TRANSNET
freight rail

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

REQUIREMENTS FOR OUTDOOR POST TYPE CURRENT TRANSFORMERS FOR TRACTION AND DISTRIBUTION SUBSTATIONS.

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Circulation Restricted To:

Transnet Freight Rail
Transnet and Relevant Third Parties

Contents

1.0 SCOPE

1.1 This specification covers Transnet Freight Rail's requirements for the design, manufacture, testing and supply of outdoor post type current transformers for use with electrical measuring instruments and electrical protection devices.

1.2 The current transformers shall be suitable rated for nominal system phase to phase rms voltages ranging from 22 kV up to 220 kV.

2.0 STANDARDS

2.1 Unless otherwise specified all materials used and equipment developed and supplied shall comply with the current equivalent edition of the relevant SANS, IEC or Transnet Freight Rail publications where applicable.

2.2 The following publications/specifications (latest editions) are referred to herein:

2.2.1 SOUTH AFRICAN NATIONAL STANDARD (SANS)

SANS 1019:	Standard voltages, currents and insulation levels for electricity supply.
SANS 60529:	Degree of protection provided by enclosures (IP code)
SANS 61869-1:	Instrument transformers Part 1: General requirements.
SANS 61869-2:	Instrument transformers Part 2: Additional requirements for current transformers.
SANS 62271-204:	High-voltage switchgear and control gear Part 204: Rigid gas-insulated transmission lines for rated voltage above 52 kV
SANS 9001:	Quality management systems - Requirements.

2.2.2 INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60296:	Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear.
IEC 60376:	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment.
IEC 60417:	Graphical symbols for use on equipment.
IEC 60455:	Resin based reactive compounds used for electrical insulation.
IEC 60815:	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.
IEC 60867:	Insulating liquids - Specifications for unused liquids based on synthetic aromatic hydrocarbons.

2.2.3 TRANSNET FREIGHT RAIL'S SPECIFICATIONS

CEE 0183:	hot dipped galvanizing and painting of electrification steelwork.

3.0 METHOD OF TENDERING

3.1 Tenderers shall indicate clause-by-clause compliance with this 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.

3.2 A statement of non-compliance shall be motivated by the tenderer.

3.3 Tenderers shall submit descriptive literature consisting of a detailed technical specifications,

general constructional details and principal dimensions, together with clear illustrations of the equipment offered.

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

4.0 SERVICE CONDITIONS

4.1 ENVIRONMENTAL CONDITIONS

Altitude:	0 - 1800 m above sea level
Relative humidity:	10% to 90%
Ambient temperature:	-10° C to +55° C
Wind pressure:	750 Pa
Lightning conditions:	20 ground flashes/km^2 per annum
Pollution:	Heavily salt laden with industrial pollutants including diesel-electric locomotive emissions
Electromagnetic interference:	The device shall be used in environments exposing it to substantial electric and magnetic field intensities

4.2 ELECTRICAL SERVICE CONDITIONS

4.2.1 The current transformer shall be suitable for single phase AC traction supply systems with nominal voltage ranging from 22 kV – 220 kV AC with +-5% tolerance.

4.2.2 The current transformer shall be able to operate at a frequency of 50 Hz with +- 2.5% tolerance.

4.3 MECHANICAL SERVICE CONDITIONS

4.3.1 The device may be exposed to vibration and shock. The design must be adequately robust so as to ensure reliability of the equipment under such handling and transportation conditions.

5.0 TECHNICAL REQUIREMENTS

5.1 GENERAL REQUIREMENTS

5.1.1 The current transformers shall be designed, manufactured and tested in accordance with the requirements of SANS 61869-1 and SANS 61869-2 specifications.

5.1.2 The current transformers shall be suitable for operation under the nominal phase to phase voltages or phase to neutral voltages specified in Appendix A.

5.1.3 The current transformers shall be designed for outdoor use.

5.1.4 The current transformers shall be provided with measuring and protection cores as specified in Appendix A.

5.1.5 For certain applications, dual measuring cores as specified in Appendix A shall be provided for the purpose of ESKOM metering.

5.2 INSULATION LEVELS

The rated insulation levels of the current transformers shall comply with the requirements specified in Table 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. (Um)	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	550 kV 650kV	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 $0{,}8\sqrt{3}$.			

TABLE 1: Standard Voltages and insulation levels in accordance with SANS 1019:2014

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.

5.2.1 Primary terminal

5.2.1.1 The primary terminal insulation levels of the current transformer shall be as per clause 5.2 table 2 of SANS 61869-1 specification.

5.2.1.2 The partial discharge level shall not exceed the limits specified in Table 3 of SANS 61869-1 specification. These limits shall be tested as per clause 7.3.2.2 of SANS 61869-1 specification.

5.2.1.3 Current transformers that are not Gas Insulated shall be capable to withstand a chopped lightning impulse voltage applied to its primary terminals having a peak value of 115 % of the rated lightning impulse withstand voltage.

5.2.1.4 The primary terminals shall be of approved type material i.e. aluminium or electroplated copper and shall be able to carry the rated short circuit current of the current transformer.

5.2.1 **Secondary terminal**

5.2.1.1 The rated power-frequency withstand voltage for secondary insulation shall be at least 3 kV.

5.2.1.2 The secondary terminals shall be mounted in a metal terminal box suitable for the termination of the current transformer secondary windings to the outgoing external circuits for the protection relays, metering and indicating instruments.

5.2.1.3 The secondary winding connections shall be brought out through the tank into the terminal box by means of bushings.

5.2.1.4 Links shall be provided for shorting out the secondary windings not in use.

5.2.1.5 A rail mounted terminal strip shall be provided inside the terminal box for the termination of the current transformer secondary connections to the external circuits. The terminals shall be of the screw clamp type or spring-loaded insertion type.

5.2.1.6 The secondary winding terminal box shall be provided with a weatherproof cover and bottom entry cable entries. The degree of protection shall be at least IP 54 in accordance with SANS 60529.

5.2.1.7 An earthing stud of at least 6mm shall be provided inside the terminal box for the earthing of the secondary windings.

5.3 CURRENT TRANSFORMER RATINGS

5.3.1 MEASURING CURRENT TRANSFORMERS

5.3.1.1 The transformer ratio(s) shall comply with the requirements of Appendix A.

5.3.1.2 The secondary current rating shall be 1 Ampere unless otherwise specified in Appendix A.

5.3.1.3 The minimum rated output burden shall be 10 VA unless otherwise specified in Appendix A.

5.3.1.4 The accuracy class shall be as follows:

- For metering purposes the class of accuracy shall be 0.5 for current transformers with ratios up to 400/1 and class 0.2 for ratios greater than 400/1.
- For Indication or measuring purposes the accuracy class shall be 0.5.

5.3.2 PROTECTION CURRENT TRANSFORMERS

5.3.2.1 The transformer ratio(s) shall comply with the requirements of Appendix A.

5.3.2.2 The secondary current rating shall be 1or 5 Ampere. Refer to Appendix A.

5.3.2.3 The rated output burden shall comply with the requirements of Appendix A but shall not be less than 10 VA.

5.3.2.4 The accuracy limit factor shall be as specified in Appendix A.

5.3.2.5 The accuracy class shall be as specified in Appendix A.

5.3.2.6 The protection core shall be provided with a 10 ampere test winding.

CLASS PX CURRENT TRANSFORMERS

5.3.2.7 Class PX protection current transformers shall be provided where specified in Appendix A.

5.4 DESIGN AND CONSTRUCTION

5.4.1 Requirements for liquid filled in equipment

5.4.1.1 The manufacturer shall specify the type and the required quantity and quality of the liquid to be used in current transformer.

5.4.1.2 For oil-filled equipment, insulating oil shall comply with IEC 60296 specification.

5.4.1.3 For synthetic liquid-filled equipment refer to IEC 60867 specification.

5.4.1.4 The current transformer shall have a device for checking the liquid level. The device shall indicate whether the liquid level is within the operating range, during operation. This device shall be readable from the ground level.

5.4.1.5 The device shall be sealed to avoid any liquid loss. Liquid loss represents a danger of insulation contamination.

5.4.2 Requirements for gas filled in equipment

5.4.2.1 The manufacturer shall specify the type and the required quantity and quality in the equipment.

5.4.2.2 New SF6 (sulphur hexafluoride) gas shall comply with IEC 60376 specification.

5.4.2.3 The handling of SF6 gas shall be in accordance with clause 6.2 of SANS 61869-1 specification.

5.4.2.4 The maximum allowed moisture content within current transformers filled with gas at rated filling density for insulation shall be as per clause 6.2.2 of SANS 61869-1 specification.

5.4.2.5 Gas-insulated transformers having a minimum functional pressure above 0,2 MPa shall be provided with pressure or density monitoring device. Gas monitoring devices may be provided alone or together with the associated equipment.

5.4.2.6 All current transformers that use gas, other than air at atmospheric pressure, as an insulating medium shall conform to clause 6.2.4.2 of SANS 61869-1 specification.

5.4.2.7 The pressure relief valve shall be protected against any accidental damage.

5.4.2.8 For Gas Insulated Switchgear (GIS) current transformers refer to SANS 62271-204, Clause 5.105.

5.4.3 Requirements for solid materials used in equipment

5.4.3.1 Specifications for organic material used on current transformer (i.e. epoxy resin, polyurethane resin, epoxy-cycloaliphatic resin, composite material, etc.) shall conform to IEC 60455 series specifications.

5.4.3.2 For insulation guidance, IEC 61109 specification for outdoor insulation shall be used.

5.4.4 Requirements for temperature rise of parts and components

5.4.4.1 The temperature-rise of windings, magnetic circuits and any other parts of the current transformer shall not exceed the appropriate value given in SANS 61869-1 specification Table 5, when operating under the conditions specified on 4.0 of this specification.

5.4.4.2 The influence of altitude on temperature rise of the transformer shall be as per clause 6.4.2 of SANS 61869-1 specification.

5.4.5 Requirements for earthing of equipment

5.4.5.1 The frame of each equipment device, if intended to be earthed, shall be provided with a reliable earthing terminal for connection to an earthing conductor suitable for specified fault conditions. The connecting point shall be marked with the "earth" symbol, as indicated by symbol No 5019 of IEC 60417 specification.

5.4.5.2 The enclosure of current transformers for gas-insulated switchgear (GIS) shall be connected to earth. All metal parts which do not belong to a main or an auxiliary circuit shall be earthed.

5.4.5.3 The continuity of the earthing circuits shall be ensured.

5.4.5.4 For the interconnection of enclosures, frames, etc., fastening (e.g. bolting or welding) is acceptable for providing electrical continuity.

5.4.5.5 The tank or base of each current transformer shall be fitted with an earthing terminal suitable to accommodate a cable lug for a 95mm² copper conductor or copper busbar for the earthing of the current transformer.

5.4.6 Requirements for the external insulation

5.4.6.1 For outdoor instrument transformers with ceramic insulators susceptible to contamination, the creepage distances for given pollution levels shall conform to Table 6 of SANS 61869-1 specification.

5.4.6.2 The creepage distances shall also conform to IEC 60815 specification.

5.4.6.3 For installations at an altitude higher than 1000 m, the arcing distance under the standardised reference atmospheric conditions shall be determined by multiplying the withstand voltages required at the service location by a factor k in accordance with Figure 2 of SANS 61869-1 specification.

5.4.7 Mechanical requirements

These requirements apply only to current transformers having a highest voltage for equipment of 72,5 kV and above.

5.4.7.1 The current transformer shall be capable of withstanding static loads as per table 7 of SANS 61869-1 specification.

5.4.7.2 Provision shall be made that the current transformers can be bolted to the support structure.

5.4.8 Multiple chopped impulse on primary terminals

5.4.8.1 Chopped impulses shall be as per clause 7.4 of SANS 61869-1 specification.

5.4.9 Internal arc fault protection requirements

5.4.9.1 Internal arc fault test on all oil- immersed and gas-insulated free-standing current transformers having rated voltage ≥ 72,5 kV shall conducted and classed as per clause 6.9 of SANS 61869-1 specification.

5.4.10 Degrees of protection by enclosures

5.4.10.1 The degree of protection of all current transformers with the associated components shall be as per clause 6.10 of SANS 61869-1 specification; this shall be done in conjunction with SANS 60529 specification.

5.4.11 Electromagnetic Compatibility (EMC)

5.4.11.1 For current transformers that have rated voltage (*U*m) ≥ 123 kV, the Radio Interference Voltage (RIV) shall not exceed 2 500 µV at 1,1 *U*m 3 .

5.4.11.2 The current transformers that are containing active electronic components shall conform with the requirements of electromagnetic immunity as per clause 6.11 of SANS 61869-1 specification.

5.4.11.3 All current transformers that have rated voltage (*U*m) ≥ 72,5 kV shall have requirement for transmitted overvoltage's as stipulated in SANS 61869-1 specification.

5.4.12 Corrosion

5.4.12.1 Caution has to be taken against corrosion of the equipment during the service life.

5.4.12.2 All bolted or screwed parts of the main circuit and of the enclosure shall remain easy to demount.

5.4.12.3 Galvanic corrosion between materials in contact shall be considered because it can lead to the loss of tightness. All these parts shall be galvanized as per CEE 0183 specification.

5.4.13 Markings

All instrument transformers shall carry at least the following markings on a rating plate securely attached to the transformer:

a) The manufacturer's name or other mark by which he may be readily identified;

b) The year of manufacture and a serial number or a type designation, preferably both,

c) Rated frequency;

d) Highest voltage of equipment;

e) Rated insulation level;

f) Temperature category;

g) Mass in kg;

h) Class of mechanical requirements (for *U*m≥72kV).

i) Class of insulation if different from Class A;

j) All indications relative to the measuring characteristics;

k) Type of the insulating fluid;

l) Rated filling pressure;

m) Minimum functional pressure;

n) Insulating fluid volume (or mass) contained;

p) the corresponding terminals of each winding.

6.0 QUALITY ASSURANCE

6.1 The manufacturer shall ensure a manufacturing process that is compliant with specification SANS 9001.

7.0 DOCUMENTATION REQUIREMENTS

7.1 The manufacturer must provide one PDF file and two hard copies of the technical specification of the current transformer.

7.2 The manufacturer must provide one PDF file and two hard copies of the installation procedure, these includes connection diagram with terminal and polarity markings.

7.3 Drawings showing details of construction and outline dimensions of the currents transformers shall be submitted with the tender documents.

7.4 The manufacturer must provide type test certificates from a SANAS/international accredited laboratory to verify conformance to the requirements and these must be submitted with tender documents.

7.5 The manufacturer must complete and provide technical data sheet as per Appendix B.

8.0 GUARANTEE AND DEFECTS

8.1 The contractor shall guarantee the satisfactory operation of the current transformers supplied and accept liability for maker's defects, which may appear in design, materials and workmanship.

8.2 The guarantee period shall expire after: - A period of 12 months commencing on the date of energising of the current transformers

8.3 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.

8.4 If urgent repairs have to be carried out by Transnet Freight Rail's 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.

9.0 SUPPORT

9.1 The supplier shall provide support whenever is required, this can be in a form of telephone or email communications and also a site visit.

9.2 Training and support shall be provided by the supplier if required.

10.0 PACKAGING AND TRANSPORT

10.1 The package shall have handling instructions on it.

10.2 The tenderer shall provide transport for the delivery of the equipment to the site where required.

END

APPENDIX A

SCHEDULE OF REQUIREMENTS
(To be completed by client)

1.0 SYSTEM DETAIL

1.1 Current transformers required for: _____ substation/location.

1.2 Pollution level: Heavy_____ Very Heavy _____

1.3 Quantity of current transformers required. 2

1.4 Nominal phase to phase voltage for 3 phase system: _____ kV.

1.5 Nominal phase to neutral voltage for single phase systems: _____ kV.

1.6 Frequency: 50 Hz

2.0 DETAIL OF CURRENT TRANSFORMER.

MEASURING CURRENT TRANSFORMERS

2.1 Measuring current transformer required: Yes / No

2.2 Number of measuring cores required: _____

2.3 Transformer ratio: Primary _____ Ampere, Secondary _____ Ampere.

2.4 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere

2.5 Rated burden: _____ VA

2.6 Accuracy class: _____

PROTECTION CURRENT TRANSFORMERS

2.7 Protection current transformer required: Yes/No

2.8 Number of protection cores required: _____

2.9 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere

2.10 Accuracy class: _____

2.11 Accuracy limit factor: _____

2.12 Rated Burden: _____ VA

CLASS PX PROTECTION CURRENT TRANSFORMERS

2.13 Class PX protection required: Yes/No

2.14 Number of Class PX protection cores required:_____

2.15 Transformation ratio: Primary_____Ampere, Secondary_____Ampere.

2.16 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere.

2.17 Rated turns ratio: _____

2.18 Rated knee point e.m.f: _____V

2.19 Maximum secondary winding resistance: _____ Ohms at _____ ° C

END

APPENDIX B

TECHNICAL DATA SHEET
(To be completed by tenderer)

1.0 DESIGN DETAIL

1.1 Manufacturers name: _____

1.2 Highest voltage for equipment: _____ kV

1.3 Nominal r.m.s voltage: _____ kV

1.4 Rated insulation level: _____ kV

1.5 Rated frequency: _____ Hz

2.0 DETAIL OF CURRENT TRANSFORMERS.

MEASURING CURRENT TRANSFORMERS

2.1 Transformer ratio: _____

2.11 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere

2.12 Accuracy class: _____

2.13 Rated Burden: _____ VA

2.14 Rated short-time current: _____kA for _____ seconds

PROTECTION CURRENT TRANSFORMERS

2.15 Transformer ratio: _____

2.8 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere

2.16 Accuracy class: _____

2.17 Accuracy limit factor: _____

2.11 Rated Burden: _____ VA

2.12 Rated short-time current: _____kA for _____ seconds

CLASS PX PROTECTION CURRENT TRANSFORMERS

2.20 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere.

2.21 Rated turns ratio: _____

2.22 Rated knee point e.m.f: _____V

2.23 Maximum secondary winding resistance: _____ Ohms at _____ ° C

2.24 Rated short-time current: _____kA for _____ seconds

END

RAIL NETWORK
TECHNICAL SPECIFICATION
FENCING & STERILE ZONES

Authors:	Engineering Team		
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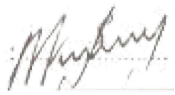
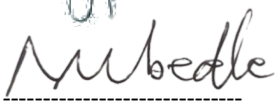
Reviewed	Technical Manager Security	Lerothodi Moramang	
Approved	Technology Management Electrical	Sguda Sibande	
Approved	Rail Network Bridges & Structures	Nkululeko Mbedle	

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TABLE OF ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
DC	Direct Current
℃	Degrees Celsius
IEC	International Electrotechnical Commission
SANS	South African National Standards
BS	British Standards
PVC	Polyvinyl Chloride
V	Volt
kV	kiloVolt
HV Yard	High Voltage Yard

Summary of Revisions

Rev.	Section	Description	Date
00	All	Original Document	23 April 2021
01	4,5,6,7,10,13	Revision of technical elements including: dimensions, construction standards, supplied material/components, earth resistance testing. Clauses have been put in, where applicable, that deviations to specified dimensions, standards, services and supply of material be subject to the approval of the Project Manager.	02 September 2021

1.0 SCOPE

1.1 This specification covers Transnet Freight Rail's requirements for both the removal of existing fencing and the supply, installation, testing and commissioning of the novel Fencing and Sterile Zones security approach at all Traction Substations (3kV DC, 25 & 50 kV AC) and Distribution Substations (6.6 & 11 kV AC), High Sites and Relay Rooms in commission under Transnet Freight Rail and Real Estate Management.

2.0 SPECIFICATIONS AND STANDARDS

2.1 All material, equipment and work shall be done in accordance with Transnet Freight Rail's specifications, drawings and relevant SANS standards. Any reference made to specifications and standards shall mean the latest publications or edition to these documents which might have superseded earlier standards.

2.2 There may be specific requirements in addition to the generic specifications that shall be taken into consideration by the Contractor(s) and/or various equipment designers and manufacturers. It is therefore just as important to read this particular specification, together with the generic specifications listed below.

2.2.1 SOUTH AFRICAN NATIONAL STANDARDS:

SANS 1063	Earth rods, couplers and connections.
SANS 1507-1-3	Electric cables with extruded solid dielectric insulation for fixed installations
SANS 2063	Thermal spraying – Metallic and other inorganic coatings – Zinc, aluminium and their alloys.
SANS 10199	The design and installation of earth electrodes.
SANS 121	Galvanising of steel
SANS 10222-3	Electrical security installations Part3: Electrical security installations and Electric fences (non-lethal) and manufactures requirements
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles
SANS 3575	Continuous hot-dip zinc-coated carbon steel sheet of commercial and drawing qualities
SANS 4998	Continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of structural quality
SANS 60335-2-76	Particular requirements for electric fence energizers
National Railway Safety Regulator Act 2002	Regulations regarding infrastructure or activity affecting Safe Railway Operations - 2020

2.2.2 Transnet Freight Rail:

Whenever "Transnet", "Transnet Freight Rail" or "S.A. Transport Services" is used in the generic specifications, it should be read as "the Employer", and wherever "Engineer" or similar

terminology is used, it should be read as “the Engineering Manager”. The employer here is Transnet. The designs are based on the Transnet specifications. The information and/or requirements as stated in Transnet’s specifications shall be considered as the minimum requirements for equipment to be offered. The Contractor may use the specifications as a guidance and offer material and equipment that comply with the latest technology. The Contractor shall provide details indicating how the equipment offered differs from what was specified and obtain Transnet’s approval. Contractor will be liable for any delays due to approval process.

