8.4.6.
- 9.1.6 Closing on to a steady (residual) load, clause 8.4.7.
- 9.1.7 Breaker "fail to safety" feature, clause 8.7.9.
- 9.2 The tenderer shall provide type test certificates to confirm that the breakers comply with the requirements as specified in clauses 9.1.1 to 9.1.7.

10.0 PACKING

- 10.1 Each circuit breaker shall be completely assembled and operationally checked before packing and dispatch.
- 10.2 The circuit breakers and arc chutes shall be packed separately.
- 10.3 The breakers shall be bolted down to substantial battens firmly secured to the packing cases to prevent movement of the breakers in the cases during transit. The packing cases shall be of substantial construction to prevent damage to the breaker by rough handling. The bases of the cases shall be suitable for handling with a fork lift truck.
- 10.4 The interiors of the cases shall be lined with waterproof paper or other suitable material.

11.0 INSPECTION

- 11.1 An Inspection Certificate will be issued by Technology Management – Electrical Technology to certify that material / equipment conforms to Transnet Freight Rail's requirement.

END

SCHEDULE OF DRAWINGS**LIST OF DRAWINGS**

DRAWINGS ISSUED WITH THIS SPECIFICATION

DRAWING NUMBER	DESCRIPTION
CEE-TBP-35	Wiring diagram: H.S.C.B, Electronic Control Relay
CEE-TBP-39	Circuit diagram; H.S.C.B, Electronic Control Relay
CEE-TBP-40	Truck circuit diagram
CEE-TBP-41	Truck wiring diagram
CEE-TBP-42	Connection diagram for HSCB
CEE-TBP-44	Connection diagram for Ansaldo IR6003 HSCB
CEE-TCQ-63	Assembly of lightweight concrete cell with H.S.C.B. truck in position.
CEE-TCQ-69 Sheet 1	Truck frame assembly H.S.C.B.
BBF1336	List of Components
BBF1337	Secheron Breaker fitted with DC feeder protection relay
BBF1338	EMC Breaker fitted with DC feeder protection relay

SCHEDULE OF REQUIREMENTS

Supply of the 110V closing contactor 154X as depicted on drawing CEE-TBP-35 if required.

TECHNICAL DATA SHEET

(To be completed by tenderers and submitted as part of their tender)

1. Make of breaker: _____
2. Experience with tendered design of breaker: (Clause 8.1.3)

NUMBER SUPPLIED**WHERE INSTALLED****DATE SUPPLIED**

<u>NUMBER SUPPLIED</u>	<u>WHERE INSTALLED</u>	<u>DATE SUPPLIED</u>

3. Continuous current rating of breaker (Amperes): _____
4. Rated voltage of breaker(Volts): _____
5. Mechanically latched Yes/No: _____
6. Magnetically latched Yes/No: _____
7. Main contact material: _____
8. Indirect tripping mechanism required Yes/No: _____
9. Arcing contacts fitted Yes/No: _____
10. Contact material of main contact (or arcing contact, if fitted)