1	BBB0041	Preparation of drawings for Transnet Freight Rail infrastructure.
2	CEE.0023.2012:	Specification for installation of cables.
3	BBC0198	Requirements for the supply of cables.
4	CEE.0045.2014/1:	Painting of steel components of electrical equipment.
5	CEE.0224.2002:	Drawings, catalogues, instruction manuals and spares lists for electrical equipment supplied under contract.
6	S420	Specification for concrete work.
7	BBF3690	Electrical Safety Instructions
8	BBC1678	Bonding specification for 3kV DC Traction Systems.
9	BBB2007	Environmental guidelines and specifications for electrical construction work.
10	BBF2283	Fall protection and rescue equipment specifications.
11	E7/2	Agreement to work on, over, under or adjacent to railway lines and near high voltage equipment
12	CEE-0059	Earthing and Bonding DC Electrification
13	BBC5989	Steel palisade and Electric fencing
14	BBB3620	3 kV DC earthing arrangement system for high voltage outdoor yards.
15	CEE.0177	Code of practice for Earth systems for electric light and power and traction installations.
16	CEE-TBD-7	Spark gaps and rail earth switch drawing
17	S310	Painting of steel structures
18	BBB3235	Installation of earthing and lightning protection of electronic measurement equipment housing
19	CSE-1154-001-CAT E48	Physical characteristics of the Railway Environment in South Africa

2.3 Occupational Health and Safety Act No. 85 of 1993 (Available at for depot for referral)

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

3.0 SERVICE CONDITIONS

3.1.1 ATMOSPHERIC CONDITIONS

All work relating to the following conditions: Altitude, Ambient temperature, Relative humidity, Lightning Conditions and Pollution shall comply with Transnet's environmental specification *CSE-1154-001-CAT E48*.

4.0 FENCING AND GATE DESIGN

4.1 TECHNICAL REQUIREMENTS

4.1.1 The installation of fencing and sterile zones in all operational assets shall be in accordance with BBC5989.

4.1.2 Concrete foundations for the fence and the gate (main entrance and pedestrian) posts shall be 300 x 300 x 600 mm. Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

4.1.3 The concrete base at main entrance gates shall have a width of 500 mm a foundation depth of 250 mm.

4.1.4 The concrete base at the pedestrian entrance shall be suitable for safe and unobstructive passage of staff and hand drawn maintenance equipment.

4.1.5 The foundations at all points of fencing shall not protrude above ground level to prevent damming – in addition the foundation level should be in line or below yard level of the substations, relay rooms and high sites.

4.1.6 The strength of all concrete used shall not be less than 21 MPa after 28 days of casting.

4.1.7 The contractor shall arrange for sampling and testing of all concrete used and shall submit all records to a Transnet representative. The method of sampling used shall comply with specification S420. If ready mix concrete is used, the contractor shall submit certificates confirming the strength of the concrete to the Transnet supervisor for approval.

4.1.8 The fence shall be intrusion resistant by means of intrusion detection sensors as per BBH4464 - *CCTV and Intrusion Detection* specification with an overlayed double mesh design.

4.1.9 The double mesh design of the fence shall be of aperture size small enough to exhibit both anti-cut and anti-climb characteristics i.e. aperture size should not be used/leveraged to aid in climbing the fence.

4.1.10 The contractor shall ensure the fence is corrosion resistant with Zinc-Aluminium alloy and PVC powder coating to prevent electrolysis from stray currents.

4.1.11 A double fence is required for sites specified by the Project Manager. Both the outer and inner fence posts shall have a height of 3400 mm. The aforementioned posts these shall be hot dipped galvanised with the galvanising thickness adhering to SANS121 and/or SANS3575, 4998 respectively - depending on the process of galvanising chosen. Any deviation of post dimensions or galvanising approaches will only be allowed subject to approval from the Project Manager.

4.1.12 None of the main posts may be joined by welding in order to comply with the specified height.

4.1.13 The corner posts shall have a 12 mm diameter hole drilled in the centre of the section 300 mm above ground level for earthing purposes. The hole shall be drilled before galvanising. Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

4.1.14 The fence shall have good see-through visibility - so that all equipment within the operational asset is clearly visible.

4.1.15 The welding at each intersection of the fence where required shall not increase the chance of penetrability i.e. fence strength must not be compromised and be as secure as at the continuous mesh panels.

4.1.16 The contractor shall ensure that the fence is surface finished after welding at all points where required.

4.1.17 The fence posts shall be fully integrated with anti-tamper fixings.

4.1.18 To prevent anyone from climbing on top of the fence only two types of fence tops shall be used:

- Flat razor wire coil with barbed wire
- Concertina barbed wire

Substations will, unless otherwise stated by the Project Manager, include the double fencing security approach, with Sterile Zone. Relay Rooms and High sites, unless otherwise stated, will employ the single fence approach.

- The outer fence shall be continuous from the top to the bottom of the panel mesh to prevent any chance of climbing on it with intrusion detection sensors mounted on the inner side of the fence.
- The inner fence shall be electrified without intrusion detection sensors.
- In the case of single fencing, the fence will not be electrified but have intrusion detection sensors.

4.1.19 The contractor shall supply and install 4.6 m wide x 3.4 m height lockable (mechanical lock with digital unlock code) gates in the perimeter fence to allow for:

- Entrance to operational asset building and/or yard.
- Entrance to the high voltage outdoor yard adjacent to the main transformer(s).
- In the case of a double unit substation - six gates shall be installed.
- In the case of a single unit substation - four gates shall be installed.
- In the case of a relay room and high site - one gate shall be installed.

Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

4.1.20 Where access to the HV outdoor yard is possible between the substation building and perimeter fence, a fence the same height as the perimeter fence shall be installed. A 1000 mm wide lockable gate (mechanical lock with digital unlock code) shall form part of the fence.

4.1.21 Provision shall be made for, with installation of, spark gaps and rail earth switches on the HV yard gate. Refer to drawings *CEE-TBD-7* and *BBB3620*.

4.1.22 Warning notices and danger signs shall be in accordance with *BBD5450* and be fitted to the perimeter fencing and gates.

5.0 STERILE ZONE

In order to provide an effective and clear line of sight for surveillance of the perimeter of the operational asset it is important to keep the area as sterile as possible, and for the sterile zone to be effective it is necessary for it to be connected to the earth mat. The width of the sterile zone will be 1 m spaced between the outer and inner fence with length specific to the dimension of the specific operational asset on all four sides.

5.1 STERILE ZONE PREPARATION

5.1.1 Clearing of 250 mm depth of soil.

5.1.2 Carting away of all debris and waste.

5.1.3 Spray the prepared soil with appropriate chemical (this chemical must be harmful to the environment and must be approved by Transnet Horticulture specialists) to prevent any future debris and vegetation growth in accordance with Transnet environmental pollution specification.

5.1.4 Placing of geotextile on the soil - the geotextile shall be able to sufficiently drain water so that no pond forms when it rains.

5.1.5 Spreading of the appropriate industrial grade carbon compound to a thickness of 120 mm across the placed geotextile – this is to create lower resistance paths for earth fault currents.

5.1.6 Crowfoot Earth with Theft Deterrent Rail:

- 25 mm x 3 mm copper bar
- 5 m long jointed to a 2m tail of 25 mm x 3 mm copper plus 2 m of 50 mm^2 clear insulated composite cable with stainless steel termination lug.
- All joints are to be exothermically welded. Where welding is carried out on galvanised surfaces of the support steel structures, the galvanising shall be removed and the surface cleaned. After completion of the exothermic weld, the surface area on the support steel structure where the galvanising was removed shall be treated in accordance with the requirements of SANS 2063.
- Exothermic joints shall be hammer tested on recommendation of the manufacturer to ensure that the mechanical strength of the joints are adequate. The exothermic weld is to be tapped by a hammer depending on the sound it will be determined whether the joints are solid or if there are voids in the joint.
- Where two earthing conductors run parallel to each other, exothermic parallel joints shall be installed every 1.5 metres on all straight sections between these conductors.

Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

5.2 SOIL CONDITION

Desired lower earth resistance enhancement methods shall be used by the contractor where necessary to obtain the desired value of 5 Ohms or less as specified in BBF8190 section 14.6.1, the contractor shall measure the earth resistance before and after completion of the specified work. The report with test results will require approval by the designated Senior Engineer from Technology Management.

6.0 EARTHING

6.1 TECHNICAL EARTHING REQUIREMENTS

6.1.1 Before any work commences at any site, an earth resistance test shall be carried out. If the test reveals that the earthing is compliant as per Transnet earthing requirements, the Contractor is to ensure that the site is still earthing compliant after work is completed, this may involve the Contractor having to perform additional earthing works at their own cost. If the earth resistance test before work commences reveals that the site is not earthing compliant as per Transnet earthing standard, the Contractor is to include earthing works as part of their billable scope of work.

6.1.2 The design and installation of Transnet Freight Rail's earth mat system shall be in accordance with Transnet Freight Rail's drawings *CEE-TBD-7* and *BBB3620* Sheet 1 for areas that is susceptible to theft.

6.1.3 A 5-second fault current duration shall be used for the rating of the earth mat system. The earth down conductors and earth tails shall be able to withstand 6.2 kA for 5 seconds when exothermically welded. The rated AC fault level for 3 kV DC traction substations shall be taken to be 16 kA.

6.1.4 Deviation of the design shall be submitted to the project manager for approval before commencing with work.

6.2 EARTHING MATERIALS TO BE USED

6.2.1 Copper rods of 70 mm^2 shall be used for earth electrodes in accordance to SANS 1063. For areas susceptible to theft (as identified by Transnet Freight Rail, alternate electrodes shall be considered for approval by Technology Management responsible Senior Engineer) a copper equivalent rod of at least 70 mm^2 can be used.

The length of the rods will be dependent on the application:

- Earth electrodes (earth spikes). Minimum length of 1.5 meters shall be used.

- Down conductors, earth tails and interconnecting conductors. Rods of varying lengths may be used.

6.2.2 The minimum size of conductor used for the earthing system shall be 95 mm^2 copper. For areas susceptible to theft a copper equivalent rod of 95 mm^2 can be used.

6.2.3 For the installation or replacement of the main earth mat/earth electrode a copper conductor of at 16 mm diameter shall be used and shall be buried at 1.5 m below the ground. The earth mat shall cover an area of at least 1.5 m^2.

6.2.4 The earth mat shall be provided with a test point connection for test purposes. This test point shall protrude 100 mm above ground level and shall be protected by means of a metal pipe or metal housing.

6.2.5 The location of the earth mat/earth spike shall be as close as possible to the main surge arresters support structures.

Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

6.3 INSTALLATION OF EARTHING SYSTEM

6.3.1 Before any trenching commences the contractor shall consult with Transnet Freight Rail (Depot Engineering Manager) for approval with regard to the routing of the trenches in the outdoor yard.

6.3.2 Trenching done shall include all trenches required for the installation of the earthing system according to *BBD3620*.

6.3.3 The perimeter fence trenching shall be as close as possible to the perimeter fence on the inside of the HV yard.

6.3.4 The depth of trenches shall be 600 mm. Care shall be taken not to damage existing cables in the high voltage outdoor yard during trenching operations, any damage shall be repaired and/or replaced, where applicable, at the expense of the contractor. Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

6.3.5 Before the trenches are closed a representative from Transnet Freight Rail (Technical office and Technology Management) shall inspect the earthing system for correct installation procedure.

6.4 EARTHING INSTALLATION PROCEDURE

6.4.1 Earth electrodes shall be driven into the ground in the perimeter fence trench at the corners of the outdoor yard and in between the corners.

6.4.2 In the case of double unit substations, the number of earth electrodes between the corner electrodes shall be determined in consultation with Transnet Freight Rail (Technology Management).

6.4.3 The depth of the earth electrodes driven into the ground shall be such that the top of the earth electrode shall be at least 700 mm below the surface of the ground.

6.4.4 The earthing of the support steel structures for the surge arresters, AC disconnects, voltage transformers (where installed) and current transformers shall be in accordance with Transnet Freight Rail's drawing BBB 3620.

6.4.5 The surge arresters base shall be connected directly to earth mat/spike.

6.4.6 Where surge arresters are fitted on the main transformer provision shall be made to install an earth electrode in close proximity to the transformer. The earth electrode shall be connected directly to the earth system as shown in drawing BBB3620.

6.4.7 All underground connections which include connections to the earth electrodes, the joints in the copper plated steel rods, connections to the perimeter fence posts, support steel structures and the connection to the new or existing earth mat shall be exothermically welded or crimped by means of tinned lugs or by means of brass clamping system.

6.4.8 Where exothermic welding cannot be carried out, galvanised or stainless steel grade S304 studs, nuts, tinned cable lugs and any other approved means may be used for the termination of the earthing conductors to the fence posts, surge arresters down leads, metal structure and other electrical equipment.

6.4.9 Exothermically welded joints and steel components exposed to corrosion shall be sealed with a durable waterproofing compound i.e. Bitumen, Denso tape or Noxide.

6.4.10 All crimped connections that are above ground level shall be filled with an anti-corrosive compound.

6.4.11 Where the exothermic welding is carried out on galvanised surfaces of the support steel structures, the galvanising shall be removed and the surface cleaned. After completion of the exothermic weld, the surface area on the support steel structure where the galvanising was removed shall be treated in accordance with the requirements of SANS 2063.

6.4.12 Exothermic joints shall be hammer tested on recommendation of the manufacturer to ensure that the mechanical strength of the joints are adequate. The exothermic weld is to be tapped by a hammer depending on the sound it will be determined whether the joints are solid or if there are voids in the joint.

6.4.13 Where two earthing conductors run parallel to each other, exothermic parallel joints shall be installed every 1.5 m on all straight sections between these conductors.

6.4.14 The contractor shall remove the necessary crusher stone before any excavation commences.

6.4.15 The contractor shall restore the crusher stone of size 25 mm to its original condition once the installation work has been completed.

6.4.16 The contractor shall supply any additional crusher stone required to restore the trenched areas to a depth of 150 mm.

Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

7.0 INSTALLATION OF ELECTRIC FENCE

All material the supplier will use for erecting the electric fence must comply with SANS 10222-3.

7.1 ELECTRICAL FENCE WIRE

7.1.1 A solid wire must be used in order to ensure no additional conducting filament is required for increasing current carrying capacity.

7.1.2 When joining wire ends crimp ferrules of the same material composition as the wire must be used to eliminate any electrolytic effect which can lead to corrosion and eventually breaking the wire, this will also ensure there is no communication interference.

7.1.3 The maximum distance between wires on the bracket must be 100 mm.

7.1.4 Strain brackets must be adequately stayed.

7.1.5 Barbed or razor wire may not be electrified either with an energizer or any other power source.

Any deviation from these dimensions will only be allowed subject to approval from the Project Manager.

7.2 ENERGIZER

7.2.1 The energizer shall be installed in a dry, dust free environment.

7.2.2 As required by the Act, the energizer must comply with SANS 603335-2-76 and the supplier of the product must be able to produce a certificate issued by an internationally recognized laboratory to verify this.

7.2.3 The energizer shall be powered by 220 V – 240 V mains.

7.2.4 The energizer shall have a minimum energy output of 500 Ohms with a load of 7 Joule.

7.2.5 The minimum open circuit voltage shall be 9 kV.

7.2.6 A lightning arrestor shall be attached as close to the connection from the energizer and the electric fence as possible, two arrestors shall be used one on the out-put wire and one on the return wire.

Any deviation from these power ratings will only be allowed subject to approval from the Project Manager.

8 MATERIAL AND EQUIPMENT

8.1 The Contractor shall supply all the material and equipment necessary to complete the work subject to Transnet approval.

8.2 All material and equipment supplied and utilized during the installation, testing and commissioning shall comply with the Occupational Health and Safety Act with its regulations (Act 85 of 1993).

8.3 All material specifications are covered in the assembly drawings, component drawings and generic specifications as well as the layout designs.

8.4 All material shall be inspected and certified by Transnet before it can be shipped to site and shall be later inspected and accepted or rejected by the Project Manager or designated Technical Officer(s) of the project.

8.5 The contractor shall inspect all material before it can be sent out for installation. No defective material shall be installed.

8.6 All bonding shall comply with Transnet specification CEE 0059 and BBC1845.

8.7 The bonding layout shall be provided by Transnet.

9 CERTIFICATION OF CONTRACTORS

9.1 Only Contractors who are certified and accredited by the exothermic welding industry shall be used for the installation.

9.2 Only Contractors who are certified according to the Electrical Safety Instructions are permitted to work at Transnet's site.

10 WARRANTY AND DEFECTS

10.1.1 The Contractor shall guarantee the satisfactory operation and lifespan of all works completed and accept liability for defects that may potentially appear in design, materials and workmanship.

10.1.2 The Contractor shall be issued with a completion certificate with the list of all defects to be repaired within 14 working days after commissioning.

10.1.3 The guarantee period for all works shall expire after a period of 36 months commencing on the date of completion of the contract or the date the work was handed over to Transnet Freight Rail.

10.1.4 Any defects that may become apparent during the guarantee period shall be rectified to the satisfaction of Transnet Freight Rail, and to the account of the Contractor.

10.1.5 The Contractor shall undertake work on the rectification of any defects that may arise during the guarantee period within 7 days of being notified by Transnet Freight Rail of such defects.

10.1.6 Should the Contractor fail to comply with the requirements stipulated above, Transnet Freight Rail shall be entitled to undertake the necessary repair work or effect replacement of defective apparatus or materials, and the Contractor shall reimburse Transnet Freight Rail the total cost of such repair or replacements, including the labour costs incurred in replacing defective material.

10.1.7 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 e.g., faulty locomotive or overhead track equipment, etc. shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the Project Manager or Supervisor and at the cost of the Contractor.

10.1.8 If urgent repairs have to be carried out by Transnet Freight Rail staff to maintain supply during the guarantee period, the Contractor 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 COMMISSIONING

11.1.1 Commissioning will only take place after all defects have been rectified to the satisfaction of the Senior Responsible Engineer (Technology Management/Technical Office).

11.1.2 On completion of commissioning, the Contractor will hand the equipment over to the relevant Transnet Manager.

11.1.3 The commissioning of protection equipment by Transnet Freight Rail will in no way absolve the Contractor from any responsibilities during the guarantee period.

11.1.4 It is the Contractor's responsibility to satisfy themself that the commissioning of the protection equipment has been carried out in a satisfactory manner, and in no way compromises the proper operation of the equipment supplied in terms of the contract.

11.1.5 The Contractor shall be present during the testing and setting of the protection to rectify any faults found.

12 GENERAL REQUIREMENTS

12.1.1 The Contractor shall provide the suppliers and/or manufacturers of their material and equipment with a copy of the equipment specification to ensure compliance.

12.1.2 The Contractor may offer quality product from any manufacturer based in any Country of the world, as long as the product complies with the requirements of the relevant equipment specification. The product will have to be approved by Transnet before it can be purchased and used in Transnet property. Contractor will be liable for any delays due to approval process.

12.1.3 The Contractor shall supply and install all material needed to complete the work, which shall be according to Transnet drawings, specifications, SABS and SANS.

13 DEMOLITION AND TRANSPORT OF MATERIAL

13.1.1 The contractor shall dismantle and stock pile all old fencing equipment at the identified areas. The areas will be identified and indicated to the contractor by Transnet's Environmental Officer or Technical Officer for the project.

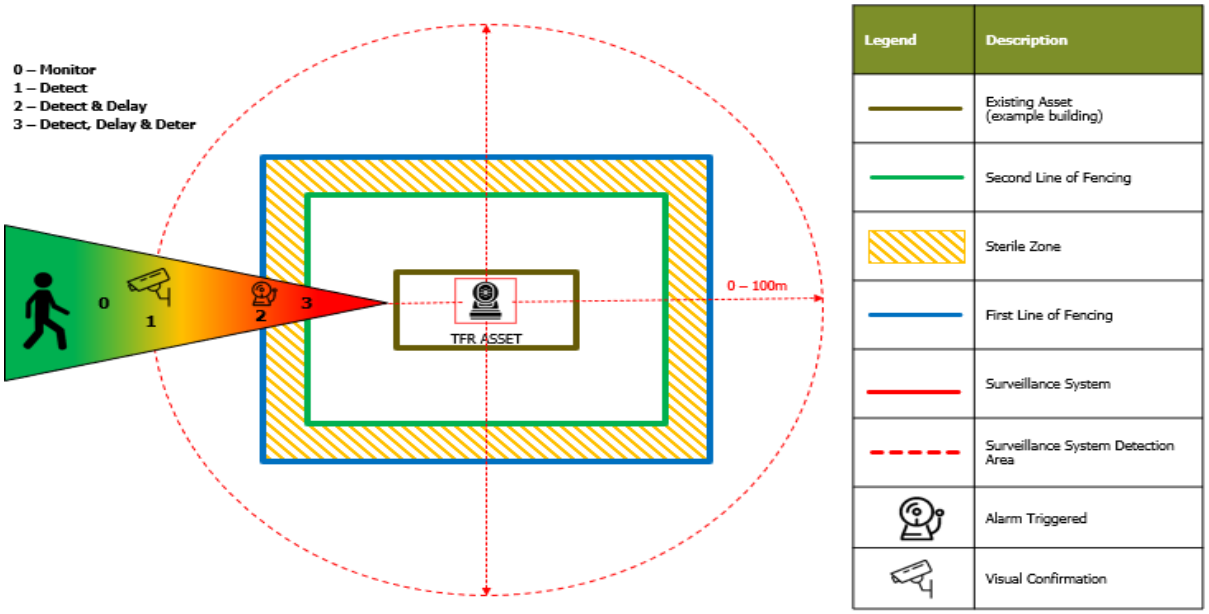
13.2 The stock piling area shall be within Transnet reserved land.

13.2.1 The Contractor shall demolish and dispose of the existing fencing and equipment, where applicable.

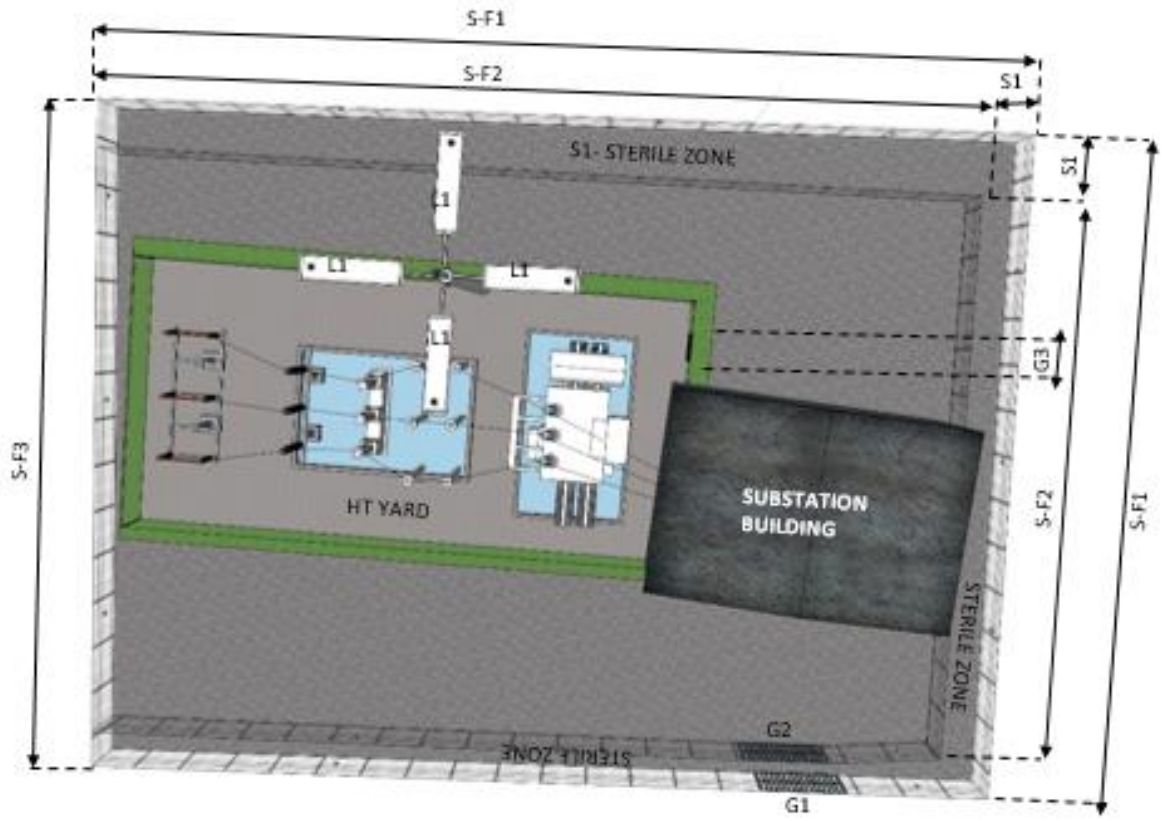
14 APPENDIX

ANNEXURE 1

Overall Security Approach



Electrical Substation


S-F1
S-F2
S1
S1- STERILE ZONE
S1
L1
L1
L1
L1
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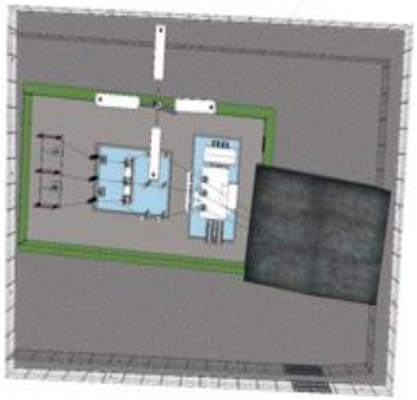
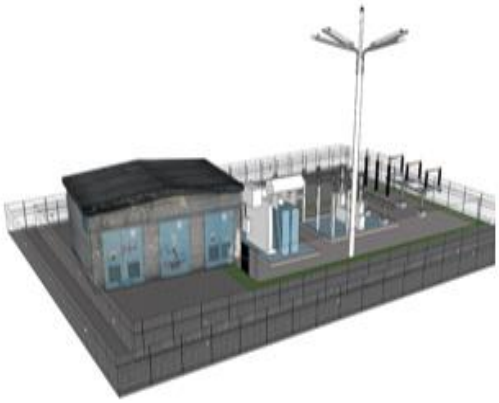
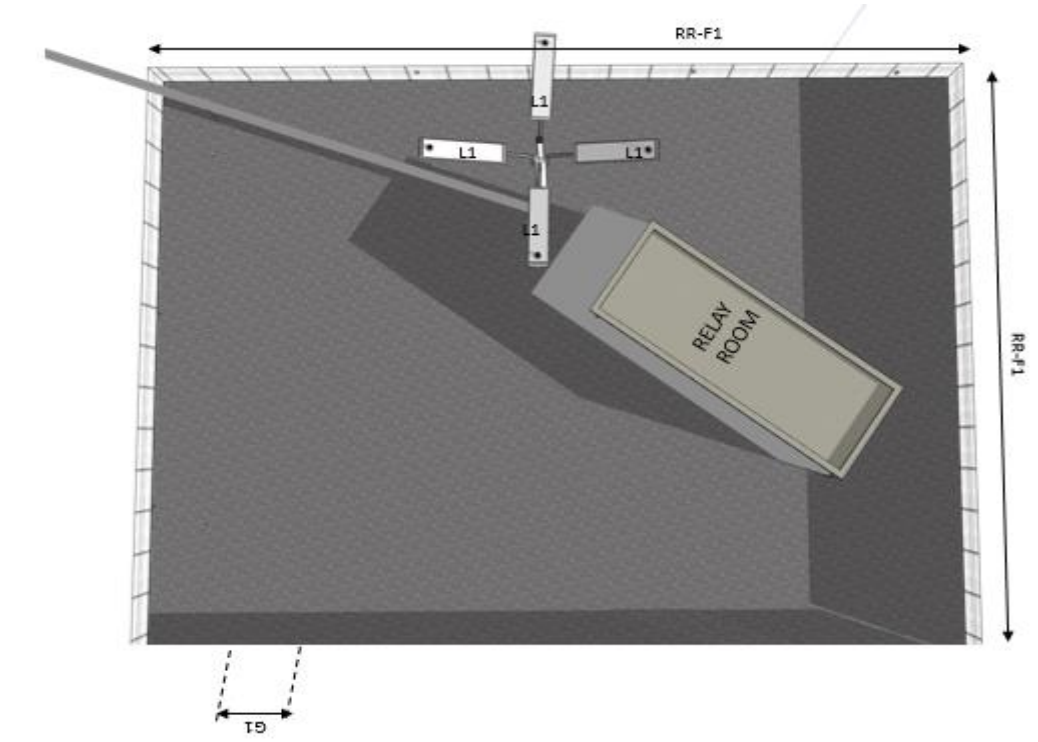
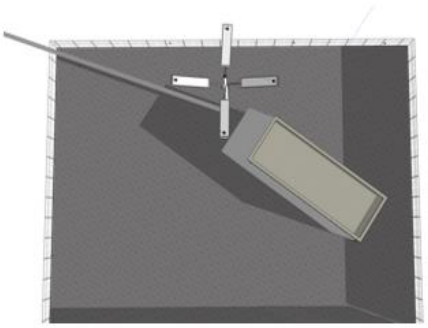
S-F3
HT YARD
SUBSTATION
BUILDING
S-F2
S-F1
STERILE ZONE
STERILE ZONE
G2
G1

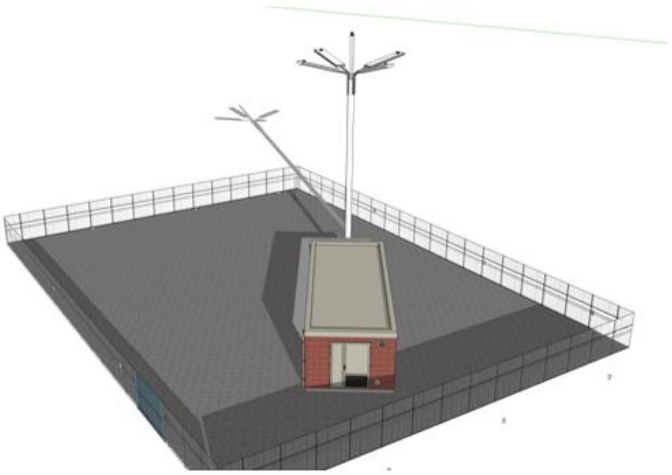




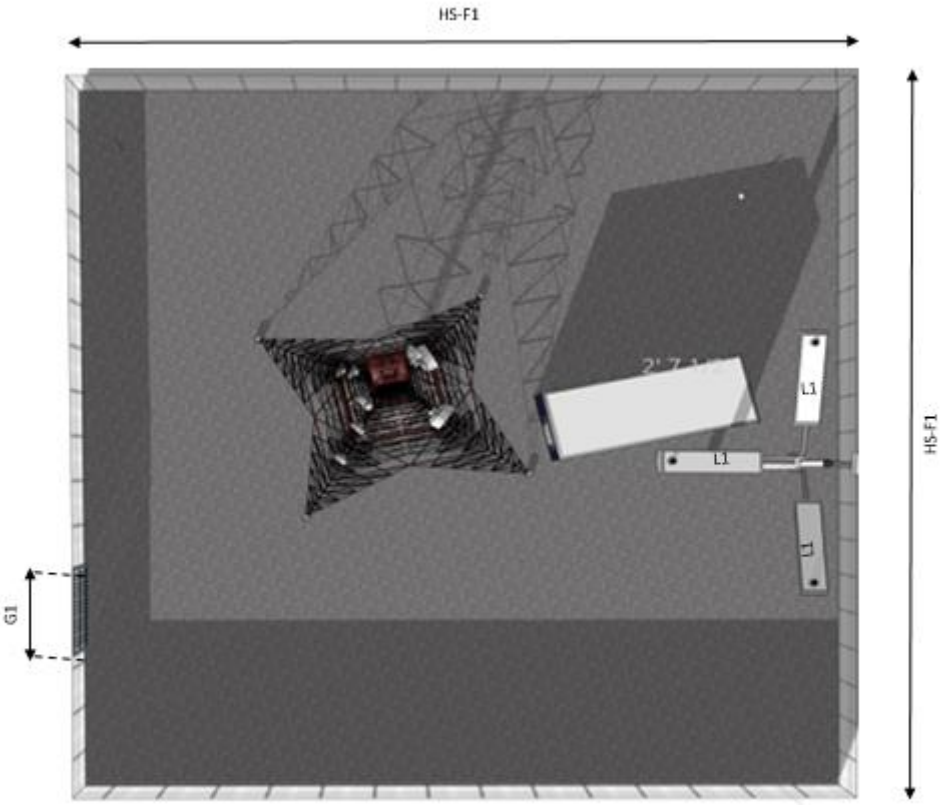
Signalling Relay Room







Telecommunication High Site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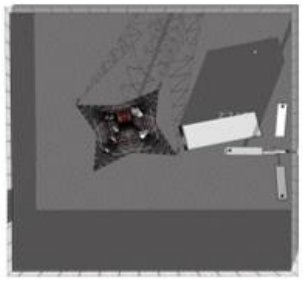

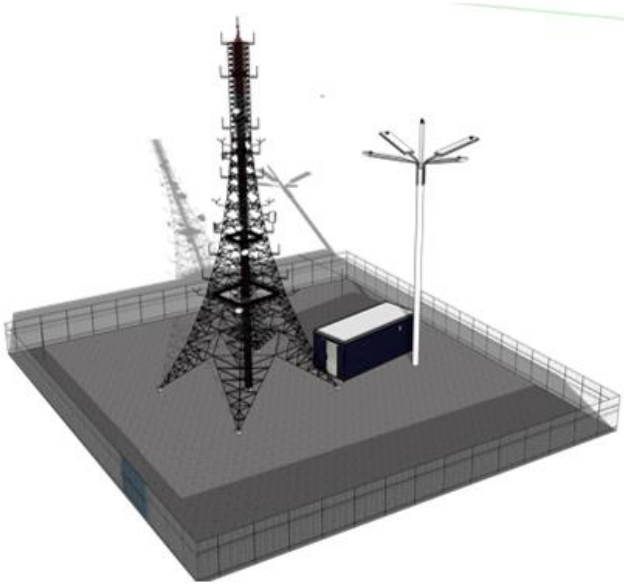

TRANSNET
freight rail

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

3kV DC UNDER VOLTAGE RELAY MANUFACTURING SPECIFICATION

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Circulation Restricted To:

Transnet Freight Rail - Rail Network
- Technology Management

CONTENT

1.0 SCOPE

This specification provides Transnet Freight Rail's requirements for the manufacturing of the 3kV DC Under voltage relay utilising optic fibre.

2.0 BACKGROUND

The 3kV DC under voltage relays are installed at Transnet Freight Rail's 3kV DC traction substations and tie-stations. The purpose of the relay is to clear faults which occur whilst the feeding network is crippled. The relay is set to operate at the highest voltage (i.e. smallest volt-drop) that can occur under crippling conditions with a fault in the section.

The under voltage relay trips the 3kV DC track breakers when the 3kV DC busbar voltage drops below the set value. This optic fibre relay is an alternative to the existing switching under voltage relay and other models of relays fitted in the 3kV DC traction substations throughout Transnet Freight Rail.

Spare parts for the switching under voltage relays and other models are difficult to obtain and are costly. The optic fire under voltage relay is constructed from components, which can be locally sourced.

3.0 STANDARDS AND PUBLICATIONS

Unless otherwise specified all materials and equipment shall comply with the current edition of the relevant SANS or Transnet Freight Rail publication where applicable.

3.1 SOUTH AFRICAN NATIONAL STANDARDS

SANS 1091:	National Colour Standards
SANS 1274:	Coatings applied by the Powder Coating Process

3.2 TRANSNET FREIGHT RAIL DRAWINGS

CEE- TBD-7:	3kV DC earthing arrangement system for traction substations.

4.0 APPENDICES

The following appendix from an integral part of this specification,

Appendix 1:	Circuit and manufacturing drawings

5.0 TENDERING PROCEDURE

5.1 Tenderers shall indicate clause by clause compliance with the specifications. 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 and it shall be written in English.

5.2 A statement of non-compliance shall be motivated by the tenderer.

5.3 Tenderers shall submit descriptive literature consisting of detailed technical specifications, general constructional details and principal dimensions, together with clear illustrations of the equipment offered.

5.4 Failure to comply with clauses 5.1, 5.2 and 5.3 could preclude a tender from consideration.

6.0 SERVICE CONDITIONS

The equipment shall be designed and rated for operation under the following service conditions.

6.1 ENVIRONMENTAL

6.1.1	Altitude:	0 - 1800m above sea level.
6.1.2	Ambient temperature range:	- 5°C to +55°C.
6.1.3	Relative humidity:	10% to 90%.
6.1.4	Lighting conditions:	19 flashes/km²/annum
6.1.5	Pollution:	Heavily salt laden or polluted with smoke from industries sources

6.2 ELECTRICAL SERVICE CONDITIONS

6.2.1	Nominal 3 kV DC busbar voltage:	3150 volts DC
6.2.2	Variable 3 kV DC busbar voltage:	2100V DC – 4000V DC

6.3 MECHANICAL SERVICE CONDITIONS

6.3.1	Vibration:	Vibration can be expected as the Substations are next to the railway lines.

7.0 GENERAL REQUIREMENTS

7.1 Equipment supplied shall be in terms of this specification. Deviations from this specification will not be allowed without written consent of Transnet Freight Rail's Traction Power Supply Technology staff.

7.2 Transnet Freight Rail reserves the right to subject equipment offered to test or inspection to check compliance with clauses of this specification.

7.3 The onus to prove compliance with the manufacturing specification shall rest with the successful tenderer once the manufacturing contract has been awarded.

7.4 The successful tenderer will be responsible for all costs caused by modifying or replacing equipment accepted by Transnet Freight Rail on the grounds of his statement of compliance and found by Transnet Freight Rail not to comply.

8.0 TECHNICAL AND MANUFACTURING REQUIREMENTS

8.1 DESCRIPTION OF THE UNDERVOLTAGE RELAY

8.1.1 The main components of the 3kV DC under-voltage relay are as follows:

- 3kV Voltage divider.
- Optic fibre transmitter.
- Optic fibre receiver.
- Control circuit.

8.2 3kV VOLTAGE DIVIDER

8.2.1 The voltage divider shall consist of 9x22 kΩ, 50 watt and 3x8,2 kΩ, 50 watt aluminium housed resistors in series as shown in circuit diagram BBB2932.

8.2.2 A 3 Ampere 3.3 kV, minimum 5kA rated fuse shall be provided and connected on the 3 kV positive input side in series with the resistors as shown in circuit diagram BBB2932.

8.2.3 The resistors shall be arranged on a Celeron plate, which shall be fitted with stand off insulators for mounting on the wall in the busbar chamber. These insulators must provide a minimum allowable clearance of 100mm for 3kV potential.

8.2.4 If encapsulated voltage dividers are offered the successful tenderer shall supply Transnet Freight Rail Electrical samples for inspection and acceptance.

8.2.5 The encapsulated voltage divider shall consist of the same amount of resistors and the ohms values as the above divider.

8.2.6 Carbon resistors are not acceptable, as they are extremely temperature sensitive. Only high quality resistors such as metal oxide or vitreous enamel resistors may be used for the encapsulated voltage divider.

8.2.7 Suitable studs minimum 6mm shall be provided for the positive connection from the potential divider to the under-voltage relay and 10mm stud for the negative return circuit.

8.3 OPTIC FIBRE TRANSMITTER

8.3.1 The circuitry components for the optic fibre transmitter shall be in accordance with circuit diagram, drawing No BBB2930 and printed circuit board layout, drawing No BBB2935. These shall be housed in a high impact plastic /fibre box which is mounted on the 3kV voltage divider board.

8.3.2 The reference voltage of 0 to 400 volts is obtained from the voltage divider and is the operating voltage for the fibre optic transmitter unit.

8.3.2.1 The required reference voltages are obtained and generated from an integrated circuit, IC1 and a 24V Zener diode.

8.3.1 Voltage comparison is carried out by IC2 (LM 741). Pick up and drop out voltages are adjusted with potentiometers P2 and P3, which are multi turn top adjustable potentiometers.

8.3.2 The transmitter is mounted on a high quality fibreglass printed circuit and is populated by resistors (tolerance 2%) and capacitors.

8.3.3 The circuitry is protected by Metal Oxide Varistors (MOV'S).

8.3.4 The output of the optic fibre transmitter is connected to the optic fibre receiver.

8.4 OPTIC FIBER RECEIVER

8.4.1 The optic fibre receiver and control circuits shall be mounted in a metal enclosure with a hinged door to enable ease of maintenance.

8.4.2 The optic fibre printed board shall be manufacture according to circuit diagram BBB2929 and circuit board layout BBB2934.

8.4.3 The optic fibre isolation level for the transmitter and receiver shall not be less than 7 kV.

8.4.4 The operating voltage for the receiver is a 110 V DC voltage obtained from a voltage divider R1 and R2. Activating the optic fibre receiver results in the energising of a relay by means of a transistor on the fibre optic receiver printed circuit board.

8.5 CONTROL CIRCUIT

8.5.1 The control circuitry shall be mounted in same metal enclosure as the optic fibre receiver and shall consist of the components shown in drawing BBB2931.

8.5.2 The front door of the metal enclosure shall be fitted with a red lamp which indicates that the 3kV DC is present and an amber lamp which indicates that a trip has occurred as well as electrically actuates the trip counter which counts the number of trips.

8.5.3 The operating voltage for the control circuit is 110V DC.

8.5.4 The input control signals as well as the output control signals shall be routed to a clearly marked terminal strip.

8.5.5 The internal wiring of the control circuit shall be wired with 1.0 mm^2 stranded copper wire.

8.5.6 The 110V DC shall be protected by a 180V MOV and a 4 Ampere fuse.

8.5.7 If the line voltage is above the pick-up voltage the optic fibre transmitter activates and the optic fibre receiver enables the switching transistor to energise relay 1 (R1) this retains the circuit breaker holding coil when timed contacts open.

8.5.8 If the line voltage drops below the drop out voltage the fibre optic transmission stops and relay 1 is de-energised.

The metal enclosure shall be power coated in accordance with SANS 1274 and the colour of the enclosure shall be light orange to SANS 1091 colour No. B26.

8.5.9 Provision shall be made for cable entry at the bottom of the metal enclosure.

8.5.10 A suitable earthing terminal for a 95mm^2 earth conductor shall be provided on the metal enclosure.

8.6 MODIFICATIONS AND IMPROVEMENTS

8.6.1 If the successful tenderer wishes to submit recommendations for modifications or improvements he shall first contact members of Transnet Freight Rail Technology Management (Electrical) staff who will approve or reject them.

8.6.2 No additions, alterations or modifications shall be accepted unless Transnet Freight Rail (Technology Management - Electrical) staff is in agreement.

8.7 TEST METHOD

For testing of the operation of the under-voltage relay a variable 0 to 400V DC supply is required.

- Inject 140V DC on the input side of the Optic Fibre transmitter and set the Trimpot P1 until a output voltage of 10V (reference voltage) is obtained at pin N06 on the output side of the reference IC1. Connect a temporary Optic Fibre cable between Optic Fibre transmitter and the receiver.
- Supply the under-voltage relay with 110V DC at terminals 1 (positive) and 2 (negative) and inject 250V to the transmitter. Adjust the Trimpot P2 until the under-voltage relay picks up. Reduce the voltage to the transmitter to 240V and adjust The Trimpot P2 until the relay drops out.
- To set the pick-up time, connected a positive 110V DC supply to terminal 7 of the fleeting timer relay and adjust until the require time setting is obtained.

END

APPENDIX 1

CIRCUIT AND MANUFACTURING DRAWINGS

DRAWING No	**TITLE**
BBB2929:	Optic Fibre Receiver Circuit Diagram.
BBB2930:	Optic Fibre Transmitter Circuit Diagram.
BBB2931:	3kV Under-voltage Relay Circuit Diagram.
BBB2932:	Voltage Divider Circuit Diagram.
BBB2934:	Optic Fibre Receiver PC Board and component Layout.
BBB2935:	Optic Fibre Transmitter PC Board and component Layout.
BBB2942:	General arrangement of High Tension Divider Board.

END

TECHNOLOGY MANAGEMENT.

SPECIFICATION.

REQUIREMENTS FOR ISOLATION TRANSFORMERS

Author:	Chief Engineering Technician Technology Management	D.O.Schulz	.....
Approved:	Senior Engineer Technology Management	L.O.Borchard	.....
Authorised:	Principal Engineer Technology Management	W.A.Coetzee	pp.....

Date: 21st September 2009

Circulation Restricted To:

Transnet Freight Rail – Chief Engineer Infrastructure
- Technology Management

1.0 SCOPE

This specification covers Spoornet's requirements for the design, manufacture and supply of 3 phase 400 Volt isolation transformers for use in 3 kV DC traction substations.

2.0 BACKGROUND

Isolation transformers are used in 3 kV DC traction substations to isolate the 3 phase 400 V AC auxiliary supplies fed from external sources other than that from the auxiliary transformer which is fed of the traction transformer.

The isolation of the external sources via the isolation transformer helps to protect these supplies from any 3kV DC, which may feed accidentally into the auxiliary control equipment and circuits due to flashovers.

3.0 STANDARDS AND PUBLICATIONS

3.1 Unless otherwise specified all materials and equipment supplied shall comply with the current edition of the relevant SANS or Spoornet's publication where applicable.

3.2 The following publications are referred to in this specification:

3.2.1 SOUTH AFRICAN NATIONAL STANDARDS

SANS 780:	Distribution transformers.
SANS 1019:	Standard voltages, currents and insulation levels for electricity supply.
SANS 1037:	Standard Transformer Bushings
SANS 61558 -1:	Safety of power transformers, power supply units and similar. Part 1 - General requirements and tests.
SANS 61558 -2-4:	Safety of power transformers, power supply units and similar. Part 2 - General requirements for isolating transformers and general use.
ISO 9000:	Quality Management Systems - Requirements

3.2.2 SPOORNET SPECIFICATIONS

CEE.0224:	Drawings, catalogues, instruction manuals and spares list for electrical equipment supplied under contract.

4.0 TENDERING PROCEDURE.

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.

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

4.3 Tenderers shall submit descriptive literature consisting of detailed technical specifications, general constructional details and principal dimensions, together with clear illustrations of the transformers offered.

4.4 Tenderers shall complete Appendix 2

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.

5.1 ATMOSPHERIC SERVICE CONDITIONS

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 SERVICE CONDITIONS

5.2.1	Frequency:	The frequency of the AC supply will be 50 ± 2.5 Hz.
5.2.2	No of phases:	The supply will be a three phase system.
5.2.3	Supply voltage:	Under normal conditions the system supply voltage shall be maintained at ± 5% of the nominal voltage.

5.3 MECHANICAL CONDITIONS

Isolation transformers are installed at traction substations next to railway lines and will be subjected to vibration.

6.0 TECHNICAL REQUIREMENTS

6.1 GENERAL

The isolation transformers shall be of the oil immersed type or dry type and shall be suitable for indoor use only.

6.2 CONSTRUCTURAL REQUIREMENTS

OIL IMMERSED TRANSFORMER

6.2.1 The design, construction and testing parameters for the oil immersed type isolating transformer shall comply with the requirements of SANS 780.

6.2.2 The transformer shall be of the sealed type with a welded tank cover.

6.2.3 An oil level gauge shall be fitted to the transformer tank.

6.2.4 An earthing terminal suitable for a 95 mm² cable lug shall be welded on the tank.

6.2.5 The transformer shall be provided with a flat under base.

6.2.6 The interior and exterior surfaces of the transformer tank shall be treated and coated for protection against corrosion.

6.2.7 The primary and secondary terminals of the transformer shall be brought out with bushings suitable for cable boxes. The cable boxes shall be provided with a protective cover for the terminals.

6.2.8 The bushings shall be suitably rated and shall comply with requirements of SANS 1037.

DRY TYPE TRANSFORMERS

6.2.9 The design, construction and testing parameters for the dry type isolating transformer shall comply with the requirements of SANS 61558- 1 and SANS 61558 –2-4.

6.2.10 The transformer shall be a stationary / fixed and air cooled (natural) type.

6.2.11 The design of the transformer shall incorporate the following features:

6.2.11.1 It shall not cause any danger to persons when used, installed and maintained.

6.2.11.2 It shall be so constructed and enclosed so that there is adequate protection against accidental contact with live parts.

6.2.11.3 The windings of the transformer may be of the encapsulated or non-encapsulated type.

6.2.11.4 The windings shall be so constructed to prevent any displacement of the input and output windings.

6.2.11.5 The input and output circuits shall be totally insulated each other and from any metal parts on the transformer.

6.2.11.6 Terminals shall be provided for the permanent connection to the external fixed wiring of the input and output circuits.

6.2.11.7 The terminals shall form an integral part of the transformer.

6.2.11.8 Terminal blocks shall be provided with covers and shall not be accessible without the aid of a tool.

6.2.11.9 The accessible metal parts of the transformer shall be provided with an earthing terminal suitable to accommodate a 95 mm² cable lug.

6.2.11.10 The transformer shall have adequate mechanical strength.

6.2.11.11 The transformer shall be provided with a metal enclosure to protect it from external influences i.e. Moisture, corrosion, mechanical damage etc.

6.3 RATINGS

6.3.1 The oil immersed and dry type isolation transformers shall be designed to operate at the following parameters.

6.3.2 The kVA ratings of the transformers can vary from 16kVA to 40kVA

6.3.3 The input supply voltage shall be 400 volts

6.3.4 The output supply voltage shall be 400 volts.

6.3.5 The ratio of the transformers shall be 1:1.

6.3.6 The input winding shall be three phase delta connected and the output winding, star connected with a neutral point.

6.3.7 The vector group of the transformers shall be a Dyn11.

6.3.8 The rating of the transformers shall be as specified in Appendix 1.

6.4 INSULATION LEVELS

6.4.1 The output winding of the isolating transformer can be subjected to 3 kV DC under fault conditions and requires to be insulated to reduce the risk of damage caused by the over voltages.

6.4.2 The insulation between the input winding and the output winding shall be able as to withstand the rated power frequency test of 22kV specified for a system highest voltage of 7,2 kV as specified in SANS 1019.

6.4.3 The output winding shall be insulated between windings and the winding to the metal tank or frame and shall be able as to withstand the rated power frequency test of 22kV specified for a system highest voltage of 7,2 kV as specified in SANS 1019.

6.4.4 The output winding terminals shall be insulated for high voltage.

6.4.5 The transformer shall be able to withstand a test voltage of 22 kV AC as specified in SANS 1019 for applied between the shorted output terminals and the input winding and tank for one minute.

7.0 INSPECTION AND TESTING

7.1 Spoornet reserves the right to carry out inspection and any tests on the equipment at the works of the supplier/ manufacture.

7.2 Arrangements must be made timeously for such inspections to be carried out before delivery of the equipment to the client.

7.3 Routine tests shall be carried out at the supplier's premises and shall be witnessed by Spoornet's Quality Assurance staff.

8.0 DRAWINGS AND MAINTENANCE MANUALS

8.1 3 copies of each of the following drawings shall be submitted to the Project Manager/Engineer for approval within 7 days of the order being placed.

8.2 Dimension drawings showing external and internal arrangements of transformer.

8.3 Diagram and rating plate.

9.0 QUALITY ASSURANCE

9.1 Tenderers must indicate what steps have been taken to implement a Quality Assurance system in terms of the ISO 9000 series of recommendations.

END

APPENDIX 1

SCHEDULE OF REQUIREMENTS
(To be completed by client)

SYSTEM DETAIL

1.0 Transformer required for: _____ substation/location

TRANSFORMER DETAIL

1.0 Rated power: _____KVA

2.0 Impedance %: _____

3.0 Primary voltage rating: _____Volts

4.0 Secondary voltage rating: _____Volts

TRANSFORMER CONSTRUCTION

1.0 Dry type: Yes / No

2.0 Oil cooled type Yes / No

2.0 Oil cooled transformer tank:

- Sealed Unit: Yes / No
- Free Breathing Yes / No

3.0 SPECIAL REQUIREMENTS

1.0 Special requirements: _____

_____

_____

_____

END

INFORMATION TO BE PROVIDED BY TENDERERS

GENERAL

1.0 Manufacturers name_____

TRANSFORMER CONSTRUCTION

1.0 Oil cooled: Yes / No

2.0 Dry type: Yes / No

TRANSFORMER DETAIL

1.0 Primary voltage rating: _____Volts

2.0 Secondary voltage rating: _____Volts

3.0 Rated power: _____kVA

4.0 Impedance %: _____

6.0 Vector group: _____

TANK

1.0 Overall dimensions: Length_____mm. Breadth_____mm. Height_____mm.

2.0 Winding material: HV_____ LV_____

3.0 Mass of core and windings: _____kg

4.0 Oil capacity: _____(Litres)

5.0 Mass of transformer complete with oil: _____kg

6.0 Iron loss (Watts): _____

7.0 Copper loss at full load: _____at_____°C

8.0 Total load losses (Watts): _____at _____°C

9.0 Impedance at full load (%Z): _____

10.0 Reactance (% X): _____;

11.0 Regulation at full load at: 1.0 PF _____Percent, 0.8 PF _____ Percent at _____°C

12.0 Efficiency at full load at: 1.0 PF _____Percent, 0.8 PF _____Percent at _____ °C

13.0 Temperature rise at rated voltage and power of:

Windings: _____°C

Top oil: _____°C

END

TRANSNET
freight rail

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

REQUIREMENT FOR THE SUPPLY OF BATTERIES FOR 3 kV DC TRACTION SUBSTATION

Author:	Engineer Technology Management	C Babunandan	C. Babunandan
Authorised	Principal Engineer Technology Management	S.E Sibande	
Date:		17 July 2020	

Circulation restricted to:

Transnet and Relevant Third Parties

Revision No.	Date Issued	Clause No.	Page No.	Remarks
1	08/11/2019			Original Edition
2	17/07/2020	1	4	Amended Scope
		2	4	Added background
		3	4	Additional/amended normative references
		4	5	Added mechanical and electrical conditions
		5	5	Updated to technical requirements
		5.1	5	General requirements for 2 battery types
		5.2	6	Vented lead-acid batteries
		5.3	6	Valve-regulated lead-acid batteries
		6	6	Testing and inspection
		10	7	Packaging, storing and handling

TABLE OF CONTENT

1.0 SCOPE

1.1 This specification details Transnet's requirements for the supply of stationary Plantè vented lead-acid batteries or Gel valve-regulated lead-acid batteries.

1.2 This specification contains schedule of requirements (Appendix A) which shall be completed by the relevant Transnet Representative.

1.3 This specification contains technical datasheet (Annexure B) which shall be completed by the supplier and must be submitted as part of the tender documents.

2.0 BACKGROUND

Batteries are used in 3 kV DC traction substations for the following purposes:

- Tripping and closing of primary circuit breakers.
- Supply to protection relays.
- Closing and holding coil supply to DC high speed circuit breakers.
- 110 V DC supply to control panel.

Currently, Plantè Lead-Acid batteries are used in 3 kV DC traction substations for the supply to protection and control equipment when there is a loss of the auxiliary power supply. However, due to the maintenance intensive nature of this battery type, newer battery types have been investigated to replace Plantè Lead-Acid batteries.

One of the battery types investigated and approved includes Gel valve-regulated lead-acid batteries that were piloted in Bon Accord 3 kV DC traction substation for performance testing. This specification serves as a temporary solution aimed at allowing for the procurement of either Plantè vented or Gel valve-regulated lead-acid batteries, based on the depot requirements, while other technologies are being tested.

3.0 NORMATIVE REFERENCES

Unless otherwise specified all materials used and equipment developed and supplied shall comply with the current edition of the relevant South African National Standards (SANS) or Transnet publications where applicable.

The following publications/specifications (latest editions) are referred to herein:

3.1 SOUTH AFRICAN NATIONAL STANDARDS (SANS)

SANS 9001	Quality Management systems.
SANS 60896-11	Stationary lead-acid batteries. Part 11: Vented types - General requirements and methods of test
SANS 6089-21	Stationary lead-acid batteries Part 21: Valve regulated types - Methods of test
SANS 60896-22	Stationary lead-acid batteries Part 22: Valve regulated types – Requirements
SANS 61056-1	General purpose lead-acid batteries (valve-regulated types) Part 1: General
SANS 61429	Marking of secondary cells and batteries with the international recycling symbol ISO 7000-1135

3.2 TRANSNET SPECIFICATIONS

BBB 2502	Requirements for battery chargers for 3kV DC traction substations.

4.0 SERVICE CONDITIONS

4.1 ENVIRONMENTAL CONDITIONS

Altitude:	0 - 1800 m above sea level
Relative humidity:	10% to 90%
Ambient temperature:	-10° C to +55° C

4.2 MECHANICAL CONDITIONS

4.2.1 The batteries shall be designed to withstand all mechanical stresses, vibrations and shocks occurring in normal transportation, handling and use in accordance with clause 4 of SANS 60896- 11.

4.3 ELECTRICAL CONDITIONS

4.3.1 Batteries shall be connected to the battery charger with a 110 V DC supply with voltage regulation in accordance with clause 7.4.1 of BBB 2502.

4.3.1.1 All battery components, connectors and terminals shall be designed for current rates as specified in SANS 61056-1.

5.0 TECHNICAL REQUIREMENTS

5.1 GENERAL

5.1.1 The battery types allowed in 3 kV DC traction substations shall be limited to Plantè vented lead-acid batteries or Gel valve-regulated lead-acid batteries.

5.1.2 The batteries procured shall be rechargeable and compatible with the battery charger specified in BBB 2502 for 3 kV DC traction substations.

5.1.3 The battery type and capacity required shall be specified by TFR in Appendix A.

5.1.4 Each battery set shall comprise of a series connection of 55 cells or equivalent, depending on the nominal voltage per cell to supply the nominal output voltage range of 110 V DC.

5.1.5 The recommended nominal voltage per cell is 2 V DC, to allow for 5.1.6.

5.1.6 All intercell connectors shall accommodate for higher operating temperature conditions resulting from high rate discharge as per clause 6.10 of SANS 60896-22.

5.1.7 The covers and containers used for individual cells shall be spill-proof.

5.2 VENTED LEAD ACID BATTERIES

5.2.1 The vented type battery technology for 3 kV DC traction substations shall be Plantè Lead-Acid batteries.

5.2.2 The allowable rated capacity of these batteries shall range between 100-150 Ah, as per schedule of requirements and manufacture’s design.

5.2.3 The nominal output voltage for the batteries shall be 110 V DC

5.2.4 Each cell shall be equipped with markings or a device that indicates the minimum and maximum electrolyte levels in accordance with clause 5 of SANS 60896-11.

5.2.5 The battery shall be capable of delivering minimum of 10 A for 10 hours, as defined in clause 7 of SANS 60896-11, with corresponding final voltage and discharge current values per cell.

5.2.6 The batteries shall be designed to operate under float conditions in accordance with clause 8 of SANS 60896-11.

5.3 **VALVE-REGULATED GEL LEAD-ACID BATTERIES**

5.3.1 The valve-regulated type battery technology for 3 kV DC traction substations shall be Gel Lead-Acid batteries.

5.3.2 The allowable rated capacity of these batteries shall range between 100-200 Ah, as per the schedule of requirements and manufacture's design.

5.3.3 The nominal output voltage for the batteries shall be110 V DC.

5.3.4 The batteries shall be designed to operate under floating batteries conditions defined in clause 3.7 of SANS 60896-22.

5.3.5 All functional requirements including safe operation, performance and durability of valve-regulated batteries shall comply with clause 4 of SANS 60896-22.

6.0 TESTING AND INSPECTIONS

6.1 Any additional, relevant sample tests or visual examinations may be agreed upon by the supplier and the Transnet Freight Rail, Technology Management (Electrical Technology) department representative in accordance to clause 14 to clause 20 of SANS 60896-11 for Plantè lead-acid batteries.

6.2 Any additional, relevant sample tests or visual examinations may be agreed upon by the supplier and the Transnet Freight Rail, Technology Management (Electrical Technology) department representative in accordance to SANS 60896-21 for Gel lead-acid batteries.

6.3 Valve operation testing results as per clause 8.6 of SANS 860896-22 shall be submitted to the relevant Transnet Freight Rail, Technology Management (Electrical Technology) department representative.

6.4 A Transnet Freight Rail, Technology Management (Electrical Technology) department representative may request any additional test deemed necessary to ensure compliance and reserves the right to be present at all tests and inspections as called for in this clause.

6.5 Transnet Freight Rail reserves the right to carry out any check tests on data submitted. However, the successful tenderer will still be responsible for efficient operation of the equipment in service and its compliance with the specification.

7.0 RATING PLATE AND INSTRUCTION LABELS

7.1 Cell and battery markings shall comply with clause 21 of SANS 60896-11.

7.2 The marking of cell polarity shall comply with clause 24 of SANS 60896-11.

7.3 Additional information and labelling required in battery rooms shall comply with clause 23 of SANS 60896-11.

7.4 Markings for recycling symbols on battery cells shall comply with SANS 61429.

8.0 DOCUMENTATION

8.1 Drawings and technical documentation shall be submitted with tender in English.

8.2 The manufacturer must provide one soft copy and two hard copies of the technical specification.

8.3 The manufacturer must provide one soft and two hard copy of the method of installation and mounting details.

8.4 All wiring and component diagrams must be provided to Transnet.

8.5 The manufacturer must provide one soft copy and two hard copies of maintenance manual.

8.6 The manufacturer must provide design and type test certificates to verify conformance to the

requirements and these must be submitted with tender documents.

8.7 Supplier shall advise how to dispose of the equipment at the end of its operating life, taking into consideration environmental requirements and regulations.

8.8 The tender documentation should cover all of the design requirements recommended in this specification.

8.9 Instructions for installation of individual components of assembly rack and battery set shall be provided by manufacturer.

9.0 QUALITY ASSURANCE AND COMPLIANCE

9.1 The equipment and materials used to manufacture the equipment, shall be of high quality design and manufacture, and shall comply with the relevant clauses outlined in this specification.

9.2 Where the equipment or material does not comply with the relevant specifications, the documentation must be submitted to the relevant Transnet Freight Rail, Technology Management (Electrical Technology) department representative.for approval.

9.3 Components must have a final quality inspection done by Transnet Freight Rail, Technology Management (Electrical Technology) department representative. prior to installation.

9.4 The successful tenderer shall maintain a Quality Management System (QMS) based on or certified to SANS 9001.

9.5 The tenderer shall indicate clause by clause whether his tender complies in all respects, and where alternative offers are submitted these shall be indicated to be assessed by the Transnet Freight Rail, Technology Management (Electrical Technology) department representative.

9.6 The successful tenderer shall submit drawings of the designs for retention by Transnet Freight Rail, Technology Management (Electrical Technology) department.

10.0 PACKAGING, STORAGE AND HANDLING

10.1 All batteries shall be delivered in the complete set of 55 cells, along with connectors and battery rack as a complete set.

10.2 Each package must be clearly marked indicating the equipment contained within the package and handling instructions.

10.3 Storage instructions for new batteries shall be clearly indicated in documentation available in packaging.

11.0 GUARANTEE AND DEFECTS

11.1 The appointed tenderer shall guarantee that the all supplied individual components of the batteries conform to Transnet’s requirements.

11.2 The appointed tenderer shall accept liability for makers’ defects, which may appear in design, material and workmanship.

11.3 The appointed tenderer shall provide all information regarding guarantees and warranties in writing.

12.0 METHOD OF TENDERING

12.1 Tenderers shall indicate clause-by-clause compliance document with the specification. This shall take the form of a separate document listing each of the specification’s clause and sub-clause numbers, indicating the individual statements of compliance or non-compliance.

12.2 Statement of non-compliance shall be motivated by the tenderer, as per 11.1.

12.3 Tenderers shall submit comprehensive literature consisting of detailed technical specifications,

general constructional details and principal dimensions, maintenance schedules, datasheets, together with clear illustrations of the equipment offered.

12.4 Any items offered in accordance with other standards will be considered at the sole discretion of Transnet. The tenderer shall supply full details stating where the item differs from these specifications as well as supplying a copy (in English) of the recognized standard specification(s) with which it complies. Any deviations must be approved by Transnet Freight Rail, Technology Management (Electrical Technology) department in writing.

12.5 Failure to comply with clauses 12.1, 12.2, 12.3 and 12.4 could preclude a tenderer from consideration.

12.6 In the event of any conflict between the various submitted relevant documents, the order of precedence shall be, and in consultation with Transnet Freight Rail, Technology Management (Electrical Technology) department:

12.7 a) Legal and safety requirements.

12.8 b) This Specification.

APPENDIX A: SCHEDULE OF REQUIREMENTS

The schedule of requirements should be completed by circling relevant characteristics, as per procurement requirements.

(To be completed by relevant Transnet Freight Rail Representative)

Battery type	Plantè	Gel	
Capacity requirements (Ah)	100 Ah	150 Ah	200 Ah
Assembly rack required	Yes	No	
Hydrometer required (only for Plantè to measure SG levels)	Yes	No	

Completed by ……..

Capacity ……..

Signature ……..

Date ……..

ANNEXURE B: TECHNICAL DATA SHEET

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

	Battery	
	Manufacturer	
	Manufacture date and inspection date	
	Battery type	
	Rated Capacity (Ah)	
	Weight per cell (kg)	
	Nominal voltage per cell (V)	
	No. of cells	
	Float voltage per cell (V)	
	Boost voltage per cell (V)	
	Equalising voltage per cell (V)	
	Final voltage per cell (V)	
	Dimensions of cell	
	Dimensions of assembly rack (if applicable)	
	Material of cell cover and container	
	Material of assembly rack (if applicable)	
	Material of intercell connector	
	Flammability rating of materials (Attach document)	
	Discharge capacity performance results (Attach documents)	
	Service life (years)	
	Internal resistance (Ohms)	

TRANSNET
freight rail

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT.

SPECIFICATION.

REQUIREMENTS FOR POSITIVE ISOLATOR FOR 3 kV DC TRACTION SUBSTATIONS

Author:	Chief Engineering Technician Technology Management	B.L Ngobeni	.....
Approved:	Senior Engineer Technology Management	L.O.Borchard	.....
Authorised:	Principal Engineer Technology Management	S.E Sibande	.....

Date: 28 March 2013

Circulation Restricted To:

Transnet Freight Rail – Rail Network
- Technology Management

INDEX

1.0 SCOPE.

1.1 The specification covers Transnet Freight Rail's requirements for the design, manufacture, testing, supply and installation of 3kV DC positive isolator for 3kV DC traction substations.

2.0 BACKGROUND.

2.1 The positive isolator is an Off-load isolating switch which must be installed between the 3kV DC reactor and the substation 3 kV DC positive busbar. The purpose of the positive isolator is to isolate and earth the 3kV DC output of the rectifier and wave filter equipment from the substation positive busbar that feeds via high-speed circuit breakers to the overhead track equipment.

2.2 The positive isolator switch combined with its 2 X earthing switches and control equipment is housed in a freestanding metal cubicle.

3.0 STANDARDS AND PUBLICATIONS

Unless otherwise specified all materials used and equipment developed and supplied shall comply with the current edition of the relevant SANS, NEMA and Transnet freight rail specifications which are referred to in this specification:

3.1 SOUTH AFRICAN NATIONAL STANDARDS

SANS 1091:	National Colour Standard.
SANS 1274:	Coatings applied by the powder-coating process.

3.2 NATIONAL ELECTRICAL MANUFACTURING ASSOCIATION

NEMA GPO-3:	For Grade GPO-3 insulating material.

3.3 TRANSNET FREIGHT RAIL

BBB 3005:	3kV DC Under Voltage relay manufacturing specification.
BBD5994:	Technical Documentation Management Policy.
BBF3690:	Transnet Freight Rail - Electrical Safety Instructions 2012.

4.0 TENDERING PROCEDURE.

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.

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 Failure to comply with clauses 4.1, 4.2, and 4.3 could preclude a tender from consideration.

5.0 SERVICE CONDITIONS.

5.1 ATMOSPHERIC SERVICE CONDITIONS

Altitude:	0 to 1800m 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 ELECTRICAL SERVICE CONDITIONS

5.2.1 The nominal traction substation DC supply voltage is 3kV DC but can vary between 2.2kV and 3.9kV for sustained periods.

5.2.2 The positive isolator can be subjected to short circuit conditions up to 30kA for 200 milli seconds.

5.3 MECHANICAL SERVICE CONDITIONS

The 3kV DC traction substations are situated next to railway lines and the equipment will be subjected to vibration. The design must take appropriate counter measures to ensure reliability of equipment that is sensitive to vibration.

6.0 GENERAL DESIGN

6.1 The positive isolator comprises of an isolating switch and 2 X earthing switches complete with its operating mechanism. The equipment is housed in a metal cubicle with the required control circuitry for the 3kV DC Ampere and Voltage meters and the 3kV DC undervoltage relay protection (if required).

6.1.1 The isolating and earthing switches with its operating mechanism shall be mounted on a metal frame.

6.1.2 The 3 kV DC voltmeter and DC ammeter and undervoltage relay (if specified) shall be fitted in the low voltage metering and calibration compartment and shall be totally isolated from the high voltage compartment.

6.2 The general design and layout of the positive isolator shall ensure that no access to the equipment is possible when the switch is in the closed position.

ISOLATING SWITCH

6.3 The isolating switch shall be a medium voltage, manually operated off load switch rated at a minimum for 3kV DC and 4000 Amperes continuous (rated according to the transformer and rectifier).

6.4 The isolating switch shall be designed to carry the continuous rectifier output current without overheating when switched on load.

6.5 The isolating switch shall comprise of a moving arm finger contact that engages smoothly and solidly with a fixed contact.

6.6 The isolating switch moving arm finger contact and fixed contact shall be manufactured from copper or silver plated.

6.7 The minimum dimensions of the moving arm contact shall be 120mm X 10mm. The fixed contact shall be designed to accommodate the moving contact.

6.8 The contact surfaces of the isolating switch moving contact, fixed contact, and busbar joints in positive isolator cubicle shall be silver plated.

EARTHING SWITCHES

6.9 The earthing switches shall comprise of a moving arm contact and a fixed contact into which the moving contact makes contact.

6.10 The earthing switches shall be a medium voltage, manually operated off load switch with minimum rating of 1500 Ampere. For the main earthing switches – the wave filter earthing switches only need to carry 750 Amperes.

6.11 The earthing switches moving and fixed contact shall be manufactured from copper or silver plated.

PANEL CONSTRUCTION

6.12 The panel shall be constructed from steel sheeting of at least 2,5 mm thickness. The panel shall be of a rigid construction with facilities for lifting purposes.

6.13 The dimensions of the panel shall be in the order of:

Height	2000 mm
Width	800 mm
Depth	1000 mm

6.14 The removable covers shall be fitted with fasteners that require a special tool in order to remove the covers. Hinged covers are not acceptable.

6.15 The panel shall have a High Voltage and a Low Voltage compartment partitioned by a substantial metal sheet.

6.16 The front cover for the low voltage compartment shall be fitted with a window to give visibility to the indicating / measuring instruments.

6.17 A window shall be provided in the HV compartment to provided visibility of the position of the moving and fixed contacts of the positive isolator and earthing switches.

6.18 The windows shall be manufactured from clear polycarbonate, or non-shattering laminated glass or other approved material.

6.19 The interior and exterior surface of the panels shall be powder coated in accordance with SANS 1274. The coating shall be type 4 for corrosion-resistant coatings for interior use using thermosetting type high gloss coatings.
The interior and exterior of the panel shall be Eau-de-Nil, colour code No H 43 in accordance with SANS 1091.

6.20 The frame of the metal cubicle that houses the positive isolator shall be fitted with support insulators to insulate the equipment from the floor.

LOW VOLTAGE COMPARTMENT

6.21 The 3kV DC voltmeter and DC ammeter and under-voltage relay (if specified) shall be fitted in the low voltage compartment and shall be totally isolated from the high voltage compartment.

6.22 The compartment shall be provided with a hinged plate on which the 3kV DC indicating/measuring instruments are mounted.

6.23 The hinge plate shall provide easy access to the under voltage relay transmitter and receiver in the LV compartment for calibration purposes.

6.24 The hinged plate shall be fitted behind the front cover of the low voltage compartment so that the front cover must first be removed before access can be gained to the low voltage compartment.

6.25 The supplier shall make provision for an electrical interlock to be fitted on the front cover of LV compartment which will cause the substation to trip and lockout in the event of the cover been removed while the traction substation is on load.

HIGH VOLTAGE COMPARTMENT

6.26 The HV compartment shall house the positive isolator switch combined with its earthing switches, all the 3kV DC busbars and 500mm² copper cables, the potential dividers and fuse for the metering equipment.

6.27 Provision shall be made for the rail connection for the negative connections of the 3 kV DC potential dividers for the undervoltage relay and voltmeter. The rail connection shall consist of a copper busbar mounted on an insulator.

6.28 The positive connections for the fuse and potential dividers for the 3 kV DC undervoltage relay and voltmeter shall be connected to the 3 kV DC positive busbar on the track breaker side of the positive isolator.

6.29 High voltage insulated cables shall be used for the fuses and positive and negative connections of the potential dividers.

6.30 A 6mm X 50mm copper busbar connected to the earthing switches be provided in the rear of the HV compartment for the termination of the cables of the traction substation DC earth leakage system and the earthing cable of the metal cubicle of the positive isolator.

6.31 All low voltage wiring in the high voltage compartment shall be run in metal trunking.

CLEARANCES AND INSULATION

6.32 The positive isolator switch 3kV insulation to earth shall be designed to withstand a test voltage of 10,5kV, 50 Hz AC for one minute.

6.33 The clearance of the positive isolating equipment at nominal 3kV DC and steelwork shall be not less than 150 mm.

6.34 The insulating material used in the construction of the positive isolator switch shall comply with NEMA standards for GP03 or better for satisfactory operation at coastal and other high humidity areas.

6.35 All insulation used for the construction of apparatus shall resist the effects of humidity, dust and temperature variations and shall not have a tendency to distort.

MECHANICAL INTERLOCKING (ONLY ON INSTALLATION)

6.36 An externally mounted mechanical interlock shall be fitted to prevent the on load operation of the positive isolator switch or reconnection to the overhead track system while the rectifier bay is open.

6.37 The mechanical interlocking system for the positive isolator switch shall be of the key exchange type The "Castell" key exchange system is preferred.

6.38 The switching operation of the opening and earthing of the positive isolator shall only be possible once the traction substation has been switched off load from the incoming AC supply.

7.0 METERING, UNDERVOLTAGE RELAY AND WIRING

7.1 METERING

The 3 kV DC voltmeter and ammeter shall conform to the following requirements.

7.1.1 The 3 kV DC voltmeter shall be a moving coil type, 96mm X 96mm. The range shall be 0-4000V with a class of 1.5 accuracy (0 – 400 Calibration scale).

7.1.1.1 The 3 kV DC voltmeter shall be provided with a high voltage fuse and potential divider consisting of not less than 10 aluminium case resistors mounted on aluminium flat bars in series of 2 X flat bars and shall be installed in the HV compartment of the positive isolator panel.

7.1.1.2 The 3 kV DC voltmeter shall be labelled “Busbar Voltage”.

7.1.1.3 The fuse and voltage divider shall be housed in the HV compartment of the panel. The fuse shall be connected by means of a single core HV conductor from the positive 3kV to the potential divider.

7.1.2 A moving coil DC Ampere meter 96mm X 96mm with range of 0 - 4000 amperes and accuracy class of 1.5 shall be supplied (90^0 Display).

7.1.2.1 The 3 kV DC Ampere meter shall be calibrated for 4000 amperes full scale with an input of 50mV obtained from a 4000 amperes 50 mV shunt, which shall be supplied by the tenderer (Shunt on a rectifier).

7.2 3 kV DC UNDERVOLTAGE RELAY

7.2.1 Where specified the tenderer shall supply a 3kV DC undervoltage relay in accordance with Transnet freight rail's specification BBB 3005.

7.2.2 The potential divider and fuse shall be installed in the HV compartment of the positive isolator switch panel.

7.2.3 The transmitter and receiver of the undervoltage shall be mounted in the LV compartment.

7.2.4 Depending on space constraints in the LV compartment of the positive isolator switch panel, the 3kV DC undervoltage relay may be wall mounted in an easily accessible location.

7.2 WIRING AND TERMINALS

7.3.1 All terminal blocks and groups of terminal blocks shall be suitably numbered.

7.3.2 All wires shall be provided with identification tags at terminals and shall be marked as reflected on the panel-wiring diagram. The diagram markings and wire markings shall be the same.

8.0 LABELLING

8.1 All removable covers of the positive isolator shall be fitted with approved Transnet freight rail warning signs.

8.2 The warning signs and labelling shall be of the engraved type.

8.3 The warning signs shall read as follows:

8.4 The lettering "**CAUTION-HIGH VOLTAGE**" shall be 15mm in size and the rest of the wording on the label 10mm. The lettering shall be red on a white background.

8.5 The labels shall be screwed or riveted to the panels.

9.0 INSPECTION AND TESTING.

9.1 Transnet freight rail reserves the right to carry out inspections and any tests on the equipment at the works of the supplier/ manufacture.

9.2 Arrangements must be made with The Senior Engineer, Technology Management Transnet freight rail for inspections to be carried out before delivery of the equipment.

9.3 Routine test quality assurance (QA) stickers shall be mounted on each positive isolator switch and under voltage relay.

10.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

10.1 Drawings, instruction manuals and spare parts catalogues shall be supplied in accordance with Transnet freight rail specification BBD5994.

10.2 The tenderer shall supply three copies of an instruction/maintenance manuals and construction and schematic diagrams.

10.3 The contractor shall submit details of spares required in accordance with Transnet freight rail's specification BBD5994.

11.0 GUARANTEE AND DEFECTS

11.1 The contractor shall guarantee the satisfactory operation of the complete electrical installation supplied and installed by him and accept liability for maker's defects, which may appear in design, materials and workmanship.

11.2 The guarantee period for all substations shall expire after: -

11.2.1 A period of 12 months commencing on the date of completion of the contract or the date the equipment is handed over to Transnet freight rail whichever is the latest.

11.4 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 e.g., faulty locomotive or overhead track equipment, etc., shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the Maintenance manager and at the cost of the Contractor.

11.5 If urgent repairs have to be carried out by Transnet freight rail staff to maintain supply during the guarantee period the contractor 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.

- END -

TRANSNET freight rail

TECHNOLOGY MANAGEMENT.

SPECIFICATION.

REQUIREMENTS FOR BATTERY CHARGERS FOR 3kV DC TRACTION SUBSTATIONS.

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Transnet Freight Rail – Chief Engineer Infrastructure
- Technology Management

INDEX

1.0 SCOPE.

1.1 This specification covers the requirements for the design, manufacture and supply of battery charger units used in 3 kV DC traction substations.

2.0 GENERAL.

2.1 The equipment is required to charge a 53 cell lead acid 3 kV DC substation or tie station battery bank. The ampere-hour rating of the battery bank may vary between 100 to 250 ampere hours. The charger must be able to supply the substation or tie station load as well as float charge the battery under normal conditions.

2.2 The battery could be subjected to momentary heavy discharges from 50 amperes to 250 amperes for a period of 1 to 3 seconds. The discharge current is for the closing coils of the 3 kV DC high-speed circuit breakers. The discharge current is dependent of the model of the circuit breaker used.

2.3 In addition to charging the battery bank the charger must supply a constant voltage to the high-speed circuit breaker's holding coils. As the trip calibration of the high-speed circuit breakers is dependent on the holding coil voltage, the voltage must be maintained at 110 volts by means of a suitably tapped diode string or other means. In the event of failure of the battery charger, the diode string shall be automatically short-circuited and the holding coils of the track breakers shall be fed directly from the battery.

3.0 STANDARDS.

The following latest editions of the following publications are referred to herein.

3.1 SOUTH AFRICAN NATIONAL STANDARDS

SANS 1091:	National colours standards for paint.
SANS 1274:	Coatings applied by the powder-coating process.
SANS 1652:	Battery chargers – Industrial type

3.2 TRANSNET FREIGHT RAIL.

BBB0041:	Preparation of drawings for Transnet Freight Rail infrastructure.
CEE.0045:	Painting of steel components of electrical equipment.
CEE.0224:	Drawings, catalogues, instruction manuals and spares lists for electrical equipment supplied under contract.

4.0 DEFINITIONS

4.1 BOOST CHARGE: A partial charge, generally at a high rate, for a short period. It is also known as a fast charge or a quick charge.

4.2 FLOAT CHARGE: A constant voltage charge ideally sufficient to maintain a cell or battery in a fully charged state.

4.3 EQUALISING CHARGE: An extended charge applied to correct relative density imbalance amongst the cells of a battery.

4.4 INITIAL CHARGE: An increased charge for new or uncharged battery cells.

5.0 TENDERING PROCEDURE

5.1 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.

5.2 A statement of non-compliance shall be motivated by the tenderer.

5.3 Tenderers shall submit descriptive literature consisting of detailed technical specifications, general constructional details and principal dimensions, together with clear illustrations of the equipment offered.

5.4 Failure to comply with clauses 4.1, 4.2, and 4.3 could preclude a tender from consideration.

6.0 SERVICE CONDITIONS.

The battery charger shall be designed to operate under the following service conditions.

6.1	Altitude:	0 – 1800 meters above sea level.
6.2	Ambient Temperature Range:	-10°C to +45°C.
6.3	Relative Humidity:	10% to 90%
6.4	Lightning Conditions:	12 Ground flashes per square kilometre per annum.

7.0 ELECTRICAL REQUIREMENTS

7.1 INPUT VOLTAGE.

7.1.2 The charger must be capable of working off an auxiliary supply with a poor waveform, as a result of thyristor controlled locomotives, line switching and lightning induced surges. A total harmonic voltage distortion figure of 27% must be catered for.

7.1.3 Appendix 1 shows the Quality of Supply characteristics of a typical 230 Volt AC auxiliary supply of a 3 kV DC traction substation.

7.1.4 The battery charger output shall be fitted with low pass filtering to reduce the effect of harmonic frequencies and ripple on the battery and load circuits.

7.2 The following input supplies are available at the 3 kV DC traction substations.

1. Single phase 230 volts AC ± 10% (r.m.s)
2. Three phase 400 volts AC ± 10% (r.m.s)
3. Frequency 50Hz ± 2Hz.

7.3 OUTPUTS.

7.3.1 The charger must be capable of driving varying loads and be unaffected by sudden changes in load current and transients generated by the load.

7.3.2 With no battery connected to the output, the charger must be capable of withstanding a short-circuit across its terminals, without any resultant component damage.

7.3.3 The conductors of the battery charger output must be rated to carry the maximum load current continuously. For a 100 ampere hour battery bank, 35 milli meter square conductors are recommended to make provision for short circuit ratings.

7.3.4 Upon switch on, the charger must incorporate a soft start feature, so that at no time either the DC output current or voltage exceeds their full load values.

7.3.5 The charger outputs shall be voltage and current limited for "float" and "boost" charging.

7.4 OUTPUT PARAMETERS.

The following parameters shall be complied with:

7.4.1 SYSTEM DC VOLTAGE.

7.4.1.1 The nominal voltage shall be 110 volts.

7.4.1.2 The charging battery voltage shall be 110volts to 119.25volts for the automatic mode. (2.25volts per cell).

7.4.1.3 The charging battery voltage shall be 110 volts to 127.2 volts for the boost mode. (2.35 volts to 2.40 volts per cell)

7.4.2 TOTAL CURRENT

7.4.2.1 The output current shall be 30 ampere (current limit in the automatic mode)

7.4.2.2 The current shall be 5 ampere to 25 ampere in the boost mode.

7.4.3 LINE REGULATION

7.4.3.1 The line regulation shall be a maximum of 0.75% when the input varies ± 10%.

7.4.4 RIPPLE VOLTAGE

7.4.4.1 For all output current up to 100% battery charger capacity into a resistive load:
The maximum peak to peak ripple voltage at the charger output terminals (with resistive load coupled to the output terminals instead of the battery) shall not exceed 5% of the nominal battery voltage.

7.4.4.2 The peak to peak ripple voltage shall be measured at nominal input voltage.

7.4 .5 RIPPLE CURRENT

7.4.5.1 The maximum peak to peak ripple (AC) voltage measured across the shunt for the total current shall not exceed 5% of the nominal battery voltage.

7.4.5.2 The peak to peak ripple current shall be measured at nominal input voltage.

7.4.5.3 The maximum superimposed r.m.s value of the AC component shall always have a positive value even if it is very small i.e. 100 milli ampere. The AC ripple shall be limited to 5% of the ampere hour rating capacity expressed in amps for example 5 ampere or less for a 100 ampere hour battery bank.

7.4.5.4 The battery charger shall meet the requirement that the charging current never becomes negative (discharge) in value.

7.4.6 DC OUTPUT CHARGE VOLTAGE

7.4.6.1 The DC output voltage must remain within ± 1% of the respective value for boost and float modes and within 5% for initial charge mode.

7.4.7 FLOAT MODE

7.4.7.1 The output voltage shall be pre-set at 2,25 volts per cell but adjustable by ± 5%. For 53 cells the float voltage shall be 119,25 volts adjustable. The values shall be within 1% in the automatic mode.

7.4.8 BOOST MODE

7.4.8.1 The output voltage shall be pre-set at between 2,35 volts to 2,40 volt – 5% per cell, adjustable. For 53 cells the boost voltage shall be set at 124,55 volts. (2,35 volts per cell) to 127.2 volts (2.40 volts per cell). The boost voltage shall remain within 1% of the required boost voltage. In automatic operational mode the battery charger shall revert back to float charge mode when the boost charge cycle is completed.

7.4.9 MANUAL BOOST MODE

7.4.9.1 A push button is required to switch the charger to "boost mode" manually. The battery charger shall revert back to float charge mode when the boost charge cycle is completed i.e. when the set boost voltage is reached. (124.55 volts to 127.2 volts). An additional push button shall be provided to be able to cancel the boost mode when required.
An adjustable 0-4 hour timer shall be installed to automatically switch off the manual boost in the event of the manual boost mode not being switched off by the technical staff.
After the boost mode has being switched off, the charger shall remain in the trickle charge mode for a period of not less 30 minutes before changing back to automatic boost mode if the battery voltage has not reached the required float voltage.

7.4.10. AUTOMATIC BOOST CHARGE.

7.4.10.1 The battery charger shall initiate an automatic boost charge every 28 days to ensure maximum life and reliability of the battery. The battery charger shall revert back to float charge when the battery is fully charged.

7.4.11 CURRENT LIMITING

7.4.11.1 Current limiting is required for the battery charger current. In float and boost modes these limits must be downward adjustable by 25% of the maximum values.
The charger shall control limits within ± 5% of the adjustable value.

7.5 EFFICIENCY

7.5.1 The efficiency shall not be less than 60% for single phase chargers at maximum charger output capacity.

7.5.2 The efficiency shall not be less than 70% for three phase chargers at maximum charger output capacity.

7.6 INPUT TRANSFORMER.

7.6.1 The main power transformer shall incorporate an electrostatic screen between the primary and secondary windings. The screen shall be connected to the frame.

7.7 ELECTRONIC CIRCUITRY.

7.7.1 PRINTED CIRCUIT BOARDS

Printed circuit boards shall comply with the following requirements in accordance to SANS 1652:

7.7.1.1 They shall be made of material similar to epoxy fibreglass laminate or better.

7.7.1.2 They shall be suitably protected from the effects of moisture and dust.

7.7.1.3 They shall be marked to allow the board type, and each individual component to be readily identified.

7.7.1.4 Printed circuit boards shall be provided with rigid and positive support and shall be easily replaceable.

7.7.1.5 The plug-in-boards shall be polarised to prevent the plug-in-boards being plugged into a wrong socket or being inserted upside down.

7.8 CONTROL AND ALARM SETTINGS.

The battery charger shall be fitted with the following alarms and alarm relays:

7.8.1 Charger low voltage alarm between 90 volts and 105 volts adjustable. Relay to be fitted for flag operation when relay is de-energised.

7.8.2 Charger high volt alarm. (Float). This alarm is pre-set just above normal float voltage. This alarm allows boost charging while providing protection against overcharging. Relay to be fitted. (127.2 volts).

7.8.3 Charger high volt alarm. (Boost). This alarm level is pre-set just above normal boost volts. When the normal boost voltage is exceeded the boost mode shall be terminated and a high volt alarm and relay contacts shall be initiated.

7.8.4 Battery charger input voltage mains failure relay and contacts.

7.9 ILLUMINATED INDICATORS.

7.9.1 Only Light Emitting Diodes (LED's) are to be used.

7.9.2 The following colours for the LED's shall be used:

Green: Normal condition. Mains on.
Red: Fault condition. Battery voltage low, high volts etc.
Amber: To indicate a specific status e.g. Boost charge, Initial charge.

7.10 METERS.

7.10.1 VOLTMETER

7.10.1.1 The digital Voltmeter shall be able to measure between 80 volts to 150 volts. The display shall be 3.5 digits, 12 milli meters high with an accuracy of ± 0.5%.

7.10.1.2 The digital Voltmeter shall be connected so that it can measure both the battery voltage and the high speed circuit breaker holding coil voltage. A high quality two-way selector switch shall be employed and mounted on the face of the battery charger.

7.10.2 AMMETER

7.10.2.1 The digital ammeter shall be 3.5 digits, 12 milli meters high with an accuracy of ± 0.5%, class 0.5. The ammeter shall measure shall measure the total charger current by means shunt sensing.

7.10.2.2 The ammeter shall be connected so that it can measure total current and battery charging current. A high quality two-way selector switch shall be employed and mounted on the face of the battery charger.

7.10.2.3 The markings for both voltage and current positions shall be by means of labels, which are riveted or screwed to the face of the panel.

7.10.2.4 Both Voltmeters and ammeters shall be protected against transients and surges. Suitable protection circuitry such as metal oxide varistors and resistance capacitance circuits shall be fitted to the input leads of the meter.

7.11 LIGHTNING AND SURGE PROTECTION

7.11.1 The equipment shall be fitted with surge and lightning protection on the input AC supply to the charger. The supplier shall provide circuitry or protection units for this purpose. Separate external modules are acceptable for protection. The protection circuitry shall consist of a combination of resistors, capacitors, metal oxide varistors and gas arresters. Dehnventile type or equivalent protection will be preferred.

7.12 HIGH SPEED CIRCUIT BREAKER SERIES DROPPING DIODES.

7.12.1 A regulated supply is required for the high speed circuit breaker holding coils. Suitably rated series dropping diodes shall be employed for this purpose. Refer to clause 2.3.

7.12.2 The charger shall be supplied with a suitably rated series diode dropping chain for the high-speed circuit breakers holding coils. The series diode dropping chain shall be able to be bridged out by means of electrical contactors for regulation purposes as required.

7.12.3 The charger shall be provided with a minimum of three output terminals namely, battery positive, holding coil positive and battery negative.

8.0 CONSTRUCTURAL REQUIREMENTS

8.1 The battery charger shall be a self-contained unit housed in a rigidly constructed sheet metal cubicle, suitable for floor or wall mounting.

8.2 The inside and outside of the cubicle shall be powder coated in accordance with SANS 1274. The coating shall be type 4 for corrosion-resistant coatings for interior use using thermosetting type high gloss coatings. The exterior finishing colour shall be Eau-de-Nil to SANS 1091 colour No H 43 and the interior high gloss white.

8.3 The cubicle shall be adequately ventilated to prevent overheating of the electrical equipment and be vermin-proof. Natural cooling shall be used. The use of cooling fans is not permissible.

8.4 The design and arrangement of the cubicle and equipment shall provide ease of inspection and maintenance.

8.5 The cubicle shall be provided with an earthing terminal welded to the frame to facilitate the connection of a 95mm ^{2} earthing cable using a M12 lug.

8.6 Provision shall be made for suitable cable or conduit entry for the incoming AC supply and DC output supplies.

8.7 The wiring shall be executed in a neat and orderly fashion and shall consist of PVC insulated stranded copper conductors to ensure flexibility and mechanical strength and be suitably rated for the current carrying capacity of the circuits.

8.8 The wiring shall be provided with identification tags at terminals and shall be marked in accordance with the wiring diagrams.

8.9 The control switches, m.c.b's etc mounted on the panel shall be suitably labelled to clearly indicate their function. The lettering of the labels shall consist of white lettering on a black background.

8.10 The labels shall be permanently fixed with screws, rivets or other approved method.

9.0 INSPECTION AND TESTING.

9.1 Transnet Freight Rail reserves the right to carry out inspection and any tests on the equipment at the works of the supplier/ manufacture.

9.2 Arrangements must be made timeously for such inspections to be carried out before delivery of the equipment to the client.

10.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

10.1 Drawings, instruction manuals and spare parts catalogues shall be supplied in accordance with Transnet Freight Rail's specification CEE.0224.

10.2 The preparation of the drawings shall comply with Transnet Freight Rail's specification BBB0041

10.3 The tenderer shall supply three copies of instruction/maintenance manuals, schematic diagrams, diode application notes and protection and filter ratings.

10.4 The contractor shall submit details of spares required in accordance with specification No. CEE.0224.

10.5 All spares recommended for normal maintenance purposes that are not available locally (requires importation) must be highlighted.

11.0 SPECIAL TOOLS AND/OR SERVICING AIDS

11.1 Special tools or servicing aids necessary for the efficient maintenance, repair or calibration of the equipment shall be quoted for separately.

11.2 Tenderers shall submit detailed offers for special tools and servicing aids including all specialised equipment required for the servicing and maintenance of the equipment supplied.

12.0 TRAINING

12.1 The tenderer shall submit details with the tender of the training courses, which will be conducted by the contractor for the training of Transnet Freight Rail's maintenance staff in the operation and maintenance of the equipment supplied. 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.

13.0 GUARANTEE AND DEFECTS

13.1 The contractor shall guarantee the satisfactory operation of the complete electrical installation supplied and installed by him and accept liability for maker's defects, which may appear in design, materials and workmanship.

13.2 The guarantee period for all substations shall expire after: -

A period of 12 months commencing on the date of completion of the contract or the date the equipment is handed over to Transnet Freight Rail whichever is the later.

13.3 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 e.g., faulty locomotive or overhead track equipment, etc., shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the Maintenance manager and at the cost of the Contractor.

13.4 If urgent repairs have to be carried out by Transnet Freight Rail's staff to maintain supply during the guarantee period the contractor 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

END

APPENDIX 1

QUALITY OF SUPPLY CHARACTERISTICS OF A TYPICAL 230 VOLT AC AUXILIARY SUPPLY'S OF A 3 KV DC TRACTION SUBSTATION.

1. 230 VOLT AC AUXILIARY SUPPLY SERVICE CONDITION

1.1 The auxiliary supply is derived from the tertiary windings within the traction transformer or from the secondary of the traction transformer by means of a step down transformer. Under traction load, i.e. an electric train drawing power from the substation the AC waveform is distorted due to harmonics created by the traction rectifier.

1.2 The Total Harmonic Distortion, which can be expected is up to 27 %.

1.3 A typical voltage waveform, which can be expected, is shown in figure 1 and its corresponding frequency spectrum (FFT) is shown in figure 2.

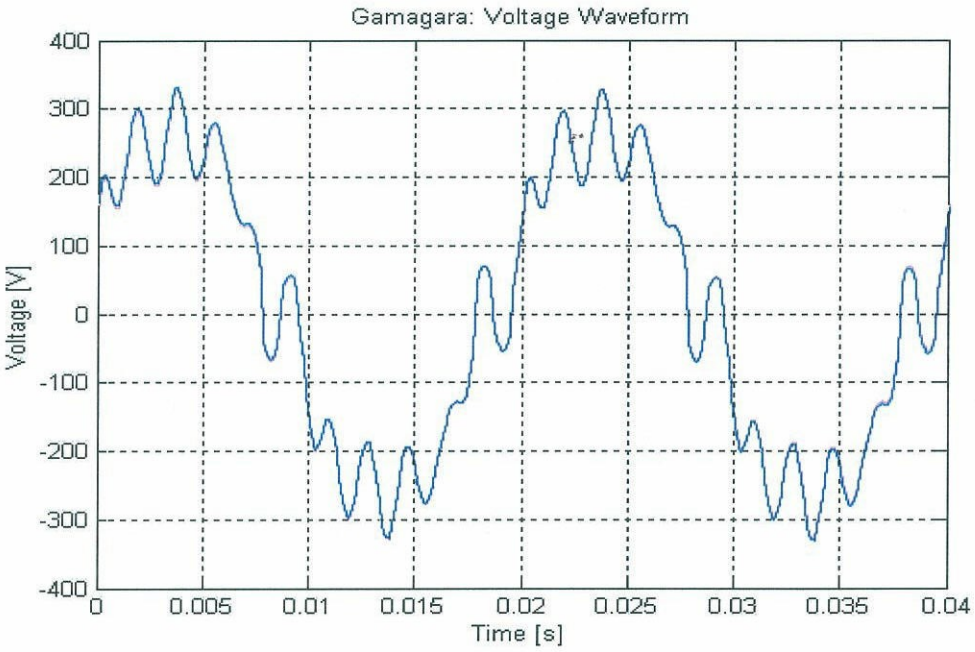

Figure 1: Voltage waveform under traction load (traction = 3000A)

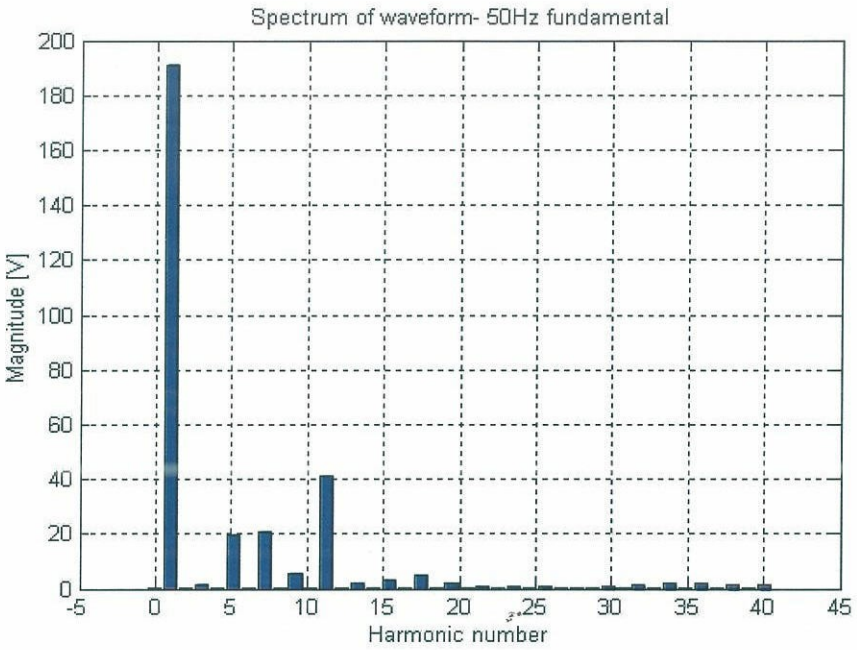

Figure 2: Frequency spectrum (FTT) of voltage waveform as shown in figure 1.

END

APPENDIX 2

TECHNICAL DATA SHEET.

(To be completed by client)

1.0 SUBSTATION NAME: _____

2.0 SUPPLY VOLTAGE: _____

3.0 AMPERE HOUR RATING: _____

4.0 CONSTRUCTION:

FLOOR MOUNTED: YES / NO

WALL MOUNTED: YES / NO

END

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

3kV RECTIFIER (5MW or 6MW) FOR TRACTION SUBSTATIONS

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Transnet Freight Rail – Rail Network
– Technology Management

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LIST OF AMENDMENTS TO THE SPECIFICATION

Version No.	Date Issued	Clause No.	Page No.	Remarks
15	28/03/2014			Original version
				POPIA declaration statement inserted
		2		IEC and SANS standards added
		7.1.10		Clause has been added
		7.4.2.4		Clause has been added
		7.5.7		Clause has been added
		17		Appendix A has been added

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1.0 SCOPE

1.1 This specification covers Transnet Freight Rail's requirements for the design, manufacture, supply and installation of 3 kV Direct Current (DC) rectifier units (5MW – 6MW) for DC traction substations.

1.2 This specification contains a schedule of requirements (Appendix A) which must be completed by the Transnet representative and technical data sheet (Appendix B) for tenderer

2.0 NORMATIVE REFERENCES

2.1 Unless otherwise specified all materials used, equipment developed and supplied shall comply with the latest edition of the relevant International Electro-technical Commission (IEC), International Organization for Standardization (ISO), South African National Standards (SANS) or Transnet publications.

2.2 The following publications are referred to in this specification:

2.2.1 INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC 60051: Direct acting indicating analogue electrical-measuring instruments and their accessories.

IEC 60146-2: Semiconductor converters - Part 2: Self-commutated semiconductor converters including direct dc converters.

IEC 61812-1: Time relays and coupling relays for industrial and residential use - Part 1: Requirements and tests.

2.2.2 SOUTH AFRICAN NATIONAL STANDARDS

SANS 1019: Standard voltages, currents and insulating levels for electrical supply.

SANS 61000: Electromagnetic compatibility (EMC) – Part 6-2: Generic standards - Immunity for industrial environments

2.2.3 TRANSNET FREIGHT RAIL

BBB 2721: AC Primary Circuit Breaker Control Panel and AC/DC Distribution Panel for 3kV Traction Substations.

BBB 5452: Transnet Freight Rail's Requirements for the Installation of Electrical Equipment for 3kV DC Traction Substations.

CEE.0224: Drawings, catalogues, instruction manuals, spares list for electrical equipment supplied under contract.

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 SERVICE CONDITIONS

3.1 ATMOSPHERIC CONDITIONS

The equipment shall be designed and rated for installation and continuous operation under the following conditions:

Altitude: 0 to 1800m above sea level.

Ambient temperature: -10°C to +55 °C.

Relative humidity:	10% to 90%.
Lightning Conditions:	20 ground flashes per square kilometre per annum.
Pollution:	Heavily salt laden or polluted with smoke from industrial sources.

3.2 MECHANICAL SERVICE CONDITIONS

3.2.1 The rectifiers are installed in substations next to or within close proximity of railway tracks and will be subjected to vibration from the trains.

3.3 ELECTRICAL SERVICE CONDITIONS

3.3.1 INPUT VOLTAGE

3.3.1.1 The rectifier AC input voltages for six-pulse configuration is in the order of 2450V AC per phase. For 12-pulse configuration the AC input voltages can be in the order of 1120V to 1375V phase to phase.

3.3.1.2 The rectifier receives its supply from a 3.3MVA to 5MVA main transformers (and 6MVA where transformers are replaced).

3.3.2 OUTPUT VOLTAGE

3.3.2.1 The nominal busbar output voltage rating of the system is 3150 Volts but can vary between 2400V DC and 3900V DC.

4.0 DESIGN OF EQUIPMENT

4.1 The rectifier unit and its associated control equipment shall be built up to form an independent unit.

4.2 The rectifier design shall be suitable for operation for existing or new traction substations, the details of which shall accompany this specification.

4.3 For multiple unit substations it shall be possible for each unit to operate completely independently of each other.

4.4 For single transformer, multi-group arrangements, it shall be possible to isolate and switch off one group without affecting the other group.

4.5 Six or twelve pulse operation is used depending on the configuration of the transformers.

4.6 This specification includes all the required control and protection circuits which shall be installed and wired to existing substation control panels by the supplier.

4.7 The control circuitry for tripping and indication purposes shall operate with 110V DC or 230V AC.

4.8 RATINGS

4.8.1 The DC output of the equipment shall be rated at 5MW or 6MW full load continuously with overload ratings related to full load as follows:

2 x full load for 30 minutes
3 x full load for 1 minute
3.5 x full load for 10 seconds.
4.25 x full load instantaneous tripping.

4.8.2 The equipment shall withstand a short circuit current for 50kA for 10 milli-seconds.

4.8.3 The ratings of the rectifier with its configuration shall be displayed on a silkscreen label fixed on the rectifier unit.

4.9 The rectifiers and associated equipment shall be designed to minimise any tendency to resonate or to produce high voltage surges when operating in conjunction with DC smoothing equipment.

4.10 Lightning, transients, surges and tripping are present in the substation environment

5.0 INSULATION LEVELS

5.1 Insulation levels for high voltage equipment shall be in accordance with the recommendations of SANS 1019.

5.2 The nominal 1.5kV and 3kV insulation to earth shall be so designed that the complete rectifier assembly shall be able to withstand a test voltage of 10.5kV, 50Hz AC for one minute.

5.3 Where PVC trunking is used for the routing of cables it shall be so installed that there can be no danger of a flash over or tracking occurring between the trunking and high voltage circuitry.

6.0 CLEARANCES AND CREEPAGE DISTANCES

6.1 The following minimum safety clearances shall be maintained:

For the nominal DC system voltage, the minimum air clearance shall not be less than 150mm from any conductor or metal normally live and ground level.

6.2 Ribbed insulators and standoff bushings shall be used for 3kV DC and shall have a creepage distance of not less than 239 mm.

7.0 RECTIFIER UNIT

7.1 RECTIFIER DESIGN REQUIREMENTS

7.1.1 The silicon rectifier diode assemblies shall comply with SANS 60146-2.

7.1.2 The rectifier unit shall comprise of silicon semiconductor-diodes and be of the hockey puck capsule type.

7.1.3 All materials used shall be flame retardant.

7.1.4 To prevent flashovers no insulation material shall be used between rectifier branches. The minimum air clearance of 150mm is required between diode modules as well as between diode modules and any earthed metal.

7.1.5 The minimum distance between the incoming supply phases to the rectifier shall not be less than 150mm.

7.1.6 It is required that the equipment offered be designed to remain in service in the event of any individual diode in a branch becoming defective.

7.1.7 The rated repetitive peak reverse voltage of a series connected branch of diodes shall be such that should a diode in that branch become defective, the rated repetitive peak reverse voltage of the remaining diodes will be at least twice the value of the applied reverse voltage. The peak inverse voltage shall be not less than 4000V DC or higher for a 24 diode bank.

7.1.8 The creepage distance across the resistor capacitor (RC) circuit components shall be commensurate with the creepage distance across the diode insulation.

7.1.9 Tenderers shall provide a full description of the over voltage and surge protection circuits offered illustrating how this circuit has been designed.

7.1.10 Each rectifier unit shall be provided with a digital DC voltmeter instrument display, range 0-4 000 volts and a digital DC ammeter instrument display range 0-4000 amperes. These shall be mounted on the front of the rectifier unit.

7.1.10.1 The digital LED / LCD display instruments shall be of flame retardant material, safe and reliable.

7.1.10.2 The digital LED / LCD display meters shall have a high definition colour backlight.

7.1.10.3 Digital instruments shall have an LED / LCD display of 4 digits, +14 millimetres character height and have an accuracy of 0.5%.

7.1.11 The DC voltmeter shall be connected to the more negative side of the voltage divider.

7.1.12 For the DC ammeter a 4000 ampere 50 mV shunt shall be fitted on the negative busbar of the rectifier.

7.1.13 The DC voltmeter and ammeter shall be class 1.5 or better. The dimensions of the analogue face of the meters fitted on the rectifier unit shall not be less than 144mm x 144mm with a 90 degree display.

7.1.14 A high voltage fuse and potential divider shall be provided for the voltmeter.

7.1.15 The potential divider shall consist of not less than ten separate vitreous enamel resistance elements connected in series.

7.1.16 The DC output of the rectifier unit shall be protected from external voltage transients by means of fused resistance capacitance parallel metal oxide varistor circuitry. The fuse shall be fitted with a trip contact, which can be utilised for indication and control.

7.2 DIODES

7.2.1 For 5MW and 6MW rectifiers the diodes ZP 3000/68 (exact equivalent or approved types) shall be used.

7.2.2 Proof of origin of the diodes and certified test certificates shall be supplied with the diodes.

7.2.3 The forward voltage drop of the diodes shall be within ± 5% variations.

7.2.4 Tenderers shall submit fully detailed data sheets of the type of diode offered.

7.2.5 Each individual diode shall form an integrated module with its heatsink, snubber circuit and parallel voltage- equalising resistor circuit. The module shall contain no connection wires or lugs. All connections shall be made directly through the mounting of the snubber printed circuit board busbar terminations. The design of the module shall enable it to be removed within a short period of time, without disturbing any other modules.

7.2.6 The rectifier design shall be such that only the diode module securing bolts need to be removed for replacement of a module. No busbars or other parts shall obstruct the removal of the diode module.

7.2.7 For identification of the diode polarity, the rectifier symbol shall be clearly marked on the heatsink module and on the diode.

7.2.8 Tenderers shall indicate the recommended intervals between the testing of diodes and their RC snubber components so as to establish their soundness.

7.3 SNUBBER (RC) AND VOLTAGE EQUALISING CIRCUITRY

7.3.1 The capacitors and resistors employed in the snubber RC circuits shall be of the highest quality and shall be suitably rated for high voltage applications encountered. Vitreous enamel wire wound resistors or similar shall be used and high voltage suitable capacitors shall be used.

7.3.2 If standoff posts are used to support sensing circuits they shall be securely fixed to the main diode module by means of lock washers and nuts to ensure that no sparking occurs due to poor contact.

7.4 DIODE MONITORING EQUIPMENT

7.4.1 DIODE SENSOR TRANSMITTER MONITORING MODULE

7.4.1.1 Sensing circuitry shall be incorporated to monitor each individual diode for open or short circuit conditions.

7.4.1.2 Specific attention shall be given to the protection of the diode monitoring circuit boards in the event of the diode going open circuit and destroying the monitoring modules.

7.4.1.3 Protection circuitry shall be provided for each sensor module.

7.4.1.4 The sensor module shall be powered from the snubber RC circuit of the diode and shall be designed so as not to change the characteristics of the RC circuit across which it is connected.

7.4.1.5 The snubber RC circuitry, and the diode sensing circuitry, shall be removable as a unit with the diode module when the diode module is removed for replacement or repair.

7.4.1.6 The components used to manufacture the diode sensor transmitter module shall be of the highest quality.

7.4.1.7 If resistors are employed they shall be vitreous enamel insulated or similar and shall withstand at least 700 Volts across them.

7.4.1.8 The diode sensing circuit board shall be removable from the diode module as an individual circuit board for repair or replacement.

7.4.1.9 The diode sensing circuit board shall be constructed in such that it will be protected against reverse polarity on installation after repair or replacement.

7.4.1.9.1 The output signal from the diode sensor transmitter board shall be fibre optic transmitted. Wire conductors are not acceptable.

7.4.1.9.2 Diode monitoring systems utilising Programmable Logic Controllers (PLC) is not acceptable.

7.4.2 RECTIFIER DIODE MONITORING PANEL AND DISPLAY

7.4.2.1 The rectifier unit shall be fitted with a diode monitoring panel for monitoring the condition of each diode.

7.4.2.2 Each diode shall be clearly numbered on the front display cover of the diode monitoring panel as well as on the diode module. The markings shall be silk screened engraved or similar.

7.4.2.3 The panel shall be fitted with Light Emitting Diodes (LED's) to indicate the condition of the diodes. The LED's shall be green for a healthy diode and red for an open circuit or short circuit diode.

7.4.2.4 The panel shall be fitted with a yellow LED for fan control and the red LED for over-temperature.

7.4.2.5 A remote reset switch or button to reset the LED's and the diode monitoring panel shall be fitted in the primary circuit breaker control panel.

7.4.3 ELECTRONICS

7.4.3.1 All printed circuit boards shall be constructed from high quality fibreglass material.

7.4.3.2 All printed circuit boards shall slide in high quality edge connectors and shall be easily removed for replacement or repairs.

7.4.3.3 All printed circuit boards with its components shall be coated for protection against moisture, corrosion and dust.

7.4.3.4 Each printed circuit board shall be polarised to prevent the card from being plugged into the wrong socket and to prevent the card from being inserted upside down.

7.4.3.5 The control unit shall be designed to fail to safe in the event of power supply failure or printed circuit board failure. Contacts shall be provided which can be utilised for lockout signals.

7.4.4 POWER SUPPLY SYSTEM

7.4.4.1 The power supply shall be of the switch mode design and shall be able to operate within the range of the voltages available in the substation.

7.4.4.2 The power supply as well as the remainder of the unit shall be extensively protected from lightning, transients and surges. Extensive use of gas arresters, inductors and capacitors will be required.

7.4.5 FIBRE OPTIC MONITORING BOARD

7.4.5.1 The annunciator shall be fitted with fibre optic receivers for signals transmitted from the diode sensor transmitter module.

7.4.6 INTERFACE INPUT-OUTPUT PRINTED CIRCUIT-BOARD

7.4.6.1 The diode monitoring main board shall be able to communicate the condition of the diodes by means of relay contacts.

8.4.6.1.1 Provision shall be made for one diode failure to lockout the substation with a remote flag indication and give a signal to the telecontrol system.

7.4.6.2 The relays shall function in the fail safe mode, i.e. the relays will be energised and will de-energise under faulty conditions.

7.5 COOLING

7.5.1 The rectifier unit shall be fitted with cooling fans with temperature sensors for the control of the cooling fan, temperature monitoring and rectifier over-temperature protection.

7.5.2 The direct heat sink temperature sensing method shall be used with multiple sensors connected in series.

7.5.3 Two thermal control switches shall be fitted to the rectifier for the energising of the cooling fans at a temperature of 50°C. Provision shall be made to prevent the fan from cycling at the energising temperature.

7.5.3.1 Suitable fan control circuitry shall be provided by the supplier.

7.5.4 The rectifier unit shall be provided with two over temperature sensing switches which shall be set at 80°C.

7.5.5 The rectifier over temperature protection shall be used for tripping purposes. The circuitry shall be provided by the supplier.

7.5.6 The wiring from the sensors to the fan controller shall be of the plastic fibre optic type and the sensors shall obtain their supply from the RC circuit.

7.5.7 The fan indication lights must be mounted on a fan cover for fan ON and OFF.

7.5.8 Fan airflow failure circuitry (vane switches) and relays shall be provided for control and indication purposes. A fan test switch which is spring loaded to the off position shall be provided and installed in the primary circuit breaker control panel.

7.5.9 Adequate measures shall be taken to ensure that the rectifier equipment does not overheat during periods of high loading. Details of the over temperature protective scheme shall be submitted with the tender.

7.5.10 Provision shall be made for adjustable current sensing to control the operation of the cooling fan(s). The fan(s) shall be energised when the main current reaches a value of 700 amps (adjustable.) The current sensing circuitry shall be sufficiently isolated and shall be installed in the primary circuit breaker control panel.

8.0 INSTALLATION

8.1 The contractor shall be responsible for the transport to site, off-loading, handling, storage and security of all material required for the installation of the rectifier unit.

8.2 The rectifier shall be installed within the substation building and shall be totally insulated from the floor by means of channel insulation or other high voltage insulating material.

9.0 EARTHING

9.1 The metal framework of the rectifier shall be connected to the existing DC earth leakage earthing system in accordance to drawing no. CEE-TBD-7. Should the existing earth strap not be suitable for re-use a new copper earth strap of least cross-section area or a stranded insulated copper conductor with a cross-sectional area of at least 95mm ^{2} shall be used.

10.0 CABLES

10.1 Armoured cables shall be used for the wiring of the cooling fans and any other external power circuitry.

10.2 All cables shall terminate in compression type glands. These glands shall be fitted with neoprene shrouds.

10.3 Screened cables and conductors shall be used for electronic screening and noise reduction techniques where required.

10.4 The fibre optic cables between the rectifier and the annunciator panel shall be protected from damage by means of conduit or trunking or other suitable means. Open fibre optic cables are not acceptable.

10.5 All cabling shall be clearly marked with high quality permanent markers. Sticker marking numbers will not be acceptable.

11.0 INTERCONNECTION OF EQUIPMENT

11.1 Suitably rated Copper or Aluminium busbars shall be used for the interconnection of the rectifier to the secondary winding of the traction transformer. The busbars between separately mounted equipment shall incorporate a degree of flexibility to avoid any over stressing of these connections due to movement caused by conductor expansion/contraction and to facilitate alignment of equipment. Sizes for AC (Copper

50X10mm and Aluminium 25X50mm) and sizes for DC (Copper 100X10mm and Aluminium 127X12.5mm).

11.2 High conductive silicon grease shall be liberally applied to all connections.

11.3 All dissimilar metal connections copper to aluminium (Cu to Al) shall be made using bi-metallic clamps that are specifically designed and manufactured to make that particular connection. (Adhoc fabricated clamps are not acceptable).

11.4 All copper connections to steel (galvanised) shall be tinned or silver coated.

12.0 INSPECTION, SITE TESTS AND COMMISSIONING

12.1 Transnet Freight Rail reserves the right to carry out inspection and any tests on the equipment at the works of the supplier/ manufacture.

12.2 Arrangements must be made timeously for such inspections to be carried out before delivery of the equipment to the client.

12.3 The contractor shall be responsible for carrying out on-site functional tests before the commissioning of the rectifier unit.

12.4 The testing of the rectifier shall include type tests for new design of rectifier units and routine tests which shall be conducted on all units. Quality Assurance labels must be mounted on the rectifier rating board.

12.4.1 The testing shall include the following: -

- Insulation tests.
- Light load tests.
- Functional tests on the associated control equipment and circuitry of the rectifier.
- Temperature rise tests i.e. temperature measurements on diode heatsinks. Maximum temperature rise shall not exceed 75° C.
- Checking of auxiliary and protective devices and control equipment.
- Rated output tests.
- Overcurrent capability test.
- Measurement of output voltage.
- Power loss determination.

12.4.2 Functional Acceptance by the Maintenance Manager of satisfactory completion of on-site tests in no way relieves the contractor of his obligation to rectify defects which may have been overlooked or become evident at a later stage.

12.5 Commissioning will only take place after all defects have been rectified to the satisfaction of the Maintenance Manager.

12.6 Commissioning will include the energising of equipment from the primary isolator to the track feeder circuits. The contractor must prove the satisfactory operation of equipment under live conditions.

12.7 On completion of commissioning the contractor will hand the equipment over to the Maintenance Manager in terms of the relevant engineering instructions.

13.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

13.1 Drawings, instruction manuals and spare parts catalogues shall be supplied in accordance with Transnet Freight Rail's specification CEE0224.

13.2 All drawings (paper prints) shall be submitted to the technical officer for approval. No Construction or manufacturing activity will be allowed prior to the associated drawings having been approved by the technical officer.

13.3 The tenderer shall supply three copies of an instruction/maintenance manuals, schematic diagrams, diode application notes and protection and filter ratings.

13.4 The contractor shall submit details of spares required in accordance with specification CEE0224

13.5 All spares recommended for normal maintenance purposes that are not available locally (requires importation) must be highlighted.

14.0 SPECIAL TOOLS AND/OR SERVICING AIDS

14.1 Special tools or servicing aids necessary for the efficient maintenance, repair or calibration of the equipment shall be quoted for separately.

14.2 Tenderers shall submit detailed offers for special tools and servicing aids including all specialised equipment required for the servicing and maintenance of the equipment supplied.

15.0 TRAINING

15.1 The tenderer shall submit details with the tender of the training courses, which will be conducted by the contractor for the training of Transnet Freight Rail's maintenance staff in the operation and maintenance of the equipment supplied. 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.

16.0 GUARANTEE AND DEFECTS

16.1 The contractor shall guarantee the satisfactory operation of the complete electrical installation supplied and installed by him and accept liability for maker's defects, which may appear in design, materials and workmanship.

16.2 The guarantee period for all substations shall expire after: -

A period of 12 months commencing on the date of completion of the contract or the date the equipment is handed over to Transnet Freight Rail whichever is the later.

16.3 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 e.g., faulty locomotive or overhead track equipment, etc., shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the Maintenance manager and at the cost of the Contractor.

16.4 If urgent repairs have to be carried out by Transnet Freight Rail's staff to maintain supply during the guarantee period the contractor 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.

17.0 APPENDIX A: SCHEDULE OF TECHNICAL REQUREMENTS

(To be completed by Transnet Representative)

1	Name of Depot	
2	Name of the substations	
3	Quantity of the rectifiers	
4	Supply Voltage to Rectifier Transformer (88KV or 132kV AC)	
5	Rectifier Transformer size (3.3MVA, 5MVA or 6MVA)	
6	Rectifier Transformer configuration (6 Pulse rectification or 12 Pulse rectification)	
7	Rectifier size (5MW or 6MW)	
8	Special requirements	…… …… …… …… …… ……

Completed by:	
Capacity:	
Signature:	
Date:	

18.0 APPENDIX B: TECHNICAL DATA SHEET

(To be completed by Tenderer)

1.0 Rectifier ratings (MW):_____

2.0 Number of diodes per branch:_____

3.0 Type of Diode:_____

3.0 Full load current rating of diode. $I_{FRMS:}$_____

4.0 Average current rating of diode. $I_{FAVM:}$_____

4.0 Repetitive Peak Reverse Voltage of diode:_____

5.0 Surge forward current 10 milli second Sine Wave:_____

6.0 Method of cooling of rectifier:_____

7.0 Method of temperature sensing: _____

8.0 Type of insulation used for frame to floor: _____

9.0 Physical dimensions of rectifier unit:

Height: _____ Breadth: _____ Width: _____

10.0 Name of suppliers where rectifier diodes can be sourced: _____

_____

11.0 Method of correct torque adjustment for heat sinks: _____

_____

12.0 Diode test certificate attached Yes/No:_____

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

Appendix 1

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

Appendix 2

SCHEDULE OF REQUIREMENTS

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

Appendix 3

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

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)

_____

TRANSNET freight rail

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

THE MANUFACTURE OF 3 KV DC BREAKER CELLS AND TRUCKS

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Date: 21 August 2018

Circulation Restricted To:

Transnet Freight Rail - Rail Network
- Technology Management

INDEX

1.0 SCOPE

This specification covers Transnet Freight Rail's requirements for the design and manufacture of a modular 3kV DC 2000A circuit breaker cell and truck for use on a 3kV DC traction system.

2.0 STANDARDS AND PUBLICATIONS

Unless otherwise specified all materials used and equipment developed and supplied shall comply with the current edition of the relevant SANS and Transnet freight rail's publications which are referred to in this specification:

2.1 SOUTH AFRICAN NATIONAL STANDARDS

SANS 1091: National Colour Standards.

SANS 1222: Enclosures for Electrical Equipment.

SANS 1274: Coatings applied by the powder-coating process.

2.2 TRANSNET FREIGHT RAIL'S SPECIFICATIONS

BBD5994: Technical Documentation Management Policy.

CEE.0045: Painting of Steel Components of Electrical Equipment.

CEE.0099: 3kV DC High Speed Circuit Breakers.

CEE.0224: Drawings, Catalogue, Instruction Manuals and Spares lists of Electrical equipment supplied under contract.

2.3 TRANSNET FREIGHT RAIL'S DRAWINGS

The following drawings form an integral part of this specification.

BBF1336: 3kV DC Circuit Breaker Components.

BBF1337: Secheron 3kV DC track breaker with DC Feeder protection relay.

BBF1338: EMC 3kV DC track breaker with DC Feeder protection relay.

CEE-TBP-42: Sheet 1. Connection Diagram for HSCB: New Breaker Cell.

CEE-TBP-42: Sheet 2 Connection Diagram for "ABB" HSCB: New Breaker Cell.

CEE-TBP-42: Sheet 3. Connection Diagram for "Ansaldo IR6003" HSCB: New Breaker Cell.

3.0 DEFINITIONS

AC: Alternating current.

Breaker: 3kV DC high speed circuit breaker.

Cell: Housing for circuit breaker and truck

DC: Direct current.

ECR: Electronic closing relay.

Truck: Circuit breaker mounted onto

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.

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 Failure to comply with clauses 4.1, 4.2, and 4.3 could preclude a tender from consideration.

5.0 APPENDIX

The following appendix forms an integral part of this specification:

Appendix 1 : List of drawings for both ECR and DC feeder protection relay.

6.0 SERVICE CONDITIONS

6.1 ENVIRONMENTAL CONDITIONS

The breaker cell, truck and associated equipment shall be designed and rated for operation under the following:

6.1.1 Altitude: 0 - 1800m above sea level.

6.1.2 Ambient temperature: -10^0 C to $+55^0$ C.

6.1.3 Relative humidity: 10% to 90%.

6.1.4 Lightning conditions: 20 ground Flashes/km^2/annum.

6.2 ELECTRICAL CONDITIONS

6.2.1 The nominal Voltage shall be 3300 Volts. The lowest shall be 2250 V and highest being 3900 V.

6.2.2 The nominal Current shall be 2000 A and the highest being 4500 A.

6.2.3 The maximum fault current shall be or up to 55kA.

7.0 DRAWINGS AND INSTRUCTION MANUALS

Drawings and instruction manuals shall be in accordance to Transnet Freight Rail's specification CEE.0224 and technical documentation management policy BBD5994.

8.0 TECHNICAL REQUIREMENTS

8.1 BACKGROUND

The older types of circuit breaker cells are made from gas concrete, Asbestos and in combination with the trucks are outdated and difficult to erect. For this reason a new modular type of design, where cells could be easily erected, added or removed, is required. The specification depicts the requirements for modular one cell and one truck. It is required that any number of individual cells be coupled together to form a unit.

8.2 BREAKER CELL

8.2.1 The cell shall be constructed using a rigid steel frame with sheet metal enclosures. The dimensions shown in Appendix 1 exclude the framework and may be modified if necessary to accommodate the breaker truck. Any other changes in dimensions shall be submitted for approval to the office of Transnet Freight Rail's Senior Engineer (Electrical) – Technology Management.

8.2.2 The sides and back of the breaker cell shall be of mild steel sheet metal not less than 2mm thick.

8.2.3 The floor of the breaker cell shall be of mild steel sheet metal not less than 3mm thick.

8.2.4 Provision must be made on the floor of the cell for "Rawl" bolts to bolt the cell to the floor of the substation. On the sides of the cell provision must be made to bolt cells together.

8.2.5 The whole cell will be moved as a unit after construction and therefore special attention must be given by the tenderer to the mechanical strength of the cell, including provision for attachment of lifting gear.

8.2.6 On both sides of the cell, the control panel (right top of the side view) and 3kV DC incoming busbar (left top of busbar chambers) shall have removable panels for the future extension of the cells.

8.2.7 At the back of the cell the 3kV DC incoming and outgoing busbars must be accessible via removable panels. All of these removable panels shall be secured with bolts or screws.

8.2.8 A warning notice of plastic material (sandwich board) shall be mounted on each of the 3kV DC incoming busbar removable panels (at the back of all cells and the two side panels) and shall read as follows (Red on white):

WARNING

DO NOT REMOVE PANEL BEFORE ALL EQUIPMENT IS ISOLATED.

8.2.9 A warning notice of plastic material (sandwich board) shall be mounted on each of the 3kV outgoing busbar removable panels (at the back of all cells) and shall read as follows (Red on white):

WARNING

DO NOT REMOVE PANEL BEFORE TRACK SWITCH IS OPEN AND THE BREAKER WITHDRAWN.

8.2.10 The size of the notice boards shall be 200mm x 150mm with red letters on a white background. The words "WARNING" shall be bigger than the rest of the easily readable words on the notices.

8.2.11 The roof of the cell shall be of a flat piece of fire retardant glass fibre or similar insulation material.

8.2.12 Provision for cooling on a trunk of the 3kV DC breaker cells (fins on the front of the trunk) shall be made at the back of the cell and have the same capacity as the truck. If the DC feeder relay is installed then the cooling shall be through the roof.

8.2.13 The 3kV DC outgoing busbar chamber shall be completely isolated from the 3kV DC incoming busbar chamber and other adjacent 3kV DC outgoing busbar chambers.

8.2.14 Provision shall be made for the termination of a 3kV DC cable onto the 3kV outgoing busbar. This cable screen must be insulated from the cell and therefore insulation material must be provided where the cable is terminated in the cell. (150mm clearance from cable to metal parts and cable chambers must stay individual).

8.2.15 Details of the 3kV incoming and outgoing busbar must be cable entry at the bottom chamber and busbar entry. The 3kV incoming and outgoing busbars must be able to handle a continuous DC current of 2000A. (Size of copper busbar: 100mm x 10mm.)

8.2.16 The 3kV incoming and outgoing busbars shall be fitted on synthetic insulators with the necessary tensile strength. (150mm clear from metal).

8.2.17 The whole busbar system must withstand the stresses created when the truck is pushed into or pulled out of the cell. The insulators must therefore be mounted on a steel frame in the cell and not only on the sheet metal.

8.2.18 Provision shall be made on the 3kV DC incoming busbar and the earth busbar to extend them from one cell to another. The extension busbar pieces (slotted) shall be provided by the tenderer.

8.2.19 The earth busbar shall not be less than half the size of the 3kV DC busbars and must be electrically connected to all the metal parts of the cell. The earth busbar must be able to handle 1500A continuously.

8.2.20 From the earth busbar a solid connection point for the truck shall be provided. This connection shall make when the truck is pushed into the cell so as to earth the truck before the main 3kV contacts make.

8.2.21 The opening which provides access to the cell's main 3kV contacts shall be covered by a non conductive, fire retardant material if the cell contacts are closer than 100mm to the shutter, otherwise metal can be used.

8.2.22 This shutter shall automatically open to give access to both main contacts as the truck enters the cell and shall close as the truck is removed from the cell.

8.2.23 Under no circumstances shall it be to come into contact with the 3kV DC incoming or 3kV DC outgoing busbars if the truck is removed from the cell.

8.2.24 This shutter shall be lockable by hand and automatically mechanically lock itself in the closed position with the truck removed from the cell. The shutter shall automatically unlock and open while the truck is pushed back into the cell. The shutter mechanism shall be developed by the tenderer.

8.2.25 In the control panel, three busbars must be provided for the operating supply of 110V DC to the breakers. The 110V busbars must be able to handle a continuous DC current of 30A.

8.2.26 Provision shall be made on all three busbars to extend them from one cell to another. The extension busbar pieces (slotted) shall be provided by the tenderer.

8.2.27 The 110V DC busbars shall be colour coded using a heat shrink method and shall be insulated from the metal cell via insulators. The top busbar shall be the negative 110V DC busbar and shall be coloured black. The second from top busbar shall be the positive 110V DC busbar and shall be coloured red. The third from the top and last busbar shall be the holding coil supply and shall be coloured grey.

8.2.28 On the front door of the control panel the ECR or DC feeder protection relay and receivers – (Current and voltage), open/close switch, local/remote switch, five miniature DC circuit breakers and three lights shall be mounted in a correct order(Close, lockout and open). On the inside of the control panel a terminal strip, limiting resistors and 154X relay or similar relay approved by Transnet Freight Rail – Technology Management, depending on the breaker used shall be fitted.

8.2.29 The tender shall supply all equipment as follows:

8.2.29.1 Three 110V LED's with red, yellow and green plastic covers for the indication lights.

8.2.29.2 A 110V, 15A double pole make before break switch for the local/remote switch.

8.2.29.3 A 110V, 15A switch, similar to the local/remote switch, for the open/close switch.

8.2.29.4 Three 2A, 110V DC circuit breakers and two 5A, 110V DC circuit breakers must be provided for the control of each breaker. The tenderer shall be notified in advance of which type of breaker will be used.

8.2.29.5 All the interconnections shall be done with 2,5mm square stranded copper wires. The interconnections shall be done according to drawing no. CEE-TBP-42 and the terminal strip shall be clearly marked as in this drawing.

8.2.29.6 A single 10 core control cable, 2,5mm square stranded copper per core, shall be provided for the connections to the breaker. This cable shall be fixed to the cell.

8.2.29.7 A connector that can be mounted on the breaker truck must also be provided to fit the 20 core cable connector.

8.2.29.8 The control cable shall be mechanically strengthened by a steel cable, running parallel with the control cable, of a shorter length. This steel cable must be fixed to the control cable connector and the breaker cell. The length of the cable shall allow the breaker truck to be fully removed from the cell for service purposes.

8.2.29.9 On returning the breaker truck to the breaker cell, the cable slack shall be taken in automatically in such a way that it is 150mm away from the breaker and out of the way of the operator.

8.2.30 Breaker cell – metal enclosure shall be as follows:

8.2.30.1 All the side walls of the breaker cell enclosure shall be covered with an insulation material of 4mm thickness and no metal parts from side walls shall protrude the insulation material.

8.2.30.2 The insulation material to be used shall be of polycarbonate panels.

8.2.30.3 The insulation panels shall be installed on insulators and they shall be in such a manner that they don't interfere with the removal and inserting of the breaker.

8.3 BREAKER TRUCK

8.3.1 The breaker truck's dimensions make provision for the latest designs of breakers.

8.3.2 The truck shall consist of a rigid steel frame with a mild steel sheet metal front panel. All dimensions shown are outer dimensions and shall not be changed without the approval of the office of Transnet Freight Rail's Senior Engineer (Electrical) in Technology Management.

8.3.3 The breaker must not be accessible, in any way, if the breaker is in service. The cooling fins in the front panel must therefore be constructed as shown.

8.3.4 The cell and truck shall be vermin proof when the breaker is in service.

8.3.5 Provision for the mounting of a breaker is made via a mounting plate.

8.3.6 The safety precautions to be followed when operating the bar.

8.3.6.1 The operator must open the breaker via the open/close switch whenever he removes the breaker from the cell or returns it to the cell. For a safety measure an electrical interlocking system must be implemented through the operating bar.

8.3.6.2 With the operating bar in the "OPEN" position, it shall open the breaker if the operator fails to do so via the open/close switch.

8.3.6.3 With the operating bar in the "OPEN" position, the truck would be free to be removed from the cell and returned to the cell.

8.3.6.4 With the operating bar in the "CLOSE" position, it shall be possible to operate the breaker. This will enable the operator to operate the breaker via the open/close switch.

8.3.6.5 With the operating bar in the "CLOSE" position and the truck fully entered in the cell, it shall not be possible to remove the truck from the cell.

8.3.6.6 After removal of the truck from the cell, it shall be possible for the operator to push the operating bar from the "OPEN" position to the "CLOSE" position. With the operating bar in the "CLOSE" position, it shall not be possible for the main contacts to be closed. The distance between the main 3kV DC contacts, mounted on the truck, and main 3kV busbar contacts shall not be less than 150mm.

8.3.6.7 With the operating bar in the "CLOSE" position and the truck removed from the cell, it shall be possible to test/calibrate the breaker.

8.3.6.8 When the breaker is put back into service, by using the operating bar on the front panel, the truck must be pushed into the cell for the main contacts to connect properly. When the truck has fully entered the cell, the operating bar must lock the truck in this position.

8.3.6.9 The breaker must now be controlled by the switches on the control panel. The operating bar mechanism shall be developed by the tenderer.

8.3.7 The truck and cell must have a guide system similar to the present rail (cell) and wheel (truck) system to guide the truck to make a proper connection between the main 3kV DC busbar contacts and main 3kV DC contacts, mounted on the truck.

8.3.8 The truck must be fitted with a copper earthing contact, in the middle under the truck, which is electrically connected to all the metal parts of the truck. This contact shall be electrically connected with the earth busbar in the cell before the main contacts are connected, when the truck enters the cell.

8.3.9 The main 3kV DC contacts, mounted on the truck, shall be of the female type (covered on the outside by insulation material if clearance between cell steel work and contact is less than 75mm), fit properly (electrically and mechanically) over the main 3kV DC busbar contacts and shall be rated to carry a continuous current of 2000A.

8.3.9.1 The temperature rise of the main contacts (copper) shall not exceed 55 degrees Celsius while passing the continuous rated current.

8.3.9.2 The main 3kV DC contacts, mounted on the truck, shall be solidly mounted on fire retardant insulating material with the nearest metal part of the truck 150mm away.

8.4 ECR OR DC FEEDER PROTECTION RELAY

8.4.1 The ECR must be Transnet Freight Rail (TFR) approved according to the TFR design and drawings.

8.4.2 The DC feeder protection relay must be Transnet Freight Rail approved.

8.4.3 The relay and all its associated equipment must work on 110V DC.

8.4.4 The receivers for voltage and current must be mounted in a control cubicle and must get the input from the transducer via fibre optic.

8.4.5 The fibre optic shall not be in the same trunk or pipe as the control wires.

8.4.6 The transducer shall not have 3kV DC on the more positive connection if the line test contacts on the High Speed Circuit Breaker are closed.

8.4.7 The DC feeder protection relay shall have the Resistor, Contactor (Line test), Transducer, Voltage receiver, Current receiver and the relay.

8.4.8 The relay reset button and two receivers shall be mounted in the control cabin.

8.4.9 The transducer, resistor and line test relay shall be mounted above the busbar chamber but in a separate chamber.

8.4.10 The shunt shall be mounted on the cable side of the busbar on the breaker (4000A, 50mV shunt).

8.4.11 The equipment required for the DC feeder protection relay shall be installed on top of the busbar chamber at the back of the breaker cell and truck.

8.4.12 Sufficient airflow/ventilation shall be provided for the resistors at the top roof of its compartment.

8.4.13 The 3kV DC circuit of the feeder protection relay shall be disconnected from the main 3kV DC circuit in the event of the circuit breaker/truck being removed from the cell.

8.4.14 Wiring in the 3kV DC circuit breaker shall be of high voltage.

8.4.15 Low voltage, high voltage and fibre optic wiring shall be separately installed in its own piping/tubing.

8.4.16 Wiring installed from the front panel to the back of the cell shall be installed in separate pipes. Where one shall be for the control purposes (At 110V DC) and the other for the fibre optic.

8.4.17 High Speed Circuit breaker installed shall be in accordance to specification CEE 0099.

8.4.18 The 3kV DC circuit breaker shall be Bi-directional type.

8.4.19 In the event of 3kV DC circuit breaker being controlled by feeder protection relays an intertripping circuit/coil shall be provided.

9.0 PAINTING

9.1 All equipment shall be painted in accordance with Transnet Freight Rail Infrastructure (Electrical) specification CEE.0045. The finishing coats shall be of the colours specified below.

9.2 Colour code numbers shall be in accordance to SANS 1091.

9.2.1 Exterior of the breaker cell and truck and roof: - Eau-de nil.

9.2.2 Interior of the cell and the truck frame :- White (Gloss) fire retardant paint.

9.3 Coatings applied by powder shall be in accordance to SANS 1274.

10.0 INSULATION LEVELS

10.1 The minimum clearance distance in air that shall apply from the 3kV DC circuit to the auxiliary circuits and to the steel work of the cell and truck shall be 150mm, except for the 3kV DC busbar

configuration, where it may be reduced to 75mm. Alternatively, double insulation or barriers shall be provided.

10.2 The insulation between the 3kV DC circuit and the auxiliary circuits and the steel work of the cell and truck shall be capable of withstanding a test voltage of 10,5kV AC 50Hz for one minute.

11.0 TESTS BY TRANSNET FREIGHT RAIL

11.1 Transnet Freight Rail reserves the right to test a cell, truck and main contacts for compliance with the following clauses.

11.1.1 Insulation tests, clauses 10.1 and 10.2.

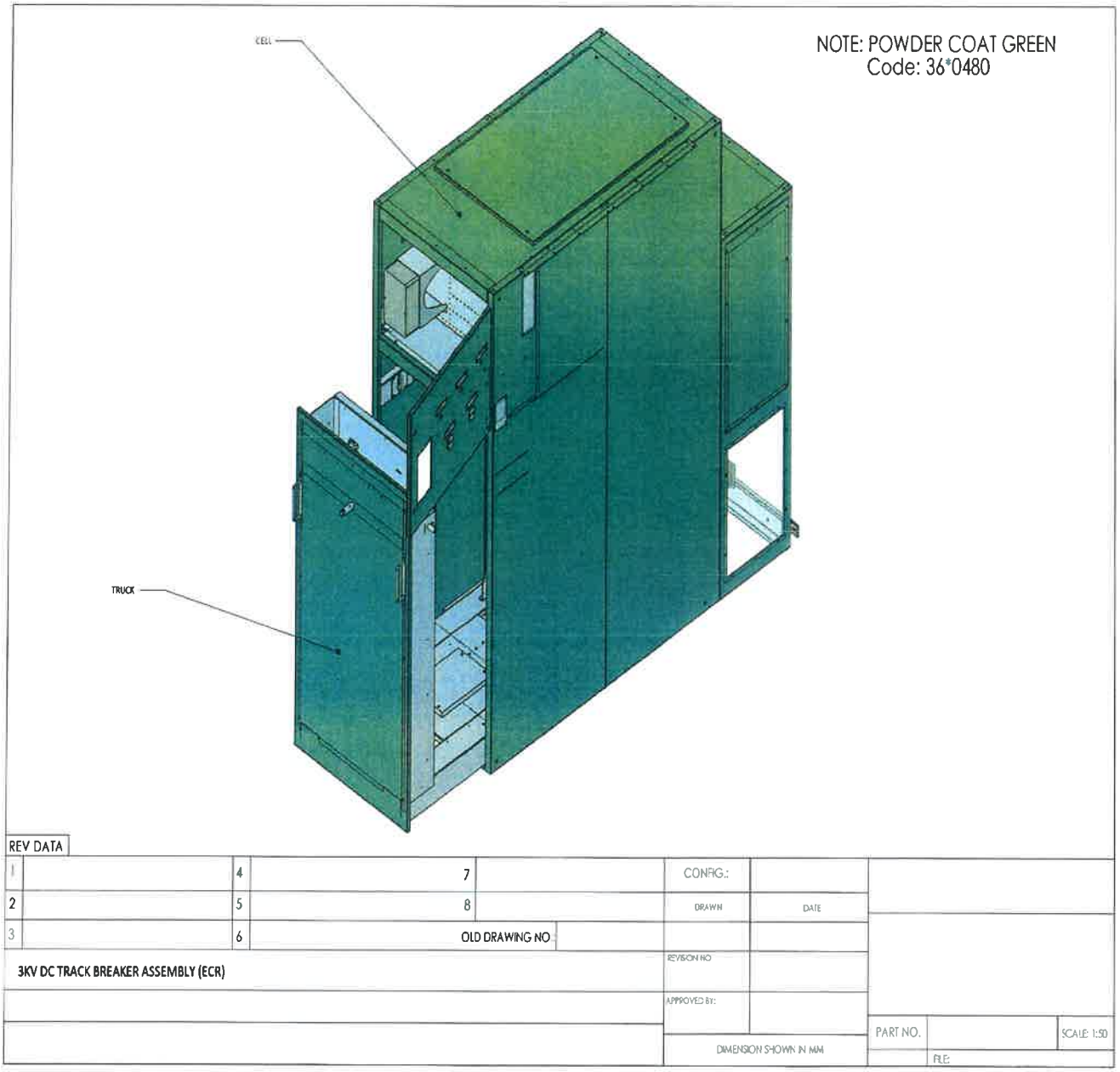
11.1.2 Temperature rise of the main contacts, clause 8.3.9.2.

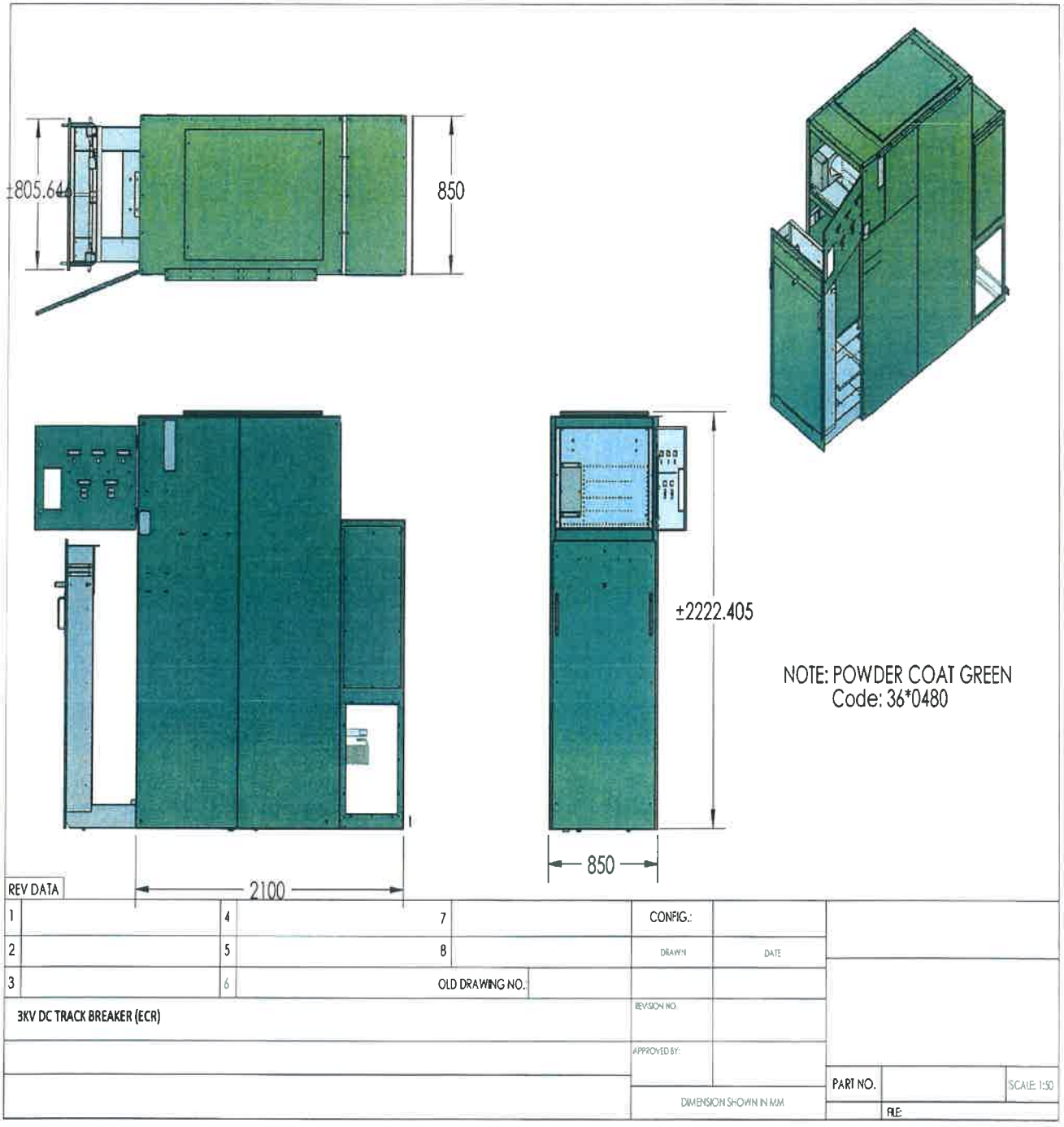
12.0 PROTOTYPE

One prototype of the breaker cell and truck shall be provided for evaluation by Transnet Freight Rail, before the balance of the order is built.

13.0 APPENDIX 1

LIST OF DRAWINGS

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2
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4
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6
7
8
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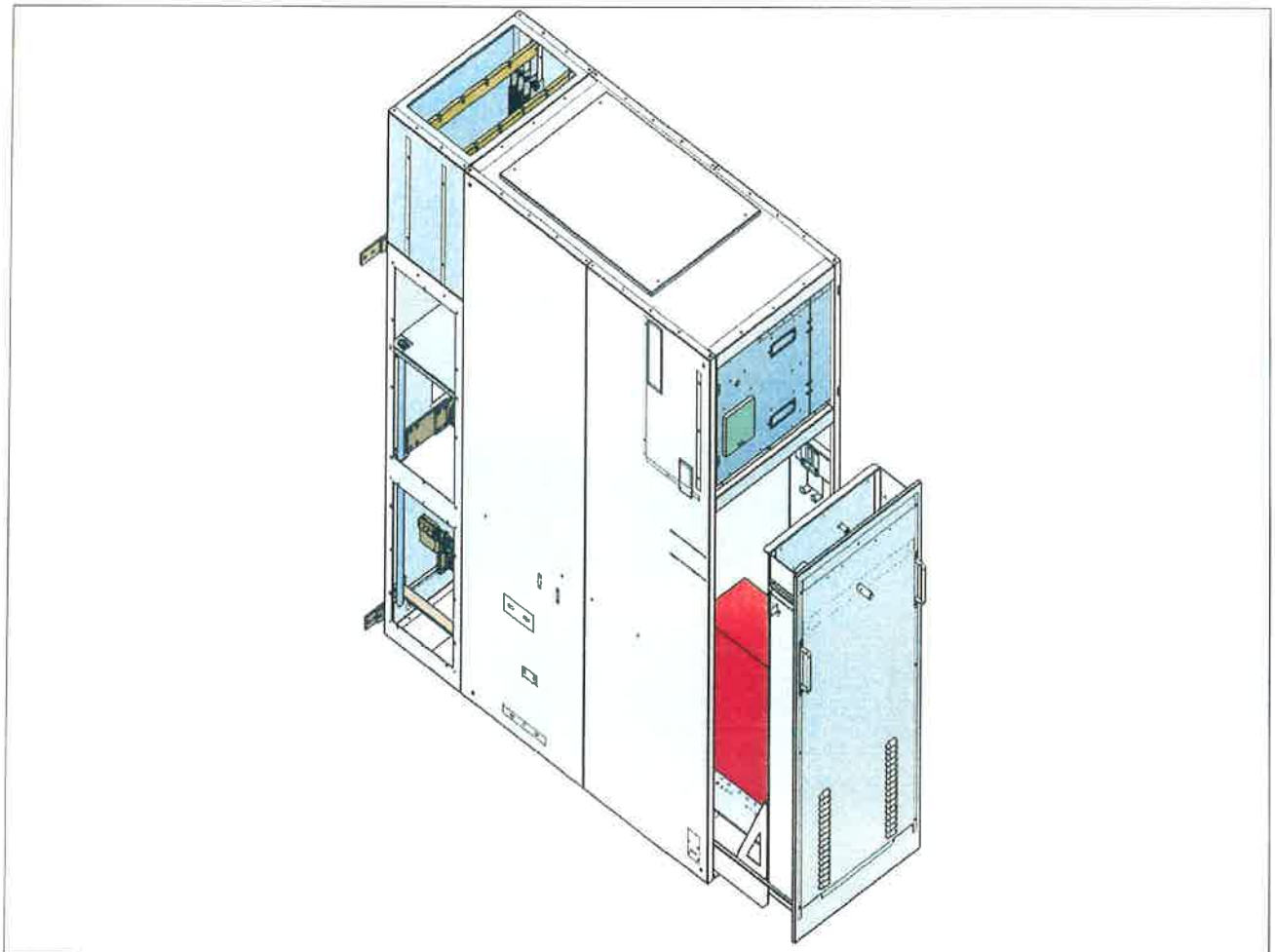
CONFIG.:
DRAWN
DATE
REVISION NO.
APPROVED BY:
DIMENSION SHOWN IN MM
3KV DC TRACK BREAKER (ECR)
PART NO.
SCALE: 1:50
FILE:



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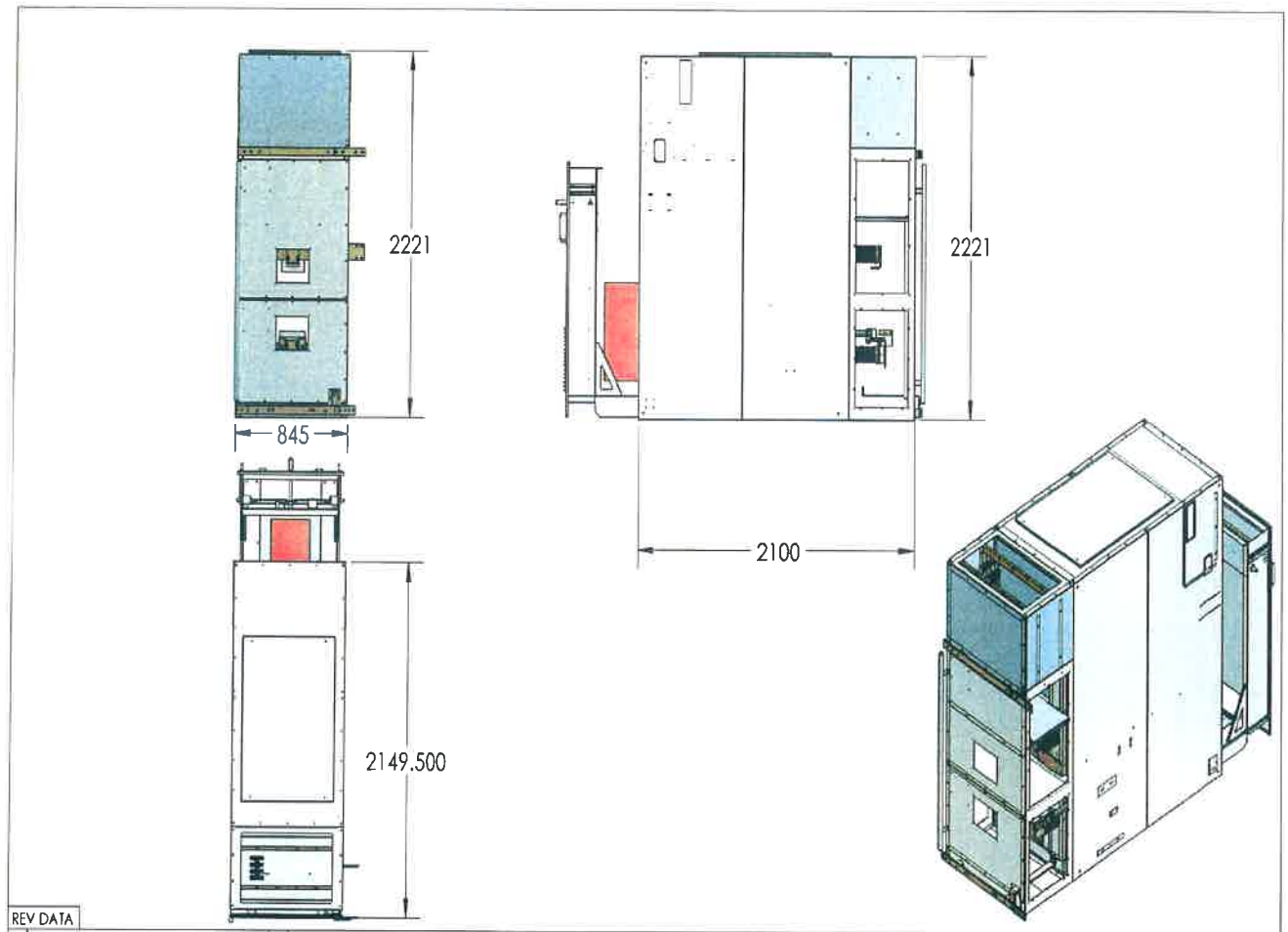

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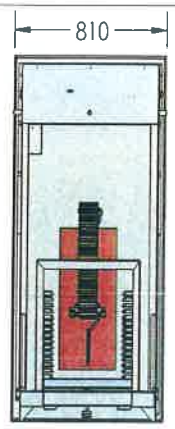

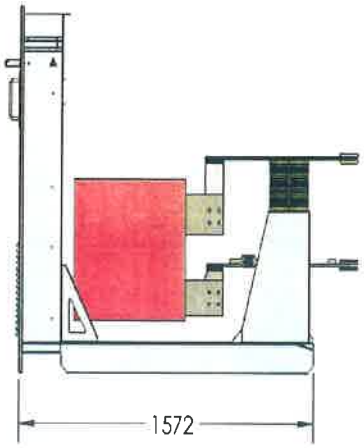

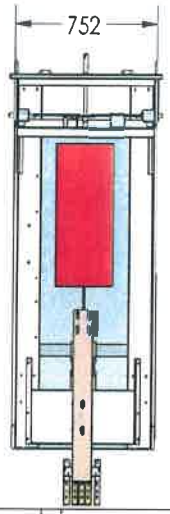

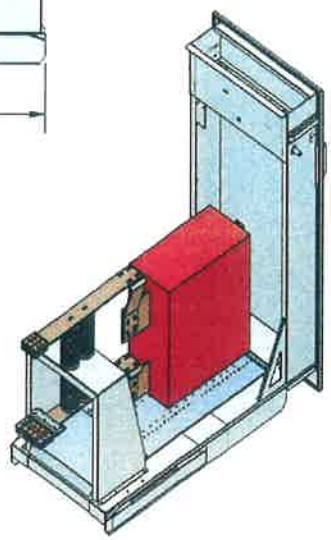

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PART NO. | SCALE: 1:33 | FILE: