Part C2:
Pricing Data

Part C3:
Scope of Work

Contract Data

The Employer is

Name	**Transnet Limited, Trading as Transnet Freight Rail**
Address	**C/o Paul Kruger & Minnaar streets, Nzasm Building, Pretoria**
Telephone	**(012) 315 2137/2 Fax No. (012) 315 2138**
E-mail	**Nico.swart3@transnet.net**

The works is: the design ,supply, install, test and commission of 5MW rectifiers, AC/DC distribution panels with DC earth leakage relays, PCB control panels, AC earth leakage relays, positive isolators and all associated cables at Elandshoek and Krokodil 3kV DC traction substations under the control of the Depot Engineer, Nelspruit

The site is	Elandshoek and Krokodil 3kV DC traction substations
The starting date is	to be advised……
The completion date is	to be advised……
The reply period is	two weeks
The defects date is	fifty two weeks after completion
The defect correction period is	within 1 (one) week after defects date
The delay damages are	R5000.00 per day
The assessment day is the	13th (thirteen) of each month
The retention is	10 %(ten)

Does the United Kingdom Housing Grants, Construction and Regeneration Act (1996) applies? **No**

The Adjudicator is

Name: To be advised if disputes arise……

Address:……..

Telephone:…..……Fax No. ……

E-mail:……..

Contract Data

The interest rate on late payment is 2% per complete week of delay.

The *Contractor* is not liable to the *Employer* for loss of or damage to the *Employer*'s property in excess of R2m (two million) for any one event.

The *Employer* provides this Insurance**: Transnet Principal Control Insurance**

The minimum amount of cover for the third insurance stated in the Insurance Table is

> R25,000.00 (Limited to R10, 000, 000.00. for any one event)

The minimum amount of cover for the fourth insurance stated in the Insurance Table is:

Not applicable ……

The adjudicator nominating body is: **The Chairman of the Association of Arbitrators (Southern Africa)**

The tribunal is: **Arbitration** ……

If the tribunal is arbitration, the arbitration procedure is: **The rules for the Conduct of Arbitrators of the Association of Arbitrators (Southern Africa)** ……

The *conditions of contract* are the NEC3 Engineering and Construction Short Contract (June 2005) and the following additional conditions:

As mentioned in paragraph 1.0 (Contractual obligations)

1.0 CONTRACTUAL OBLIGATIONS

1.1 This project specification covers Transnet freight rail's requirements for the design ,supply, install, test and commission of 5MW rectifiers, AC/DC distribution panels with DC earth leakage relays, PCB control panels, AC earth leakage relays, positive isolators and all associated cables at Elandshoek and Krokodil 3kV DC traction substations under the control of the Depot Engineer, Nelspruit.

1.2 The Contractor shall not make use of any sub-Contractor to perform the works or parts thereof without prior permission from the Employer.

1.3 The Contractor shall ensure that a safety representative is at site at all times.

1.4 The Contractor shall comply with all applicable legislation and Transnet safety requirements adopted from time to time and instructed by the Employer / Employer's Deputy. Such compliance shall be entirely at his own cost, and shall be deemed to have been allowed for in the rates and prices in the contract.

1.5 The Contractor shall, in particular, comply with the following Acts and Transnet Specifications:-

1.5.1 The Compensation for Occupational Injuries and Diseases Act, No. 130 of 1993. The Contractor shall produce proof of his registration and good standing with the Compensation Commissioner in terms of the Act.

1.5.2 The Occupational Health and Safety Act (Act 85 of 1993).

1.5.3 The explosive Act No. 26 of 1956 (as amended). The Contractor shall, when applicable, furnish the Employer / Employer's Deputy with copies of the permits authorising him or his employees, to establish an explosives magazine on or near the site and to undertake blasting operations in compliance with the Act.

1.5.4 The Contractor shall comply with the current Transnet Specification E.4E, Safety Arrangements and Procedural Compliance with the Occupational Health and Safety Act, Act 85 of 1993 and Regulations and shall before commencement with the execution of the contract, which shall include site establishment and delivery of plant, equipment or materials, submit to the Employer / Employer's Deputy.

1.5.5 The Contractor shall comply with the current Specification for Works On, Over, Under or Adjacent to Railway Lines and near High Voltage Equipment – E7/1, if applicable, and shall take particular care of the safety of his employees on or in close proximity to a railway line during track occupations as well as under normal operational conditions.

1.6 The Contractor's Health and Safety Programme shall be subject to agreement by the Employer / Employer's Deputy, who may, in consultation with the Contractor, order supplementary and/or additional safety arrangements and/or different safe working methods to ensure full compliance by the Contractor with his obligations as an employer in terms of the Act.

1.7 In addition to compliance with clause 1.4 hereof, the Contractor shall report all incidents in writing to the Employer / Employer's Deputy. Any incident resulting in the death of or injury to any person on the works shall be reported within 24 hours of its occurrence and any other incident shall be reported within 48 hours of its occurrence.

1.8 The Contractor shall make necessary arrangements for sanitation, water and electricity at these relevant sites during the installation of the equipments.

1.9 A penalty charge of **R5,000** per day will be levied for late completion of the project.

1.10 10% retention money will be retained and will be released 12 months after the completion date of the contract.

1.11 The Contractor shall supply a **site diary** (with triplicate pages). This book shall be used to record any unusual events during the period of the work. Any delays to the work shall also be recorded such as delays caused by poor weather conditions, delays caused by permits being cancelled etc. The appointed Employer or Employer's Deputy must countersign such delays. Other delays such as non-availability of equipment from 3rd party suppliers must be communicated to the Employer or Employer's Deputy in writing.

1.12 The Contractor shall supply a **site instruction book** (with triplicate pages). This book shall be used to record any instructions to the Contractor regarding problems encountered on site – for example the quality of work or the placement of equipment. This book shall be filled in by the Employer or Employer's Deputy and must be countersigned by the Contractor.

1.13 Both books mentioned in 1.10 and 1.11 shall be the property of Transnet Freight Rail and shall be handed over to the Employer or Employer's Deputy on the day of energising or handing over.

1.14 All processes or the manufacture and assembly of the product components must be subjected to a quality assurance system.

1.15 The Contractor will assume full responsibility for assuring that the products purchased meet the requirements of Transnet Freight Rail for function, performance, and reliability, including purchased products from 3rd part suppliers/Manufacturers.

1.16 The Contractor shall prove to Transnet Freight Rail that his equipment or those supplied from 3rd party suppliers/manufacturers confirms to Transnet freight rail specifications.

1.17 The Contractor will remain liable for contractual delivery dates irrespective of deficiencies discovered during workshop inspections.

1.18 ISO.9000 to 9004 inclusive (SABS 0157 parts 1 to 4) must be regarded as a guideline, where applicable.

Contract Data

The *Contractor*'s Offer

The Contractor is

Name ……..

Address ……

……

Telephone …… **Fax No.** ……

E-mail ……

The percentage for overheads and profit added to the Defined Cost for people is……...%.

The percentage for overheads and profit added to other Defined Cost is…….... %.

The *Contractor* offers to Provide the Works in accordance with the *conditions of contract* for an amount to be determined in accordance with the *conditions of contract.*

The offered total of the Prices is (VAT @14% inclusive)(**In words**)…….

……

Amount in figures: R……...(VAT @14% inclusive)

Signed on behalf of the Contractor

Name ……

Position ……

Signature……Date ……

The *Employer*'s Acceptance

The *Employer* accepts the *Contractor*'s Offer to Provide the Works

Signed on behalf of the *Employer*

Name ……

Position ……

Signature…… Date ……

Part C2.1: Pricing Data
Price Instructions

2.0 PRICING INSTRUCTIONS

1. The agreement is based on the NEC Engineering and Construction Short Contract 3. The contract specific variables are as stated in the contract data. Only the headings and clause numbers for which allowance must be made in the Price list are recited.

2. Preliminary and General Requirements are based on part 1 of SANS 1921, 'Construction and Management Requirements for Works Contracts'. The additions, deletions and alterations to SANS 1921 as well as the contract specific variables are as stated in the contract data. Only the headings and clause numbers for which allowance must be made in the Price list are recited.

3. It will be assumed that prices included in the Price list are based on Acts, Ordinances, Regulations, By-laws, International Standards and National Standards that were published 28 days before the closing date for tenders.

4. Reference to any particular trademark, name, patent, design, type, specific origin or producer is purely to establish a standard for requirements. Products or articles of an equivalent standard may be substituted.

5. The Price list is not intended for the ordering of materials. Any ordering of materials, based only on the Price list, is at the Contractor's risk.

6. The amount of the Preliminaries to be included in each monthly payment certificate shall be assessed as an amount prorated to the value of the work duly executed in the same ratio as the preliminaries bears to the total of prices excluding any contingency sum, the amount of the Preliminaries and any amount in respect of contract price adjustment provided for in the contract.

7. The amount or items of the Preliminaries shall be adjusted to take account of the theoretical financial effect which changes in time or value (or both) have on this section. Such adjustments shall be based on adjustments in the following categories as recorded in the Price list:

   a) An amount which is not to be varied, namely Fixed (F).
   b) An amount which is to be varied in proportion to the contract value, namely Value Related (V).
   c) An amount which is to be varied in proportion to the contract period as compared to the initial construction period, excluding revisions to the construction period for which no adjustment the Contractor is entitled to in terms of the contract, namely Time Related (T).

8. The following abbreviations are used in the Price list:

Hr	=	Hour
Ea	=	Each
Quant	=	Quantity

9 The prices and rates in these Price list are fully inclusive prices for the work described under the items. Such prices and rates cover all costs and expenses that may be required in and for the execution of the work described in accordance with the provisions of the scope of work and shall cover liabilities and obligations set forth or implied in the Contract data, as well as profit.

10 Where the scope of work requires detailed drawings and designs or other information to be provided, all costs associated therewith are deemed to have been provided for and included in the unit rates and sum amount tendered for such items.

11 Where no quantity has been provided against an item in the Price list, the Contractor shall use their discretion and provide the quantity.

12 The quantities set out in these Price list are approximate and do not necessarily represent the actual amount of work to be done. The quantities of work accepted and certified for payment will be used for determining payments due and not the quantities given in these Price list.

13 The short descriptions of the items of payment given in these Price list are only for purposes of identifying the items. More details regarding the extent of the work entailed under each item appear in the Scope of Work.

14 Contractor shall ensure that provision (financial as well as time) for excavations in a range of soil types is made for in their tenders.

15 For each item in the Price list, including Preliminaries, the Contractor shall provide in the appropriate column the portion of the tendered sum (inclusive of labour and material) which has been sourced locally (Republic of South Africa).

16 The Contractor shall also arrange forward cover within two weeks after contract award on all imported items.

17 The Contractor shall provide information related to imported content, i.e. equipment to be imported, value and applicable exchange rates. This information shall be provided as an Annexure to the Price list.

18 The total in the Price list shall be exclusive of VAT.

Contract Data: Price List

Item No.	Description	Unit	Qty	Rate	Price
A	**Elandshoek 3 kV DC Substation**				
1	Dismantle, remove and transport old equipment from site to Nelspruit Infra Depot.	sum	1		
2	Supply and install busbars from the wall bushings to the rectifiers	sum	7		
3	Supply and install 5 MW rectifier complete with diode monitoring and fan control	ea	1		
4	Supply and install busbars to and from Rectifier, Reactor coil, Positive isolator including negative bar	sum	1		
5	Supply and install Positive isolator with built-in 3kv under voltage relay	ea	1		
6	Supply and install AC current transformer (for AC earth leakage protection) in its polycarbonate box together with the associated cables.	ea	1		
7	Supply all cables connection to the negative bar	sum	1		
8	Supply and install 4000 A / 50 mV shunt	ea	1		
9	Dismantle and Redo indoor earthing according to specification.	sum	1		
10	Supply and install DC earth leakage relay outside the panel and its polycarbonate box		1		
11	Supply checker plates where necessary	sum	1		
12	Supply and install AC/DC control panel. Supply with all protection relays and associated cables	ea	1		
13	Supply and install AC primary circuit breaker control panel with all protection relays.	ea	1		
14	Supply and install all control cables and power cables to and from all the equipment including the telecontrol	sum	1		
15	Supply and install Track Feeder High Speed Circuit Breakers.	sum	1		
16	Supply mechanical inter-locking keys	sum	1		
17	Drawings, instruction manuals and catalogues	sum	1		
18	P's & G's	sum	1		
19	Installation, Testing and Commissioning	sum	1		
A	**Total price for Elandshoek 3kV traction substation (Excl. VAT)**				

Contract Data: Price list

Item No.	Description	Unit	Qty	Rate	Price
A	**Krokodil 3 kV DC Substation**				
1	Dismantle, remove and transport old equipment from site to Nelspruit Infra Depot.	sum	1		
2	Supply and install busbars from the wall bushings to the rectifiers	sum	7		
3	Supply and install 5 MW rectifier complete with diode monitoring and fan control	ea	1		
4	Supply and install busbars to and from rectifier, reactor coil, positive isolator including negative bar	sum	1		
5	Supply and install Positive isolator with built-in 3kv under voltage relay	ea	1		
6	Supply and install AC current transformer (for AC earth leakage protection) in its polycarbonate box together with the associated cables.	ea	1		
7	Supply all cables connection to the negative bar	sum	1		
8	Supply and install 4000 A / 50 mV shunt	ea	1		
9	Dismantle and Redo indoor earthing using 95mm flexible copper wire	sum	1		
10	Supply and install DC earth leakage relay outside the panel and its polycarbonate box		1		
11	Supply checker plates where necessary	sum	1		
12	Supply and install AC/DC control panel. Supply with all protection relays and associated cables	ea	1		
13	Supply and install AC primary circuit breaker control panel with all protection relays.	ea	1		
14	Supply and install all control cables and power cables to and from all the equipment including the telecontrol	sum	1		
15	Supply and install SF6 Primary breaker, with associated cables and multi core cable and connect the telecontrol	sum	1		
16	Dismantle and Redo outdoor earthing	sum	1		
17	Supply mechanical inter-locking keys	sum	1		
18	Drawings, instruction manuals and catalogues	sum	1		
19	P's & G's	sum	1		
20	Installation, Testing and Commissioning	sum	1		
B	**Total price for Krokodil 3kV DC traction substation(Excl. VAT)**				

2.0 **Description of work**

The Contractor shall perform the following:

3.0 **Description of work**

3.1 **SUPPLY AND INSTALLATION OF CABLES**

3.1.1 Contractor shall supply and install all the control and power cables in accordance with the specifications BBC 0198 version 1 and CEE 0023 of 1990.

3.1.2 The Contractor shall supply and connect the 95mm^2 PVC insulated welding cable to interconnect all new and existing equipment to the DC earth leakage relay system.

3.2 **MECHANICAL INTERLOCKING DEVICES AND CHECKER PLATES**

3.2.1 Supply and install an interlocking mechanism complete (similar to existing) of the key exchange type, which include the AC disconnects, positive isolator, auxiliary transformer short out links to the HT bay gate in the correct sequence in accordance with the specification BBB 5452 version 2.

3.3 **DIRECT CURRENT EARTH RELAY CIRCUIT**

3.3.1 Supply and install the DC earth leakage relay. The DC earth leakage relay shall be mounted outside the control panel at a position pointed out by Transnet Freight Rail. The relay shall be enclosed in a polycarbonate box.

3.3.2 The Contractor shall connect all existing checker plates as well as existing equipment (all indoor steelwork) to the DC earth leakage system. The Contractor shall also supply any missing checker plate.

3.3.3 The Contractor shall replace the DC earth leakage arrangement (system) as per drawing CEE TBD 0007 and enclosed in 25mm² PVC conduits against the walls. The crimping lugs of the interconnection cables shall be correspondingly marked with the busbar as shown on drawing CEE TBD 0007.

3.3.4 Only hexagon crimps will be accepted on all crimping lugs.

3.3.5 Resistance between the DC earth leakage busbar and the substation earth mat shall not be less than 25 Ohm.

3.4 **3KV DC RECTIFIER**

3.4.1 Supply and mount the copper/aluminium busbar on the substation wall inside the rectifier bay. The installation shall include the supply of all the required insulators, bolts and fasteners.

3.4.2 The Contractor shall then supply and install copper/aluminium busbars from the wall bushing to the rectifier unit.

3.4.3 Supply and install 5MW rectifier complete with the diode monitoring system and fan control in accordance with the specification BBB 0496 version 10.

3.4.4 Supply and install Aluminium/copper busbar between the rectifier and the negative bar. The negative busbar shall be painted black

3.5 AC PCB CONTROL PANEL AND AC/DC DISTRIBUTION PANEL

3.5.1 Remove the existing AC/DC distribution panels, AC PCB panels from site and transport them to Nelspruit Infrastructure depot.

3.5.2 Supply and install AC PCB control panel and AC/DC distribution panels in accordance with the specification BBB 2721 version 9.

3.5.3 The Contractor shall wire the tripping and lock out circuits in accordance with the drawings CEE TBK 0027 and CEE TBK 0028. The circuits shall be incorporated into the AC PCB control panel.

3.5.4 The Contractor shall rewire controls for the extractor fan and incorporate into the distribution panel.

3.5.5 Ensure room fan circuit is still working.

3.5.6 Transnet Freight Rail representative shall inspect all the panels on the Contractor's premises prior to delivery to site.

3.5.7 All direct current wiring shall be done in grey coloured wire.

3.5.8 Colour Red, White and Blue shall be used for AC circuits only. All alternating current wiring shall be colour coded using the standard colours red, white, blue and black for neutral.

3.5.9 Interior shall be done in gloss white and exterior shall be done in Eau- de- nil high gloss to SANS 1091 colour code no G22.

3.5.10 Panels shall be colour coated in accordance with SANS 1274.

3.5.11 Insulated lugs, of the crimp on type, shall be used to terminate wiring onto equipment, strip connectors and protection relays.

3.5.12 Screw on terminal lugs shall be used on all the protection relays.

3.5.13 All new and existing cables and wiring shall be clearly labelled by using an approved slide on wiring label system as described.

3.5.14 Where applicable, the Contractor will be responsible to connect and interconnect the control wiring and cabling of existing equipment to the new and old equipment.

3.5.15 The Contractor shall make provision for a connection strip in the AC/DC distribution panel and the primary circuit breaker control panel for remote tele-control operations.

3.5.16 The Contractor shall notify Transnet Freight Rail on completion of the panels in order to witness functional tests on the premises of the Contractor before delivery.

3.5.17 The Contractor shall incorporate all existing equipment functions into the schematic drawings as per specification CEE 0224 0f 2002.

3.5.18 A copper busbar system consisting of a busbar for each phase red, white and blue shall be used, in the AC/DC panel and concealed behind Perspex with warning sign and voltage identification label.

3.5.19 A copper busbar system consisting of battery supply, holding coil volts and negative shall be used and covered with Perspex with a warning sign and voltage labels.

3.5.20 The Contractor shall supply and install the auxiliary supply switch inside the AC/DC control panel.

3.5.21 Provision will be made in the primary circuit breaker control panel to install primary overload protection for the auxiliary supply.

3.5.22 All control panels shall be insulated from the substation floor.

3.5.23 The layout of the AC and DC equipment inside the control panels shall be done in such a way that the equipment is separated from each other.

3.5.24 Transnet Freight Rail shall inspect the layout of the equipment before wiring commences of the panels.

3.5.25 All equipment used in the primary circuit breaker control panel and the AC/DC distribution panel shall comply with the SANS 0142.

3.5.26 Clean substation inside floor.

4.0 INSTALLATION

4.1 The Contractor shall be responsible for the transport to site, off-loading, handling and storage of all material required for the construction/ execution of the works.

4.2 All fasteners on steelwork, components and electrical connections (nuts and bolts) shall be secured using flat as well as lock washers.

4.3 Contractor shall supply multi core cable and connect the tele-control. The substation shall not be switched on unless the tele-control is fully operational.

5.0 INTERCONNECTION OF EQUIPMENT

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

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

6.0 DRAWINGS, INSTRUCTION MANUALS AND SPARE PART CATALOGUES

6.1 All as built drawings shall be supplied in electronic format (Microstation/Acad).

6.2 The successful Contractor shall be required to submit all drawings (paper prints), within four weeks of award of tender, to the Employer or Employer's Deputy for approval. No construction or manufacturing activity will be allowed prior to the associated drawings having been approved.

6.3 During the duration of the contract period, the successful Contractor will be required to inform the Employer or Employer's Deputy of any changes to these drawings and will have to resubmit the affected drawings for approval prior to it being used on this contract.

6.4 All drawings, catalogues, instruction book and spares lists shall be in accordance with Transnet Freight Rail's specification CEE.0224.2002.

6.5 All final as built drawings shall be provided to Transnet Freight Rail within four weeks after commissioning.

6.6 Supply three sets of A3 schematic wiring diagrams in hard copy format and electronic format for approval.

7.0 SITE TESTS

7.1 The equipment shall be inspected/ tested and approved by Transnet Freight Rail Quality Assurance at the Contractor's workshop prior to it being taken to site. Only once the approval has been granted can the equipment be taken to site for installation.

7.2 The Contractor shall be responsible for carrying out of on-site tests and commissioning of all equipment supplied and installed in terms of this specification and the contractual agreement.

7.3 Functional on-site tests shall be conducted on all items of equipment and circuitry to prove the proper functioning and installation thereof.

7.4 The Contractor shall submit a detailed list of on-site tests for the approval of the Employer or Employer's Deputy.

7.5 The Contractor shall arrange for the Employer's Deputy or his representative to be present to witness the on-site tests.

7.6 The on-site tests and subsequent commissioning **will not commence until ALL CONSTRUCTION** work has been completed. Construction staff, material and equipment shall be removed from site prior to the commencement of testing. Testing and commissioning of the power plants equipment will not be allowed to take place in a construction site environment.

7.7 The on-site tests shall include the following:

7.7.1 Test for the functionality of all electrical circuitry.
7.7.2 Trip tests on relays.
7.7.3 Test on equipment as per manufacturer's instructions.
7.7.4 Insulation tests.

7.8 At the completion of the on-site tests, the Employer or Employer's Deputy or his representative shall either sign the tests sheets (supplied by the Contractor) as having witnessed the satisfactory completion thereof, or hand to the Contractor a list of defects requiring rectification.

7.9 Upon rectification of defects, the Contractor shall arrange for the Employer or Employer's Deputy or his representative to certify satisfactory completion of on-site tests.

7.10 Acceptance by the Employer or Employer's Deputy 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.

8.0 COMMISSIONING OF EQUIPMENT

8.1 Commissioning will only take place after all defects have been rectified to the satisfaction of the Employer or Employer's Deputy.

8.2 On completion of commissioning, the Contractor will hand the equipment over to the Employer or Employer's Deputy in terms of the relevant instruction.

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

8.4 It is the Contractor's responsibility to satisfy himself or herself 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.

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

9.0 GUARANTEE AND DEFECTS

9.1 The Contractor shall guarantee the satisfactory operation of the complete electrical installation supplied and erected by him and accept liability for maker's defects that may appear in design, materials and workmanship.

9.2 The Contractor shall be issued with a completion certificate with the list of all defects to be repaired immediately after commissioning.

9.3 The guarantee period for these indoor equipments shall expire after, a period of 12 months commencing on the date of completion of the contract.

9.4 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.

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

9.6 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.

9.7 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 Employer or Employer's Deputy and at the cost of the Contractor.

9.8 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.

10.0 QUALITY AND INSPECTION

10.1 Transnet Freight Rail shall inspect the equipment under contract on the premises of the Manufacturer or successful Contractor.

10.2 The Contractor shall notify Transnet Freight Rail 14 days in advance of such an inspection date.

10.3 The Contractor shall apply 14 days in advance for the date of energizing and ensure that all work is completed before any commissioning can take place.

10.4 The Contractor shall be responsible to issue a compliance certificate in terms of SANS 0142 for each site before energizing of the equipment shall take place.

11.0 **Specifications**

11.1 **South African National Standards:**

11.1.1 SANS 1091	National colour standard.
11.1.2 SANS 763	Hot dip galvanised zinc coating.
11.1.3 SANS 121	Hot Dip Galvanised Coating for Fabricated Iron or Steel Article.
11.1.4 SANS 8528	Reciprocating internal combustion engine driven alternating current generating set.
11.1.5 SANS 10142	Wiring Code.

11.2 **Transnet Freight Rail:**

11.2.1 BBB 0496 version 13	3kV rectifier for traction substations.
11.2.2 BBB 1267 version 10	Specification for outdoor high voltage alternating current circuit breaker in accordance with SANS 62271
11.2.3 BBB 5452 version 4	Transnet freight rail requirements for installation of electrical equipment for 3 kV DC substations.
11.2.4 BBB 2721 version 10	AC Primary Circuit Breaker Control Panel and AC/DC Distribution Panel for 3kV DC Traction substation.
11.2.5 CEE-TBD-0007	Earthing arrangement for traction substations.
11.2.6 CEE TBK 0027	Control circuit diagrams – NO volt operation.
11.2.7 CEE TBK 0028	Trip, lockout and indication circuit diagram.
11.2.8 BBB 4724 version 4	Positive Isolator switch for 3 kV DC Traction substations.
11.2.9 BBB 3005 version 1.	3 kV DC under voltage relay manufacturing specification.
11.2.10 BBC 0198 version 1	Specifications for the supply of cables.
11.2.11 CEE.0023.90	Specifications for installation of cables.
11.2.12 CEE.0045.2002/1	Painting of steel Components of Electrical Equipment.
11.2.13 CEE.0183.2002	Hot dip galvanising and painting of electrical equipment.
11.2.14 CEE.0224.2002	Drawings, catalogues, instruction manuals and spares list for electrical equipment supplied under contract.

NOTE: Any other specifications referenced in the above mentioned specification, will be for information purposes and may be provided on request.

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

12 Constraints on how the Contractor Provides the Works.

13 The constraints shall be as specified in the specifications of the particular equipment.

14 Requirements for the programme.

14.1	Programme of work	: To be submitted by successful Contractor
14.2	CIDB rating	: 4PE and above.
14.3	Format	: Any
14.4	Information	: How work is going to be executed and commissioned.
14.5	Submission	: 1 weeks after the award of contract
14.6	Site diary	: Successful Contractor to supply in triplicates carbon copies
14.7	Site instruction book	: Successful Contractor to supply in triplicates carbon copies.

Contract Data

Site Information

The works shall be performed at ELANDSHOEK AND KROKODIL 3KV DC TRACTION SUBSTATIONS.

TRANSNET
freight rail

TECHNOLOGY MANAGEMENT

SPECIFICATION

3kV RECTIFIER FOR TRACTION SUBSTATIONS

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

Date: 29th March 2010

Circulation Restricted To:

Transnet Freight Rail – Chief Engineer Infrastructure
- Technology Management

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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 for DC traction substations.

2.0 STANDARDS

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

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.

2.2.2 SOUTH AFRICAN NATIONAL STANDARDS

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

2.2.3 TRANSNET FREIGHT RAIL

CEE.0224.	Drawings, catalogues, instruction book and spares lists for electrical equipment supplied under contract.
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.
Transnet Freight Rail	Electrical Safety Instructions.

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

3.0 TENDERING PROCEDURE

3.1 Tenderers shall indicate clause by clause compliance with 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.

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

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

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 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:	-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.

4.2 MECHANICAL SERVICE CONDITIONS.

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

4.3 ELECTRICAL SERVICE CONDITIONS.

4.3.1 INPUT VOLTAGE

4.3.1.1 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 1150V to 1375V phase to phase.

4.3.1.2 The rectifier receives it supply from a 3.3 MVA or a 5.0 MVA rectifier transformer.

4.3.2 OUTPUT VOLTAGE.

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

5.0 DESIGN OF EQUIPMENT

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

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

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

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

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

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

5.7 The control circuitry for tripping and indication purposes shall operate at 110 volt DC.

5.8 RATINGS

5.8.1 The DC output of the equipment shall be rated at 3.3 MW or 5 MW 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.

5.8.2 The equipment shall withstand a short circuit for 200 milli-seconds.

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

5.9 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.

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

6.0 INSULATION LEVELS

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

6.2 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.

6.3 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.

7.0 CLEARANCES AND CREEPAGE DISTANCES

7.1 The following minimum safety clearances shall be maintained:

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

7.2 Ribbed insulators and standoff bushings shall be used for 3kV DC and shall have a creepage distance of not less than 150mm.

8.0 RECTIFIER UNIT

8.1 RECTIFIER DESIGN REQUIREMENTS.

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

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

8.1.3 All materials used shall be flame retarded.

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

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

8.1.6 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.

8.1.7 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.

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

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

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

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

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

8.1.13 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.

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

8.1.14.1 The potential divider shall of the encapsulated type or consist of not less than ten separate vitreous enamel resistance elements connected in series. These shall be spaced to provide a clearance distance of not less than 150 mm to any earthed metal.

8.1.15 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.

Overcurrent fuse protection

8.1.16 The supplier shall supply overcurrent fuse protection on the input side of the rectifier.

8.1.16.1 The fuses shall be rated for AC input voltage and the current rating shall be able to withstand the overload conditions as specified in clause 5.8.1 of the specification.

8.1.16.2 The rating of the fuses is dependant on the output rating of the traction transformer supplying the rectifier. The rectifiers may be rated for 3,0 MW or 4,5 MW and in some cases 6,0 MW.

8.1.16.3 Operation of the fuses under overload or fault conditions shall protect and isolate the rectifier from the AC input side and the 3 kV DC output side.

8.1.16.4 The overcurrent fuse protection shall trip and lock out the traction substation when one or more fuses operate. The trip and lockout signal shall be transmitted by means of fibre optics from the fuse control circuitry to the control panel.

8.1.16.5 The fuse shall be of the strike pin type and shall be fitted on each AC input phase to the rectifier unit.

8.1.16.6 The manufacturer shall submit to Transnet Freight Rail the designs for the installation and the wiring circuitry for the fuse protection.

8.2 DIODES

8.2.1 The tenderer shall supply the Westcode type W2899MC480 diode that is manufactured in the “United Kingdom” or the INFINEON (EUPEC) D1809 N40 or N46 diode. Proof of origin of the diodes and certified test certificates shall be supplied with the diodes

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

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

8.2.4 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 10 minutes, without disturbing any other modules.

8.2.5 The pre-load pressure exerted by the fixing clamps or other methods must be easily checked. Fixed indicating torque washers or other methods of obtaining the correct pre-load pressure using torque wrench spanners must be used for assembly of the diode module.

8.2.6 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.

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

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

8.2.9 Where 3kV DC rectifiers are installed within a distance of 15km from the coast, the profile of the heat sinks shall be tapered by machining, to allow for easy access to remove any salt spray condensation formed on the diode.

8.3 SNUBBER (RC) AND VOLTAGE EQUALISING CIRCUITRY.

8.3.1 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.

8.3.2 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.

8.4 DIODE MONITORING EQUIPMENT

8.4.1 DIODE SENSOR TRANSMITTER MONITORING MODULE

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

8.4.1.2 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.

8.4.1.3 Protection circuitry shall be shall be provided for each sensor module.

8.4.1.4 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.

8.4.1.5 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.

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

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

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

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

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

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

8.4.2 RECTIFIER DIODE MONITORING PANEL AND DISPLAY.

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

8.4.2.2 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.

8.4.2.3 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.

8.4.2.4 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.

8.4.3 ELECTRONICS

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

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

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

8.4.3.4 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.

8.4.3.5 The control unit shall be built into a rack mounted unit or similar and shall be able to be removed or installed as a unit.

8.4.3.6 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.

8.4.4 POWER SUPPLY SYSTEM.

8.4.4.1 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.

8.4.4.2 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.

8.4.5 FIBRE OPTIC MONITORING BOARD.

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

8.4.6 INTERFACE INPUT-OUTPUT PRINTED CIRCUIT-BOARD

8.4.6.1 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.

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

8.5 COOLING

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

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

8.5.3 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.

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

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

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

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

8.5.7 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.

8.5.8 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.

8.5.9 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.

9.0 INSTALLATION.

9.1 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.

9.2 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.

10.0 EARTHING

10.1 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.

11.0 CABLES

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

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

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

11.4 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.

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

12.0 INTERCONNECTION OF EQUIPMENT

12.1 Suitably rated copper 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.

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

12.3 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).

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

13.0 INSPECTION, SITE TESTS AND COMMISSIONING.

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

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

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

13.4 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.

13.4.1 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

13.4.2 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.

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

13.6 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.

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

14.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

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

14.2 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.

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

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

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

15.0 SPECIAL TOOLS AND/OR SERVICING AIDS

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

15.2 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.

16.0 TRAINING

16.1 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.

17.0 GUARANTEE AND DEFECTS

17.1 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.

17.2 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.

17.3 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.

17.4 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

TECHNICAL DATA SHEET

(To be completed by Tenderer)

1.0 Number of diodes per branch: _____

2.0 Type of Diode: _____

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

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

3.0 Repetitive Peak Reverse Voltage of diode: _____

4.0 Surge forward current 10 milli second Sine Wave: _____

5.0 Method of cooling of rectifier: _____

6.0 Method of temperature sensing: _____

7.0 Type of insulation used for frame to floor: _____

8.0 Physical dimensions of rectifier unit:

Height: _____ Breadth: _____ Width: _____

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

_____

10.0 Method of correct torque adjustment for heat sinks: _____

_____

TRANSNET freight rail

TECHNOLOGY MANAGEMENT.

SPECIFICATION.

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

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Date: 21st September 2009

Circulation Restricted To:

Transnet Freight Rail – Chief Engineer Infrastructure
- Technology Management

INDEX

1.0 SCOPE

1.1 This specification covers Transnet freight rail requirements for the design, manufacture, testing and supply of outdoor Alternating Current (AC) circuit breakers in accordance to SANS 62271-100.

1.2 The alternating current circuit breakers shall be suitable rated for nominal phase to phase r.m.s voltages ranging from 22 kV to 220 kV.

2.0 STANDARDS, PUBLICATIONS AND DRAWINGS

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

2.2 The following publications are referred to in this specification:

2.2.1 SOUTH AFRICAN NATIONAL STANDARDS

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

2.2.2 TRANSNET FREIGHT RAIL SPECIFICATIONS.

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

2.2.3 Occupational Health and Safety Act No 85 of 1993.

2.2.4 TRANSNET FREIGHT RAIL DRAWINGS

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

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

3.0 TENDERING PROCEDURE

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

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

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

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

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

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

4.0 APPENDICES

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

4.1 Appendix 1 -"Schedule of Requirements".

This appendix details the specific requirements for this application.

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

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

5.0 SERVICE CONDITIONS.

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

5.1 ATMOSPHERIC CONDITIONS

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

5.2 ELECTRICAL CONDITIONS

5.2.1	Supply voltage:	The incoming AC voltage can vary ± 5% of the nominal system r.m.s voltage.
5.2.2	Frequency:	Frequency of the supply voltage is 50 ± 2.5 Hz.

6.0 REQUIREMENTS FOR ALTERNATING CURRENT CIRCUIT BREAKERS.

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

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

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

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

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

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

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

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

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

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

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

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

6.11 The circuit breaker shall be electrically operated from a nominal 110 Volt DC control voltage unless otherwise specified in Appendix 1.

6.12 It shall be possible to close the circuit breaker only when the control voltage is above 85% of the nominal voltage. The circuit breaker shall trip automatically when the control voltage falls below 70% of the nominal voltage.

6.13 The circuit breaker shall have a motor wound spring operating mechanism.

6.14 The operating mechanism shall be provided with shunt release for both opening and closing.

6.15 Pneumatic, hydraulic or gas control for tripping and closing the primary circuit breakers are not acceptable.

6.16 The operating mechanism shall be so designed so that the breaker may be closed manually from ground level by means of a suitable detachable handle.

6.17 The operating mechanism shall be constructed of non-ferrous material.

6.18 The operating springs shall recharge automatically after the completion of a closing operation.

6.19 The circuit breaker shall be of the trip-free type.

6.20 A visual mechanical indicating device shall be provided to indicate the state of the spring and shall be inscribed "Spring Charged" when the mechanism is in the condition to close the circuit breaker and "Spring Free" when it is in any other condition.

6.20.1 One pair of normally open and normally closed contacts shall be provided for the indication circuitry to the substation control panel for indication of the "Spring Charged" and "Spring Discharged" conditions.

6.21 Auxiliary contacts shall be provided for operation in conjunction with the protection and other auxiliary circuits specified. At least one spare pair of normally open and one spare pair of normally closed contacts shall be provided.

6.22 Circuit breaker control switches shall be provided on the circuit breaker mechanism. They shall return automatically to the neutral position when the handle is released after being turned to either the "close" or "trip" positions.

6.23 Local/Remote selector switches shall be provided on the circuit breaker mechanism and shall be of the two-position type. The switch shall have no "off" or "neutral" position.

6.23.1 Provision shall be made that when the circuit breaker is switched to the local position, the protection and trip circuitry to the circuit breaker shall not in any way be by-passed.

6.24 Mechanical operation shall be provided on the circuit breaker for any closing or trip release, which is normally electrically operated.

6.25 The circuit breaker shall be provided with a no volt coil with a mechanical latching mechanism, which will trip, lockout and inhibit the circuit breaker from closing when the no volt coil is de-energised. Refer to Transnet Freight Rail's drawing No. CEE-TBK-27 which forms part of this specification, for details of the control circuitry for the no volt protection.

6.25.1 The no volt coil circuitry with its associated mechanical latching mechanism shall operate separately from the trip coil circuitry.

6.26 A counter shall be provided on the circuit breaker to indicate the total number of operations of the breaker.

6.27 Tenderers shall advise the number of circuit breaker operations under full load and fault conditions, after which maintenance and/or measurement of contact wear is recommended.

6.28 The circuit breaker operating mechanism including its controls and relays shall be housed in a metal enclosure.

6.29 The enclosure housing shall be manufactured from stainless steel or hot dipped galvanised steel.

6.30 The coating of the enclosure if galvanised shall comply with the requirements of Transnet freight rail's specification CEE.0045.

6.31 The degree of protection of the enclosure shall be in accordance with SANS 60529 and shall be IP 55.

6.32 Provision shall be made for the enclosure to be pad-lockable.

6.33 The enclosure shall be provided with a gland plate for bottom entry of the control cables.

6.34 VACUUM CIRCUIT BREAKERS.

6.34.1 Vacuum switching devices shall be evacuated and sealed in accordance with the latest technology and accepted practice.

6.34.2 The pre striking and chopping current shall be kept below 5 amperes. Tenderers shall give full details regarding these characteristics.

6.34.3 Where vacuum circuit breakers are specified in Appendix 1 they shall be either of the motor wound spring operating mechanism or magnetic actuator operating mechanism type.

6. 35 SULPHUR HEXAFLOURIDE CIRCUIT BREAKERS. (SF6)

6.35.1 The SF6 circuit breaker shall be fitted with a pressure gauge/densiometer to monitor the gas pressure.

6.35.2 The pressure gauge/densiometer circuit shall be provided with a minimum of two sets of contacts for alarm and indication for the substation's annunciator or flag circuit.

6.35.3 The supplier shall wire the SF6 circuit breaker local control circuit, such that in the event of a gas leakage or drop in gas pressure, the SF6 circuit breaker will trip and lockout.

6.35.4 A set of normally closed contacts shall be provided in the circuit breaker mechanism control box for the low gas trip circuitry.

6.35.5 The SF6 circuit breaker shall trip and lockout before the minimum safe SF6 gas pressure is reached.

6.35.6 In terms of the Occupational Health and Safety Act No 85 of 1993. Code 1704 (pressure vessels) the successful tenderer shall furnish a certificate of manufacture complying with the terms of the Act for the circuit breakers.

6.36 INSULATION LEVELS, CREEPAGE DISTANCES AND CLEARANCES

6.36.1 INSULATION LEVELS

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

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

Highest phase-to-phase r.m.s voltage for equipment. (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	850 kV 950 kV	360 kV 395 kV
Insulation levels for highest voltage for equipment U_m < 100 kV are based on an earth fault factor equal to $\sqrt{3}$ and for U_m > 100 kV an earth fault factor equal to $0,8\sqrt{3}$. Where more than one insulation level is given per voltage system, the higher level is appropriate for equipment where the earth fault factor is greater than 1,4			

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

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

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

6.36.2 CREEPAGE DISTANCES

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

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

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

6.36.3 CLEARANCES

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

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

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

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

6.37 SUPPORT STEELWORK.

6.37.1 The circuit breaker shall be provided with its own support steelwork, which shall be hot- dip galvanised in accordance with specification SANS 121 and shall comply to requirements of SANS 1431: for weldable structural steels.

6.37.2 Support steelwork exposed to a high pollution/corrosive atmosphere shall be painted in accordance with specification CEE.0045.

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

7.1 The tenderers shall submit a separate offer for special tools and servicing aids necessary for the servicing and maintenance of SF6 circuit breakers.

7.2 Three copies of instruction/maintenance manuals, spares list's and wiring diagrams of the circuit breakers in accordance with Transnet freight rail's specification CEE.0224. shall be supplied upon delivery.

8.0 TRAINING.

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

9.0 TEST CERTIFICATES.

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

10.0 GUARANTEE AND DEFECTS.

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

10.2 The guarantee period shall expire after: -

A period of 12 months commencing on the date of energising of the circuit breaker.

10.3 Any specific type of fault occurring three times within the guarantee period and which cannot be proven to be due to other faulty equipment not forming part of this contract, shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the maintenance manager of the depot and at the cost of the Supplier.If urgent repairs have to be carried out by Transnet freight rail staff to maintain supply during the guarantee period the supplier shall inspect such repairs to ensure that the guarantee period is not affected and should they be covered by the guarantee, reimburse Transnet freight rail the cost of material and labour.

11.0 INSPECTION.

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

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

12.0 PACKAGING AND TRANSPORT.

12.1 The tenderer shall ensure that the equipment be packed in such a manner that it will be protected during handling and transport.

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

13.0 BIBLIOGRAPHY

[1] SANS 1019: 2008. Edition 2.5

END

SCHEDULE OF REQUIREMENTS
(To be completed by client)

1.0 SYSTEM DETAIL

1.1 AC Circuit Breakers: _____ substation/location.

1.2 Pollution level: Heavy_____ Very Heavy _____

1.2 Quantity of AC Circuit Breakers. _____

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

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

1.3 Frequency: _____ Hz

1.4 Circuit breaker control DC voltage: _____ V

1.5 Circuit breakers to be used for the following:

- 3 kV DC Traction substations. Yes/No
- Distribution substations. Yes/No
- 25 kV AC Traction substations. Yes/No
- 50 kV AC Traction substation. Yes/No

DETAIL OF AC CIRCUIT BREAKERS.

2.0 Type of circuit breakers required:

Vacuum: Yes / No

Gas (SF6): Yes / No _____

2.2 Number of circuit breakers required: _____

2.3 Number of poles: _____

2.4 Rated Voltage: _____ kV

2.5 Rated short-circuit breaking current: _____kA

2.6 Rated normal current: _____ Ampere.

END

TECHNICAL DATA SHEET
(To be completed by tenderer)

DETAIL OF CIRCUIT BREAKER

1.1 Make and manufacturer _____

1.2 Rated Voltage _____ kV.
(Highest rated voltage for equipment)

1.3 Rated Insulation level _____ kV.
(Rated lightning withstand Voltage)

1.4 Number of Poles: _____

1.6 Rated short circuit breaking current _____ kA.

1.7 Rated normal current: _____ Ampere.

1.6 Breaker operating time:

1.6.1 Closing: _____ ms.

1.6.2 Opening: _____ ms.

1.7 Number of operations after which breaker contact maintenance / measurement is required:

1.7.1 Under full load conditions_____

1.7.2 Under fault conditions _____

1.8 First Pole to Clear Factor_____

1.9 DC control voltage: _____ V

TRANSNET
freight rail

TECHNOLOGY MANAGEMENT

SPECIFICATION

AC PRIMARY CIRCUIT BREAKER CONTROL PANEL AND AC/DC DISTRIBUTION PANEL FOR 3kV TRACTION SUBSTATION

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Circulation Restricted To:

Transnet Freight Rail – Chief Engineer Infrastructure
- Technology Management

INDEX

1.0 SCOPE

This specification covers Transnet Freight Rail's requirements for the design, manufacture, delivery, installation and commissioning of the high voltage AC primary circuit breaker control panel and AC/DC distribution panel for 3 kV DC traction substations. The purpose of the AC primary circuit breaker control panel and AC/DC distribution panel is to house the protective and control equipment for the suitable operation of the substation.

2.0 BACKGROUND.

3 kV DC traction substation comprises of a high voltage outdoor yard and a building housing the indoor equipment. The outdoor yard equipment consists of HV disconnects, primary circuit breakers, current and voltage transformers, and main traction - and auxiliary supply transformers. The indoor equipment comprises of a 3 kV DC rectifier with its associated control equipment,
3 kV DC high speed circuit breakers, 110 V battery charger unit and batteries.

3.0 STANDARDS AND PUBLICATIONS.

The following publications are referred to:

3.1 IEC - INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC 60255-5:	Electrical relays - 5. Insulation coordination for measuring relays and protective equipment- requirements and tests.
IEC 60529:	Degŕee of protection provided by Enclosures. (IP code.)
IEC 60051-1:	Direct Acting Indicating Analogue Electrical Measuring Instruments and their accessories. Part 1 - Definitions and general requirements common to all parts.

3.2 SOUTH AFRICAN NATIONAL STANDARDS

SANS 156:	Moulded Case Circuit Breakers.
SANS 1091:	National colours standard for paint.
SANS 1274:	Coatings applied by the powder-coating process.
SANS 10142:	Installation and wiring of premises.

3.3 TRANSNET FREIGHT RAIL'S SPECIFICATIONS

CEE.0224:	Drawings, catalogues, instruction manuals and spares list for electrical equipment supplied under contract.
BBB0041:	Preparation of drawings for Transnet Freight Rail Infrastructure.
BBB2502:	Requirements for battery chargers for 3 kV DC traction substations.

3.4 TRANSNET FREIGHT RAIL'S DRAWINGS

CEE-TBD-7:	Earthing arrangement for 3 kV DC traction substation.
CEE-TBK-0027:	Control circuit diagram. No-volt coil protection.

4.0 APPENDICES

The following appendices form part of this specification:

Appendix 1: Shows the recommended layout of the AC/DC Distribution Panel.

Appendix 2: Shows the recommended layout of the AC Primary Circuit Breaker Control Panel.

Appendix 3: Schedule of requirements.

5.0 TENDERING PROCEDURE

5.1 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.

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

5.3 Tenderers shall submit schematics and wiring diagrams, general constructional details and principal dimensions of the panels.

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 primary circuit breaker control panel and AC/DC distribution panel shall be designed and rated for continuous operation under the following conditions:

6.1 ATMOSPHERIC 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.

6.2 MECHANICAL

The substation in which the panels will be installed is situated next to a railway line and the equipment will therefore be subjected to vibration. The design must take appropriate counter measures to ensure reliability of equipment that are sensitive.

6.3 ELECTRICAL

Nominal DC control voltage:	110 V (Minimum being 88 V and maximum128 V
Nominal AC auxiliary supply:	400 V / 230 V, 50Hz

The existing main protection current transformers are of the bushing or free standing post type.
The class of the current transformers are 10P10
The burden rating is of the order of 15VA or greater
The ratios are of the order as listed below:

Supply Voltage	Ratio
132kV	30/1 or 30/5
88kV	50/1 or 50/5
66kV	75/1 or 75/5

Equipment within the substation-building environment is subjected to electromechanical interference as well as voltage surges.

7.0 GENERAL REQUIREMENTS OF CONTROL /DISTRIBUTION PANELS.

7.1. The successful supplier shall be responsible for the design, the ratings of all, cabling, wiring, protection circuitry, sizing of contactors, relays, moulded circuit breakers, (mcb's) Isolators, fused isolators, fuse ratings, terminations and any other equipment and circuitry used.
In the event of a dispute, Transnet Freight Rail staff's shall make the final decision on technical matters.

7.2 The construction of the control/distribution panels shall be either two separate panels or a combination of both into one panel with the AC and DC circuitry separated. Refer to Appendix 1 Clauses 1.0, 2.0 and 3.0.

7.3 The control/distribution panels shall be so designed that the control switches are accessible and indicating lights, flag indicators, volt and ammeters are visible without opening the doors.

7.4 Appendix 1 and Appendix 2 show the recommended layout of the control equipment on the front door of the substation control panels.

7.5 All circuitry shall be wired in the fail to safe mode i.e. relays and contactors must be de-energised under fault conditions.

7.6 All relays, control switches, indicating lights, and control push buttons, etc. which are mounted on panel door shall be suitably labelled to clearly indicate their function. The labels shall be engraved with white lettering on a black background and permanently fixed with miniature screws, rivets or high quality adhesive.

7.7 Laminated plastised labels shall be used for labelling inside the panel and panel door. The lettering shall be either engraved or etched.

8.0 AC PRIMARY CIRCUIT BREAKER CONTROL PANEL

The panel shall be fitted with the following:

- Flag relays and associated LED Annunciator panel. (Clause 8.1)
- AC Primary circuit breaker control circuitry and equipment (Clause 8.2)
- Rectifier control circuitry and equipment. (Clause 8.3)
- Main AC thermal overload and instantaneous over current protection relays. (Clause 8.4)
- Auxiliary transformer overload protection relay. (Clause 8.7)
- AC earth leakage protection relay. (Clause 8.5)
- DC Earth leakage protection relay. (Clause 8.6)
- Main and auxiliary transformer protection circuitry. (Clause 8.7)
- Local and remote control circuitry and equipment. (Clause 8.8)
- Emergency stop button. (Clause 8.11)
- Lock out reset button and indication. (Clause 8.12)

8.1 FLAG ANNUCIATOR UNIT

8.1.1 The purpose of the flag annunciator unit is to give an alarm/indication of the status of the substation equipment and shall not be used as a tripping mechanism for any of the protection circuits or form part of the tripping circuits.

8.1.2 The design of the flag annunciator unit shall allow any input condition to trigger the flag annunciator alarm and the corresponding indicator shall illuminate.

8.1.3 All inputs shall be latchable and shall continue to indicate even after a power failure.

8.1.4 The flag annunciator alarm shall be equipped with a "Test button" which will apply power supply voltage to all inputs for test purposes.

8.1.5 The alarm annunciator system shall be supplied with a "Reset button" to clear any alarm.

8.1.6 When buzzers or flashing indicators are fitted an alarm "Accept button" shall be provided.

8.1.7 The flag relay and annunciator unit shall make provision for a minimum of 20 annunciator circuits.

8.1.8 The annunciator shall have the following minimum indications.

- Main overload.
- Main overload protection relay fault. (Watchdog facility)
- Auxiliary Overload (If applicable).
- Oil temperature.
- Winding temperature.
- DC Earth Leakage.
- AC Earth leakage.
- Main transformer Bucholz operation.
- Aux transformer Bucholz operation (If applicable).
- Rectifier Attenuation and over temperature.
- Rectifier diode failure
- Rectifier fan failure.
- Battery undervoltage.
- 400 V 3 phase auxiliary supply phase failure.
- Low SF6 gas pressure (If applicable).

8.2 AC PRIMARY CIRCUIT BREAKER CONTROL AND INDICATION

8.2.1 Provision shall be made for the following:

- Local / Remote two position switch. The switch shall have no "off" or "neutral" position
- Local indication. Open/Trip (green) and closed (Red).
- Lockout indication. (Amber)

8.3 RECTIFIER FAN CONTROL AND PROTECTION CIRCUITRY

8.3.1 Provision shall be made for the following:

- Fan motor protection circuitry.
- Fan failure circuitry (vane switch).
  The circuitry shall be fail-safe and shall provide a signal to the flag annunciator panel when the fan fails.
- Rectifier current sensing circuitry.
  The operation of the rectifier fan/fans shall be dependent on the full load current rating of the rectifier as well as the temperature of the rectifier.
  The rectifier current sensing control circuitry shall operate at 50% (adjustable) of the full load current rating of the rectifier. The current sensing circuitry shall be adjustable between 10% and 90% of full load of the rectifier.
  In order to avoid oscillatory pumping action of the fans a timing circuit shall ensure that fans remain energised for a period of at least 3 minutes after each and every start irrespective of the load condition in that time span.
- Diode supervisory circuitry.
- Fan test switch (switch on front of panel).
  A spring-loaded self-resetting switch shall be provided for the manual testing of the fan/fans.

8.4 MAIN AC THERMAL OVERLOAD AND INSTANTANEOUS OVERLOAD PROTECTION RELAYS.

8.4.1 The protection relays shall be of the type readily available on the open market.

8.4.2 The protection relays shall be in accordance to IEC 60255-5 and shall be flush mounted. Electronic protection relays shall be provided with a password system to prevent any unauthorised changing of the relay settings.

8.4.3 The protection relays shall incorporate a watchdog facility, which shall energise in the event of failure of the relay or relay functions.

8.4.4 The high voltage AC primary circuit breaker shall be provided with AC thermal overload and instantaneous overload protection on each of two phases

8.4.5 The protective elements of the relay shall be suitable for operation in conjunction with the main current transformers. The secondary current ratings are 5 ampere and 1ampere.

8.4.6 In the event of protection relay failure, the relay shall fail-safe and shall trip the AC primary circuit breaker.

8.4.7 The thermal overload protection shall be provided to permit loads not less than the specified load-rating curve of the 3 kV rectifier, which is tabled below and shall not exceed the manufacturers, declared rectifier rating.
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
Short circuit proof for 200 milli seconds

8.4.8 The operating level of the overload elements and time delay settings shall be independently adjustable.

8.4.9 For AC overload the protection relay shall have a minimum calibrating range from 3 to 6 times the full load line current of the rectifier equipment.

8.4.10 The AC overload protection shall be provided with an adjustable time delay to prevent operation as a result of inrush currents during switching of the transformer, and to provided sufficient time delay of operation to ensure that only the 3 kV DC high speed track circuit breakers operate under fault conditions.

8.5 AC EARTH LEAKAGE PROTECTION RELAY

8.5.1 An instantaneous relay for the AC earth leakage protection shall be supplied. The relay may be separate or incorporated as a function of the main overload relay.

8.5.2 The AC earth fault protection shall trip and lockout the AC primary circuit breaker in the event of any flashover or earth leakage which may occur on the outdoor AC high voltage equipment

8.5.3 The relay shall be suitable for operation in conjunction with its associated earth fault current transformer. The relay shall have a calibration range of between from 50 to 100 amperes adjustable.

8.5.4 The relay shall be fitted in the primary circuit breaker control panel.

8.6 DC EARTH LEAKAGE PROTECTION RELAY.

8.6.1 The DC earth leakage relay shall not be fitted in the control panel but on the outside of the control panel. In the case of space constraints (single unit substations) the relay may be mounted on a wall or other location, which shall be decided after consultation with Transnet Freight Rail's staff.

8.6.2 The steelwork of all 3 kV DC equipment installed in a traction substation is connected to a DC earth leakage busbar which is mounted on insulators. This busbar is connected to the substation negative (which is near earth potential) through the DC earth leakage relay by means of two 95mm² PVC insulated copper cables. In the event of a failure of the 3 kV DC insulation, the fault current flows to rail (substation negative) by way of the relay causing its operation at the calibrated current setting.

8.6.3 The DC earth leakage busbar may also be installed so that its passes through the aperture of the DC earth leakage relay. The one side of the busbar is connected to the substation negative and the steelwork of the electrical equipment is connected on the other side.

8.6.4 A suitable DC earth leakage relay shall be provided that will trip at a predetermined value in the event of failure of the 3 kV DC insulation.

8.6.5 The DC earth leakage copper busbar dimensions minimum 50x10 mm² shall be provided for. Provision shall be made for a minimum of ten 95 square mm conductor lugs.

8.6.6 The connection between the DC earth leakage primary busbar and the steelwork of the equipment inside the substation shall be made by means of 95 mm² PVC insulated conductors. (Drawing CEE-TBD-7 which shows a typical layout of the interconnections between the steelwork of the equipment and the DC earth leakage busbar.

8.6.7 The DC earth leakage relay shall be robustly constructed and protected against the ingress of dust, dirt and moisture.

8.6.8 The DC earth leakage relay shall have provision for lead-and-wire sealing to prevent unauthorised tampering with the calibration.

8.6.9 Once the DC earth leakage relay has operated it shall remain latched in the tripped position until it is manually reset.

8.6.10 The operation of the DC earth leakage relay shall be instantaneous.

8.6.11 The DC earth leakage relay shall be provided with a flag indicator and facilities for electrical remote flag indication.

8.6.12 The DC earth leakage relay shall incorporate sufficient auxiliary contacts to enable the correct operation of the circuit. The contacts shall be continuously rated to carry and make or break a 5 A, 110V inductive circuit.

8.6.13 The aperture of the magnetic core of the DC earth leakage relay shall be large enough to accommodate two 95mm² PVC insulated copper conductors, which connect the DC earth leakage busbar to substation negative. (See Engineering Instruction S.013 Issue 2).

8.6.14 The DC earth leakage relay shall be capable of operating under short-circuit conditions where the fault current could be in the order of 50 kA DC and the possible rate of rise between 3 and 6 kA per second.

8.6.15 The trip setting of the DC earth leakage relay shall be easily adjustable in the range 10 – 200 A. The trip setting shall be indicated on a dial and pointer to facilitate calibration.

8.6.16 The calibration must be stable and accurate to plus minus 10 percent of the trip setting of the DC earth leakage relay.

8.6.17 The DC earth leakage relay shall be protected from accidental damage or contact by a sturdy enclosure manufactured from a suitable transparent non-conductive material.

8.6.18 The copper busbar shall be insulated from the mounting surface by means of suitable insulators etc and provision shall be for the termination of the earthing conductors.

8.7 MAIN AND AUXILIARY TRANSFORMER GAS ACTUATED AND TEMPERATURE PROTECTION RELAYS CIRCUITRY

8.7.1 Provision shall be made for the main transformer Bucholz relay and oil and winding temperature relay alarm and trip circuits.

8.7.2 Provision shall be made for the auxiliary transformer Bucholz relay and oil / winding temperature alarm and trip circuits as required.

8.8 OVERLOAD PROTECTION FOR AUXILIARY TRANSFORMERS

8.8.1 An overload relay shall be supplied for the protection of the primary winding of the auxiliary transformer.

8.8.2 The overload protection relay shall be the Strike FP2004 or other type approved by Technology Management.

8.9 LOCAL AND REMOTE CONTROL CIRCUITRY AND INDICATION EQUIPMENT

Provision shall be made for the local and remote tripping and closing of the AC primary circuit breaker.

8.10 TRIP CONDITIONS

A trip refers to a condition where a substation may be switched back on load from local or remote in the case where the relevant fault has cleared itself.

- Main Overload.
- Auxiliary transformer overload.
- Oil Temperature.
- Rectifier over temperature.
- 400 V auxiliary supply phase failure with time delay module adjustable from 0 to 60 seconds.
- Wave filter room interlock (where fitted)

8.11 LOCKOUT CONDITIONS

A lockout refers to the condition where the AC primary circuit breaker is tripped and inhibited from being closed by either local or remote control signal. In order to bring the substation back on load the relevant failure has to be addressed and rectified from inside the substation.

- DC Earth Leakage. Complete substation lockout.
- AC Earth Leakage.
- Protection relay failure. (Watchdog)
- Rectifier first diode failure.
- Rectifier attenuation failure.
- Battery undervoltage.
- Bucholz main transformer.
- Bucholz auxiliary transformer (If applicable).
- Low SF6 gas (If applicable).
- Winding temperature.
- Rectifier fan failure.
- No volt coil protection. Refer to Transnet Freight Rail's drawing No CEE-TBK–27 for control circuitry.

8.12 EMERGENCY STOP

A mushroom head (red) latched push button shall be provided. The operation of the pushbutton shall completely shutdown and isolate the substation from all supplies by the tripping of the high voltage AC primary circuit breaker(s) and all the 3 kV DC track breakers. It shall not be possible to carry out local and remote control of the equipment until the emergency push button has been reset.

8.13 LOCK OUT RESET BUTTON AND INDICATION.

Provision shall be made for the manual reset of a lock out condition, which occurs in the substation. The reset of the lockout condition shall only be possible with the operation of the annunciator flag reset and lockout reset button.

9.0 AC/DC DISTRIBUTION PANEL

The panel shall make provision for:

- AC Distribution (400 V, 3 Phase) (Clause 9.1.)
- DC Distribution (110 V DC) (Clause 9.2)
- DC Control and supervisory circuitry and track breaker control. (Clause 9.3)

9.1 AC DISTRIBUTION. (400V, 3 PHASE)

Provision shall be for the following:

- 3 phase 15 kA short circuit rated, 415 V moulded case circuit breaker / fused isolator for the protection of the three-phase auxiliary transformer supply. The fused isolator shall be the AEG or equivalent type that has been approved by Technology Management.
- busbars protected by clear Perspex barriers shall be marked with a danger sign and "400 V."
- current transformers in the control panel for the measurement of the low voltage currents for each phase of the 400 V supply.
- ammeter and voltmeter for the measurement of the 3 phase currents and voltages.
- suitable four-way rotary selector switches for the measurement of the 3 phase currents and voltages.

9.1.1 400V 3PHASE DISTRIBUTION SUPPLY

The following 3 phase supplies are normally required but could vary for each substation. These supplies shall be individually protected by moulded case circuit breakers.

- 60 A calibrating set supply.
- Substation distribution board.
- Substation building fan.
- Battery room fan including overload protection.
- Spare supply points as required.
- 40 A supply for regenerative breaking absorption equipment where specified.

9.1.2 3 PHASE DETECTION FAILURE RELAY.

One three phase detection failure relay shall be installed in the panel. The relay shall monitor the 400 V panel supply for the following:

- Phase failure.
- Sequence reversal.
- Excessive phase unbalance.
- The relay shall have of hysteresis of not more than 5% and a reaction time of 3 seconds or better.
- An adjustable time delay setting shall be incorporated on the front of the detection relay to prevent the operation of the relay due to Eskom supply dips. The time delay adjustment shall be between 0 to 60 seconds.

9.1.3 230 V SINGLE PHASE DISTRIBUTION SUPPLY

The following single phase supplies are normally required but could vary for each substation. These supplies shall be individually protected by moulded case circuit breakers.

- Telecontrol supply.
- Eskom metering supply.
- 3 pin 230 V, 15 A socket outlet protected by earth leakage unit in accordance with SANS 10142.
- Battery charger supply.
- Substation distribution board and lights.
- Supplies to the primary circuit breaker control panel.

9.1.4 400V AUXILIARY SUPPLY CHANGE OVER SYSTEM

9.1.4.1 Unless otherwise specified a 400 V auxiliary supply change over system shall be installed in the panel to provide a continuous 400 V supply in the substation for the following situations.

- Where in a double unit substation two auxiliary transformers are installed and one unit is switched off or
- Where it is required to supply the traction substation from a standby auxiliary supply in the event of the traction substation been switched off.

9.1.4.2 The contactors for the change over system shall be mechanically and electrically interlocked.

9.1.5 INDICATING INSTRUMENTS FOR THE 400 V AC DISTRIBUTION

The panel shall be fitted with the following indicating instrument for the AC distribution auxiliary supply.

- One 0 to 400 V voltmeter with its own selector switch. The instrument shall be labelled "AC VOLTS"
- One 0 to 100 A ampere meter with its own selector switch. The instrument shall be labelled "AC AMPERES"

9.2 110 DC VOLT DISTRIBUTION

9.2.1 The 110 V DC supply shall be obtained from the substation battery bank, which is charged by a freestanding battery charger unit. Refer to Transnet Freight Rail's Specification BBB 2502 latest version. The installation of a battery charger in the AC/DC distribution panel is not acceptable.

Provision shall be made on AC/DC distribution panel for the following:

9.2.2 INDICATING INSTRUMENTS

9.2.2.1 One 0 to 150 V DC voltmeter labelled "DC VOLTS" to indicate the battery output voltage. The voltmeter shall be provided with a selector switch to be able select any of the following positions:

- DC Volts.
- Battery earth fault between battery positive and negative DC earth leakage busbar. (Frame)
- Battery earth fault between battery negative and negative DC earth leakage busbar. (Frame)

9.2.2.2 One 0 to 150 V DC voltmeter labelled "HOLDING COIL VOLTS" to indicate the holding coil supply voltage.

9.2.2.3 One 0 to 30 A DC ampere meter labelled "HOLDING COIL AMPERES" to indicate the holding coil current.

9.2.2.4 One 0 to 30 A DC ampere meter labelled "DC AMPERES" to indicate the battery output current.

9.2.2.5 One DC ampere meter labelled "BATTERY FLOAT CHARGE" to indicate the float charge to the battery. A short circuiting spring loaded switch shall be provided to protect the instrument against fault conditions i.e.

- Charging batteries at the maximum rate.
- Reverse current through the ammeter when the battery charger is disconnected.

9.3 110V DC DISTRIBUTION SUPPLY

9.3.1 The following 110 V DC supplies are normally required but could vary for each substation. These supplies shall be individually protected by moulded case circuit breakers.

- Panel lamps and switches.
- Primary circuit breaker control panel.
- 3 pin 110 V, 15 A DC socket outlet.
- Substation distribution board.
- Eskom metering.
- Telecontrol.
- 3 kV DC undervoltage relay.
- For the 110 V battery supply a double pole, 100 to 150 A DC Isolator or MCB, dependant on the ampere-hour rating of the batteries shall be provided.
- Protection and control circuit supplies for regenerative braking equipment. (If specified).

9.3.2 For the track breaker control circuitry the following size mcb's shall be required:

- The 110 V positive (busbar) supply for the closing coil requires 80 amperes or less depending on type of track breaker.
- The 110 V negative (busbar) supply for the closing coil requires 80 amperes or less depending on type of track breaker.
- The 110 V constant voltage positive supply for the holding coil requires 5 amperes.
- The 110 V positive (busbar) supply for the holding coil requires 5 amperes.
- The 110 V negative (busbar) supply for the holding coil requires 5 amperes.

9.4 DC CONTROL AND SUPERVISORY CIRCUITRY AND TRACK BREAKER CONTROL.

The DC control and supervisory system shall have the following circuitry fitted:

- Battery undervoltage relay adjustable from 80 to 110 V DC.
- Lockout relay.
- Earth leakage slave relays.
- 3 kV DC High Speed Circuit Breaker control circuitry (dependant on number High Speed Circuit Breakers.)
- Selector and control switches.
- Measuring instruments for DC amperes, DC voltages, Holding coils voltage and holding coil current.

10.0 PROTECTION RELAYS

10.1 The protection relays (see clause 8.4 and 8.5) shall be flush mounted on the panel door.

11.0 CIRCUIT BREAKERS, CONTACTORS, RELAYS AND INDICATING LAMPS.

11.1 All contactors and relays shall be protected from the ingress of dirt or dust by means of suitable non-flammable dust tight covers. The relays shall have a protection rating of IP 34 as defined in IEC 60529.

11.2 All circuit breakers, contactors, relays and indicating lamps shall be readily available on the open market.

11.3 Contactors and relays shall be of the sturdiest construction and shall not be affected by vibration.

11.4 DC operated relays shall be capable of satisfactory operation between 85 Volts and 140 Volts without any damage to the relays.

11.5 AC operated relays and contactors shall be suitably rated for the auxiliary supply voltage, which could vary due to the tapping range of the main and auxiliary transformers.

11.6 The contractor shall supply and install surge protection for the 400 volt 3 phase AC and 110 volt DC supplies to the control panels.

11.6.1 Dehn type surge protection units or equivalent shall be provided for the 110 volt DC supply and shall be connected as follows:

- One unit connected between the 110 Volt DC Positive and Negative.
- One unit connected between the 110 volt DC Positive and the panel earth.
- One unit connected between the 110 volt DC Negative and the panel earth.

11.6.2 A DehnGuard MTT pole surge protection unit or equivalent shall be provided for the 400 volt three phase AC supply to the control panels.

11.7 All low voltage circuits in the panel, which require protection, shall be suitably protected by moulded case circuit breakers, which comply with the requirements of SANS 156.

11.8 The low voltage moulded case circuit breakers shall be of suitable rating and rupturing capacity.

11.9 Selector switches used for the DC voltmeter shall be of the make before break type.

12.0 ELECTRICAL MEASURING INSTRUMENTS

12.1 The type of measuring instruments shall be readily available on the open market.

12.2 All analogue electrical indication meters shall be in accordance with IEC 60051-1. The meters shall be flush mounted.

12.3 Analogue meters shall be used for the measurement of AC values and shall have a class index of 1.5. The analogue face of the meters shall not be less than 96mm x 96mm with a 90 degree display.

12.4 Analogue or digital meters may be used for the measurement of DC voltage and current.

12.5 Digital instruments shall have a display of 3.5 digits, 12 milli meters high and have an accuracy of 0.5%.

13.0 TELECONTROL

Provision is made for the closing, monitoring and tripping of the substation equipment from a Control office.
Telecontrol signals are incorporated in both the AC Primary Circuit Breaker and the AC/DC Distribution panels. Provision shall be made for the termination of the telecontrol signals to a common terminal strip. This is connected to the telecontrol panel by means of a multicore cable. Provision shall be made for the following signals:

13.1 AC PRIMARY CIRCUIT BREAKER

- Open, Close and Lockout conditions.

13.2 3 kV DC HIGH SPEED CIRCUIT BREAKERS.

- Open, Close and Lockout conditions.

13.3 TRANSFORMERS (Main and Auxiliary where applicable)

- Transformer Overload.
- Over temperature (Oil / winding).
- Bucholz operation.

13.4 EARTH FAULT CONDITIONS

- DC Earth Leakage.
- AC Earth Leakage.

13.5 RECTIFIER FAILURE

- Over temperature.
- Diode failure.
- Fan failure.

13.6 SUPPLY VOLTAGE FAILURES

- 400 V AC auxiliary supply phase failure.
- 110 V DC Failure.
- 3 kV DC undervoltage relay failure.

13.7 BATTERY

- Battery undervoltage.

13.8 MAIN OVERLOAD/AC EARTH LEAKAGE RELAY FAILURE

- Protection relay failure. (Watchdog)

14.0 WIRING AND TERMINALS.

14.1 Sufficient terminal strips shall be provided for the number of circuit breakers to be controlled.

14.2 All terminals on equipment such as switches and relays shall be suitably numbered and reflected on the substation schematics and wiring diagrams.

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

14.4 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.

14.5 Terminals shall be provided near the bottom of the panels for the connection of cables from ducts, pipes etc. The terminal strips shall be grouped together and arranged so as to facilitate the removal of connections.

14.6 Suitable terminal strips shall be provided to facilitate wiring between the various items of equipment and to the remote control station or telecontrol.

14.7 All wiring shall be carried out on the loop-in system and the looping-in shall be done at the terminal strips. "X" type wiring will not be acceptable.

14.8 The method of loop wiring from one relay to another without protection for the individual circuits is not acceptable.

14.9 The cross-sectional area of all small conductors for low voltage circuits shall be not less than that required to ensure sufficient mechanical strength. The conductors shall be stranded to ensure flexibility.

14.10 All wires and conductors for low voltage circuits shall be a minimum of 2.5 square mm with the exception of the main battery supply cables between the main battery switch and busbars, which shall be at least 16 square mm.

14.11 The conductors for the multicore telecontrol cable shall be at least 1,5 square mm per conductor. Provision shall be made for 10% spare conductors in the multicore telecontrol cable supplied.

14.12 All wires and conductors shall be routed via PVC channel trunking with a removable cover. Use should be made of trunking of sufficient capacity to easily hold the conductors and wires.

14.13 Where low voltage busbars are mounted inside panels, they must be mounted in such a manner as not to cause a hazard to maintenance staff working in the panels. These busbars shall be provided with translucent Perspex barriers to prevent accidental contact with the live busbars. The barriers shall be provided with warning signs.

14.14 Where equipment is mounted on the doors of the panels, adequate flexibility of the wiring shall be provided to eliminate any damage to the conductors.

14.15 The panels shall be provided with earthing studs for 95mm earthing cables. (CEE-TBD-7 Earthing arrangement for 3 kV DC traction substations.)

PROTECTION TEST BLOCK

14.16 A test block shall be provided for the main overload protection relays and shall be fitted in the control panel at a height of one metre from the bottom of the control

14.17 The test block shall be the PK2 or Chamberlain & Hookam type.

14.18 The test block shall form part of the circuitry from the secondary wiring of the current transformers that terminate in the control panel and the overload protection relays.

15.0 PANEL CONSTRUCTION.

15.1 The panels shall be constructed from steel sheeting of at least 2mm thickness. The panels shall be of a rigid construction with facilities for lifting purposes.

15.1.1 Only on special request will the panels be constructed from stainless steel or other rust resistant steel.

15.2 The minimum dimensions shall be:

Height 2100mm (Including metal plinth)
Width 1000mm
Depth 900 mm

Any deviation from the above dimensions shall be discussed with Transnet Freight Rail's electrical staff.

15.3 The panels shall be supplied with rigidly constructed removable gland plates fitted at least 100 mm above the metal plinth to allow for easy access to cables. All required holes shall be punched into the gland plates by the successful tenderer. Any deviation from this shall be discussed with Transnet Freight Rail.

15.4 The panels shall be provided with hinged front doors to allow easy access to the control equipment. The doors shall be fitted with a handle or panel key locks. A minimum of two keys shall be supplied with each panel.

15.5 The panels shall be fitted with dummy interior covers so as to ensure that when components are mounted, no bolts, nuts or screws are visible on the exterior of the panels.

15.6 The control panel(s) shall be powder coated in accordance with SANS 1274. The finishing colours shall be Eau-de-Nil to SANS 1091 colour No H 43 on the outside and white gloss on the inside of the panels.

15.7 The control panel shall be mounted and secure onto a 75mm high metal plinth.

15.8 The panels shall be insulated from the concrete floor to reduce stray currents flowing into the panels.

15.9 The control and protective equipment shall be mounted on or within suitable panels constructed of sheet metal and fitted with front opening hinged doors to all allow for easy access to the equipment.

15.10 The panels shall be so constructed that control switches, indicating lamps, voltmeters and ammeters as well as LED type flag indication devices are visible without opening the hinged front doors.

15.11 The layout of the control equipment fitted on or in the panels, which includes relays, contactors, busbars, terminal strips etc shall provide for easy access.

15.12 The panels shall be provided with a 230V AC light with its own standby battery supply. The light shall be switched on by means of a micro switch when the panel door is opened.

15.13 Three pin 15-ampere industrial plugs shall be supplied for both the 230V AC and 110V DC supplies.

16.0 QUALITY ASSURANCE

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

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

17.0 SITE TESTS AND COMMISSIONING.

17.1 The contractor shall be responsible for carrying out on-site functional tests before the commissioning of the equipment.

17.2 Acceptance by the Maintenance Engineer or the delegated staff 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.

17.3 Commissioning will only take place after all defects have been rectified to the satisfaction of the Maintenance Engineer or the delegated staff.

17.4 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.

17.5 On completion of commissioning the contractor will hand the equipment over to the Maintenance Engineer or the delegated staff in terms of the relevant engineering instructions.

18.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

18.1 Drawings, instruction manuals and spare parts catalogues shall be supplied in accordance with Transnet Freight Rail's specification CEE.0224 and BBB0041.

18.2 The tenderer shall supply three copies of an instruction/maintenance manuals, schematic and wiring diagrams.

18.3 Approved schematic and wiring diagrams, which are supplied for maintenance and faultfinding, shall be A3. (29,7cm x 42cm).

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

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

19.0 SPECIAL TOOLS AND/OR SERVICING AIDS

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

19.2 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.

20.0 TRAINING

20.1 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.

21.0 GUARANTEE AND DEFECTS

21.1 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.

21.2 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.

21.3 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.

21.4 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.

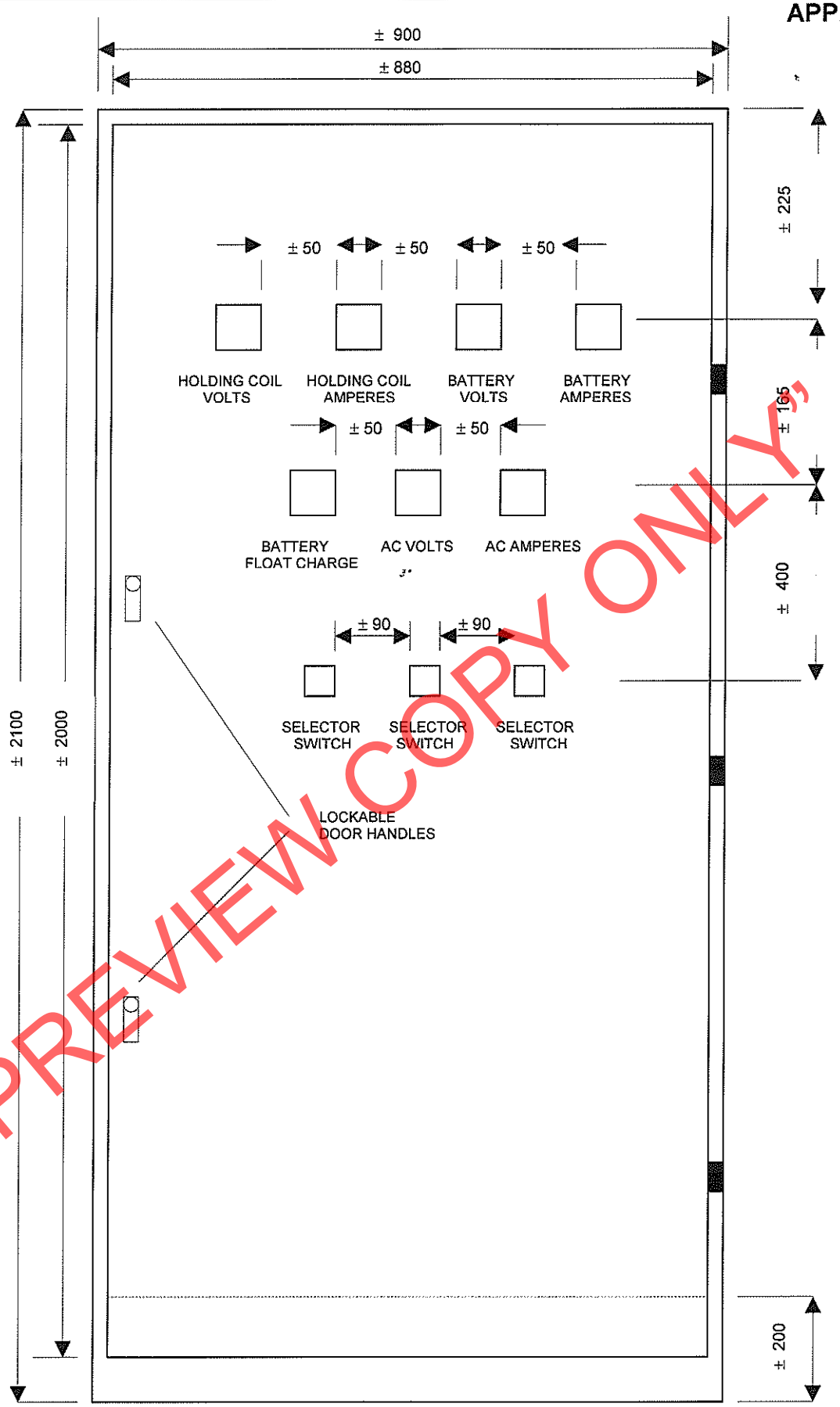
22.0 PACKAGING AND TRANSPORT.

22.1 The tenderer shall ensure that the equipment be packed in such a manner that it will be protected during handling and transport.

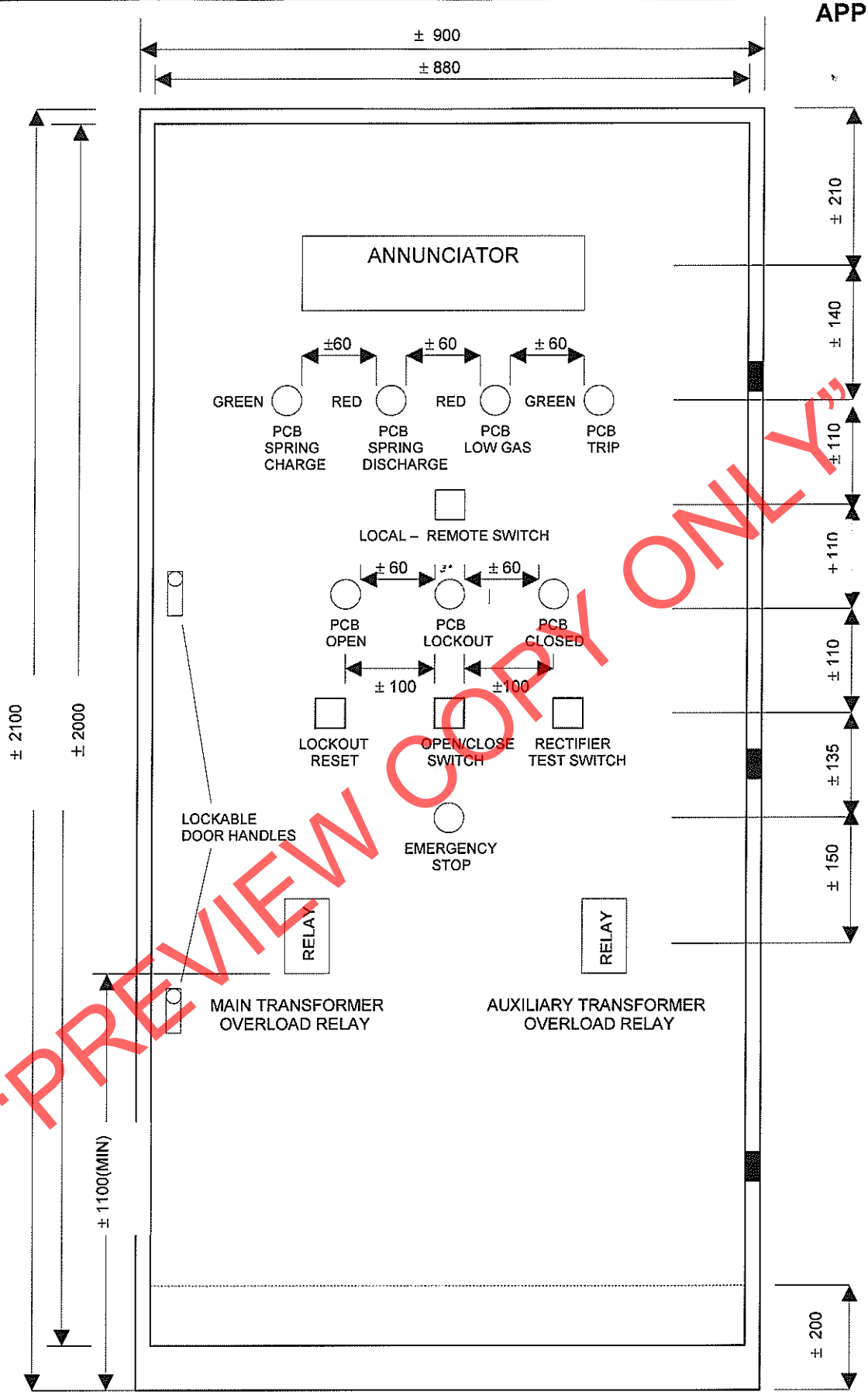
22.2 The tenderer shall provide transport for the delivery of the equipment to the site where required.

END

APPENDIX 1



AC/DC DISTRIBUTION PANEL



AC PRIMARY CIRCUIT BREAKER CONTROL PANEL

NOTE: WHERE THE ANNUNCIATOR PANEL MAKES PROVISION FOR THE SF6 LOW GAS INDICATION THE PCB LOW GAS AND PCB TRIP INDICATION LIGHTS MAY BE OMITTED

SCHEDULE OF REQUIREMENTS
(To filled in by the client)

OPTIONS OF CONTROL PANELS CONSTRUCTION.

1.0	Single AC primary circuit breaker control panel.	YES / NO
2.0	Single AC/DC distribution panel.	YES / NO
3.0	Combination of 1.0 and 2.0 into one panel.	YES / NO
4.0	Name Plate of substation to be fitted on the control panels	YES / NO

SPOORNET

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TECHNICAL
RAILWAY ENGINEERING

SPECIFICATION CONTROL PAGE

3kV DC UNDER VOLTAGE RELAY MANUFACTURING SPECIFICATION.

Statement of authorisation:

There is no SABS specification available for similar material / equipment and as far as can be ascertained no other specification/ standard suitably covers Spoornets requirements. The specification has been compiled in a manner which shall favour / encourage local manufacture of material / equipment to a maximum degree.

Author:	Grade: Chief Engineering Technician. Section: Traction Power Supply Technology	D.O. Schulz	.....
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Date: 18TH Nov 2002

This page is for control purposes only and shall not be issued with the specification.

SPOORNET

A division of Transnet limited

TECHNICAL
RAILWAY ENGINEERING

SPECIFICATION

3kV DC UNDER VOLTAGE RELAY MANUFACTURING SPECIFICATION.

Circulation restricted to:

Technical: Maintenance (Infrastructure)

Technical: Maintenance

Technical: Resource Evaluation Acquisition & Review

Technical: Railway Engineering

Specialised Business: COALlink

INDEX

6.1	ENVIRONMENTAL		
6.1.1	Altitude	:	0-1800m above sea level.
6.1.2	Ambient temperature range	:	Minus 5°C to plus 50°C.
6.1.3	Relative humidity	:	10% to 90%.
6.1.4	Lighting conditions	:	12.0 flashes/km²/annum
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 Spoornet's Traction Power Supply Technology staff.

7.2 Spoornet 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 Spoornet on the grounds of his statement of compliance and found by Spoornet 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 undervoltage 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 BBB 2932.

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 BBB 2932.

8.2.3 The resistors shall be arranged on a celleron 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.

1 .0 SCOPE

This specification provides Spoornet's requirements for the manufacturing of the 3 kV DC Under Voltage Relay utilising optic fibre.

2 .0 BACKGROUND

The 3kV DC under voltage relays are installed at Spoornet'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 3 kV DC traction substations throughout Spoornet.

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 SABS or Spoornet publication where applicable.

3.1 SOUTH AFRICAN BUREAU OF STANDARDS

SABS 1091 : National Colour Standards for Paint

SABS 1274 : Coatings applied by Powder Coating Process

3.2 SPOORNET DRAWINGS

CEE- TBD-7 : Earthing arrangement for 3 kV DC traction substation.

4.0 APPENDICES

The following appendixes from an integral part of this specification,

Appendix 1: Circuit and manufacturing drawings

5.0 TENDERING PROCEDURE

6.1 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.

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

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

6.0 SERVICE CONDITIONS

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

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

8.2.5 The encapsulated voltage divider shall consist of the same amount of resistors and the ohmic 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 undervoltage 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 BBB 2930 and printed circuit board layout, drawing No BBB 2935. 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.

8.3.3 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 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 110 V 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 mm² stranded copper wire.

8.5.6 The 110 V DC shall be protected by a 180 V 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 SABS 1274 and the colour of the enclosure shall be light orange to SABS 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 95mm² earth conductor shall be provide 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 Spoornet Engineering staff who will approve or reject them.

8.6.2 No additions, alterations or modifications shall be acceptable unless Spoornet Traction Power Supply Technology staff is in agreement.

8.7 TEST METHOD

For testing of the operation of the undervoltage 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 110VDC at terminals 1 (positive) and 2 (negative) and inject 250V to the transmitter. Adjust the Trimpot P2 until the undervoltage 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 Undervoltage 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

TRANSNET freight rail

TECHNOLOGY MANAGEMENT.

SPECIFICATION.

REQUIREMENTS FOR POSITIVE ISOLATOR FOR 3 kV DC TRACTION SUBSTATIONS

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Date: 21st September 2009

Circulation Restricted To:

Transnet Freight Rail – Chief Engineer Infrastructure
- Technology Management

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1.0 SCOPE.

1.1 The specification covers Transnet freight rail requirements for the design, manufacture, testing and supply of a 3kV DC positive isolator for traction substations.

2.0 BACKGROUND.

2.1 The positive isolator is an off-load isolating switch is 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 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 earthing switch and control equipment is housed in a freestanding metal cubicle.

3.0 STANDARDS, PUBLICATIONS AND DRAWINGS

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 GPO-3 insulating material

3.3 TRANSNET FREIGHT RAIL

CEE 0224:	Drawings, Catalogues, Instruction manuals and spares lists for electrical equipment supplied under contract.
BBB 3005:	3kV DC Undervoltage relay manufacturing specification.
Transnet Freight Rail	"Electrical Safety Instructions".

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:	-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 The nominal traction substation DC supply voltage is 3kV DC but can vary between 2,4kV 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 and earthing switch 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 switch with its operating mechanism and 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 3000 Amperes continuous.

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 phosphor bronze.

6.7 The minimum dimensions of the moving arm contact shall be 25mm thick X 80mm wide. 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 nickel-plated.

EARTHING SWITCH

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

6.10 The earthing switch shall be a medium voltage, manually operated off load switch with minimum rating of 1500 Ampere.

6.11 The earthing switch moving and fixed contact shall be manufactured from copper or phosphor bronze.

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 switch.

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 undervoltage 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 switch, 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 switch 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

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.

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 vitreous enamel resistors in series and shall be installed in the HV compartment of the positive isolator panel.
Epoxy sealed HV potential dividers may be offered subject to the approval of Transnet freight rail Technology Management.

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

7.1.1.2 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

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.

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.

7.3 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

"CAUTION-HIGH VOLTAGE
Do not open panel and work <u>on this apparatus</u>
unless the substation is totally isolated and earthed."

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 certificates shall be supplied for each positive isolator switch and undervoltage 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 CEE.0224.

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 CEE.0224.

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: -

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.

11.3 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.

11.4 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.

TRANSNET FREIGHT RAIL'S REQUIREMENTS FOR THE INSTALLATION OF ELECTRICAL EQUIPMENT FOR 3kV DC TRACTION SUBSTATIONS

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Date: 06th October 2011

Circulation Restricted To:

Transnet Freight Rail – Chief Engineer Infrastructure
- Technology Management

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SECTION 1: SUBSTATION DESIGN INFORMATION

1.0 SCOPE

1.1 This specification covers Transnet Freight Rail's requirements for the installation of electrical equipment in 3kV DC traction substations.

1.2 This specification should be read with the Scope of Work specification for each site/project and the applicable equipment specifications.

1.3 This specification also covers the requirements for the supply of security fencing, preparation of the High Voltage (HV) outdoor yard and the erection of all structural steelwork.

2.0 STANDARDS, PUBLICATIONS AND DRAWINGS

Unless otherwise specified this specification must be read in conjunction with the current edition of the relevant SANS, BS and Transnet Freight Rail's specifications.

2.1 SOUTH AFRICAN NATIONAL STANDARDS (SANS)

SANS 121:	Hot dip galvanized coatings for fabricated iron or steel articles. Specifications and test methods.
SANS 156:	Moulded-case Circuit Breakers.
SANS 780:	Distribution Transformers.
SANS 1019:	Standard voltages, currents and insulation levels for electricity supply.
SANS 1091:	National Colour Standard.
SANS 1222:	Enclosures for Electrical Equipment.
SANS 1339:	Cross-Linked Polyethylene (XLPE) - Insulated Electric cables for rated voltages (3,8/6,6kV to 19/33kV)
SANS 1431:	Weldable structural steels.
SANS 1507:	Electric cables with extruded solid dielectric insulation for fixed installations. (300/500V to 1900/3,300V) Part 1
SANS 10142-1:	The wiring of premises. Part 1
SANS 60044-1:	Instrument Transformers Part 1. Current Transformers.

2.2 TRANSNET FREIGHT RAIL SPECIFICATIONS/ ENGINEERING INSTRUCTIONS

CEE.0023:	Laying of cables.
CEE.0045:	Painting of steel components of electrical equipment.
CEE.0099:	Specification for 3kV DC high speed circuit breakers for traction substations.
CEE.0224:	Drawings, catalogues, instruction manuals and spares lists for electrical equipment supplied under contract.
CEE.0227:	The manufacture of 3kV DC breaker cells and trucks.
BBB 0496:	3kV rectifier for traction substations.
BBB 0845:	Requirements for metal oxide surge arresters in accordance with SANS 60099-4.
BBB 1267:	Specification for Outdoor High Voltage Alternating Current Circuit Breaker in Accordance with SANS 62271-100.
BBB 1616:	450 Volt gas arrester spark gap for traction power supplies.

BBB 2502:	Requirements for battery charger for 3kV DC traction substations.
BBB 2721:	AC primary circuit breaker control panel and AC/DC distribution panel for 3kV traction substation.
BBB 3005:	3kV DC under voltage relay manufacturing specification.
BBB 3139:	Wave filter capacitors for 3kV DC traction substations.
BBB 3162:	Wave filter inductors for 3 kV DC traction substations.
BBB 3890:	Requirements for 1.8 milli Henry DC reactor for 3kV DC traction substations.
BBB 5019:	Requirements for traction transformers for 3kV DC traction substations in accordance with BS 171 and IEC 60076-1.
BBB 7842	Outdoor, High Voltage, Alternating Current Disconnectors combined with earthing switch.
BBC 0198:	Requirements for the supply of cables.
BBC 0330:	Isolation transformer.

2.3 STATUTORY REQUIREMENTS

Occupational Health and Safety Act and Regulations, Act 85,1993

3.0 TENDERING PROCEDURE

3.1 Tenderers shall indicate clause-by-clause compliance with the specification as well as the relevant equipment 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.

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

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

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

4.0 SERVICE 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:	-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.

5.0 ELECTRICAL SERVICE CONDITIONS

5.1 The incoming AC voltage can vary ±5% of the nominal system r.m.s voltage. Under crippled conditions the supply voltage can drop to as low as minus 15% of the nominal r.m.s voltage.

5.2 Frequency of the supply voltage is 50 ± 2.5 Hz.

5.3 The AC high voltage system shall be treated as effectively earthed unless otherwise specified.

5.4 The traction DC supply voltage is 3,15 kV DC nominal but can vary between 2,4kV and 3,9kV for sustained periods.

5.5 The 3kV DC equipment may be subjected to fault currents up to 30kA for 200 milli seconds.

6. 0 GENERAL REQUIREMENTS

6.1 Equipment/Installations supplied shall be in terms of this specification. Deviations from the specification will not be allowed without the written consent of the Project Manager/Engineer.

6.2 Transnet Freight Rail reserves the right to subject material and equipment offered to test or inspection to verify compliance with the clauses of this specification, prior to adjudication or at any stage during manufacture.

6.3 The tenderer shall submit the layout drawings of equipment, electrical wiring schematics, and constructional designs to Transnet Freight Rail for design review.

6.4 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.

6.5 All equipment shall be adequately earthed, insulated, enclosed and interlocked to ensure the safety of staff as well as equipment.

6.6 The general design and layout of all equipment shall provide for easy access to all parts.

6.7 The equipment shall be installed in such a manner so as to limit fire damage, which may be caused by equipment failure, overheating or flashovers.

6.8 The substation control and protection circuits shall be designed and wired according to the fail-safe principle. Control equipment, contactors and relays shall de-energise under fault, power failure or alarm (flag) conditions.

6.9 No high voltage cables shall be laid in the same trench or duct as low voltage cables.

7.0 GENERAL DESIGN OF EQUIPMENT

7.1 This section covers substation equipment with electrical capacities between 3,0 MW and 6,0 MW.

7.2 The overload ratings of the rectifier units shall be:

2 times full load for thirty minutes.

3 times full load for one minute.

3 ½ times full load for ten seconds.

7.3 The substation can either be a single unit or double unit substation. Each unit comprises of one set of high voltage AC switchgear, one rectifier transformer, and one rectifier assembly, connected for 6 or 12 pulse operation and protected by a AC primary circuit breaker.

7.4 For a double unit substation each unit shall have the overload rating as specified in clause 7.2.

7.5 Each substation unit shall be capable of operating independently to allow for maintenance, fault finding and servicing of the equipment.

8.0 INSULATION AND CLEARANCES FOR 3kV DC EQUIPMENT

8.1 All indoor equipment, which may be energised at a potential of more than 1,0kV shall be protected by, metal barriers, mesh type screens or panels.

8.2 The minimum clearance in air between the rectifier unit and any metal barriers, mesh type screens or panels shall not be less than 450mm.

8.3 All exposed electrical equipment and busbars connected between the rectifier transformer secondary and the rectifier cubicle(s), or between the rectifier cubicle(s), positive isolators, DC smoothing equipment or track breakers, which is at a potential above 1,0kV, shall be arranged so that there is a minimum clearance of 2,7 m from the lowest "live" high voltage connections and ground or the floor of the access way, unless suitably screened, or otherwise protected.

8.4 All nominal 1,5kV and 3kV insulation to earth shall be designed such that the complete rectifier assembly, when installed on site ready for commissioning, will successfully withstand a test voltage of 10,5kV, 50 Hz AC for one minute.

8.5 Where the equipment or subassemblies of the rectifier assembly is enclosed and insulated from the outer framework, the insulation between the equipment and outer framework shall withstand the test voltage of 10,5kV 50 Hz for one minute.

8.6 The clearance between the reactor and any metal frame shall not be less 100mm. The reactor must successfully withstand a test voltage of 10,5kV AC 50 Hz for one minute

8.7 The successful tenderer shall advise what precautions must be taken before undertaking the withstand insulation level voltage tests to avoid damage to the equipment.

8.8 Creepage distance of insulation and the required air clearances shall be as large as possible. The latter shall not be less than:

- Outdoors: 150mm between the transformer secondary busbars and any steelwork such as wall plates, screening etc.
- Indoors: 100mm between the equipment at nominal 1,5kV or 3kV DC and negative busbars and panel steelwork, between the high voltage AC supply to the rectifier cubicles and panel steelwork, the equipment at nominal 3kV DC and negative busbars.

9.0 OUTDOOR CLEARANCES AND INSULATION LEVELS

9.1 The minimum safety outdoor earth clearances which shall be maintained between any live conductor or metal and earthed metal and the minimum clearances of power lines above ground are in accordance with the statutory requirements of clause 15.1 of the "Electrical Machinery Regulations" of the "Occupational Health and Safety Act and Regulations, Act 85,1993", and are tabled below: -

TABLE 1:

Highest phase-to-phase r.m.s voltage for equipment. (U_m)	24kV	36kV	48kV	72kV	100kV	145kV
Nominal system r.m.s. voltage. (U_n)	22kV	33kV	44kV	66kV	88kV	132kV
Minimum safety outdoor clearance	320mm	430mm	540mm	770mm	1000mm	1450mm
Minimum clearance of power lines above ground						
Outside security fence but within Transnet Freight Rail's reserve	5200mm	5300mm	5400mm	5700mm	5900mm	6300mm
Outside Transnet Freight Rail's reserve	5500mm	5500mm	5500mm	5700mm	5900mm	6300mm

9.2 In terms of Transnet Freight Rail's Electrical Safety Instructions the clearances between the nearest exposed electrical equipment and a restricted access way are tabled below: -

TABLE 2:

Highest phase-to-phase r.m.s voltage for equipment. (U_m)	24kV	36kV	48kV	72.5kV	100kV	145kV
Nominal system r.m.s. voltage. (U_n)	22kV	33kV	44kV	66kV	88kV	132kV
Restricted access way (Vertical height) *	2820mm	2930mm	3040mm	3270mm	3500mm	3950mm

*See clause 903.1.3 of "Transnet Freight Rail's Electrical Safety Instructions"
(The vertical heights in restricted access ways for the various system voltages are calculated by adding 2,5metres to the normal outdoor earth clearance for the different system voltages. Refer to Annexure 9.4 of Transnet Freight Rail's Electrical safety Instructions).

INSULATION LEVELS

9.2 For the medium and high voltage nominal r.m.s voltage systems on Transnet Freight Rail the recommended Insulation levels in accordance with SANS 1019 is tabled in table 3.

TABLE 3

Highest phase-to-phase r.m.s voltage for equipment. (Um)	Nominal system r.m.s. voltage. (U_n)	Rated lightning impulse withstand voltage peak.	Rated short duration power- frequency withstand r.m.s voltage.
7,2 kV	6,6 kV	75 kV	22 kV
12 kV	11 kV	95 kV	28 kV
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 650 kV	230 kV 275 kV
245 kV	220 kV	850 kV 950 kV	360 kV 395 kV
Insulation levels for highest voltage for equipment U_m < 100 kV are based on an earth fault factor equal to $\sqrt{3}$ and for U_m > 100 kV an earth fault factor equal to $0,8\sqrt{3}$. Where more than one insulation level is given per voltage system, the higher level is appropriate for equipment where the earth fault factor is greater than 1,4.			

TABLE 3: Standard Voltages and insulation levels in accordance with SANS 1019:2008 [1}

SECTION 2: TRACTION SUBSTATION EQUIPMENT

OUTDOOR YARD EQUIPMENT

10.0 METAL OXIDE SURGE ARRESTERS

10.1 The contractor shall supply and install metal oxide gapless surge arresters in accordance with Transnet Freight Rail's specification BBB 0845.

10.2 The surge arresters shall be connected between each phase of the high voltage supply and substation main earth electrode/earth mat

10.3 The maximum protected distance from the main transformer bushing terminal to the surge arrester terminal shall be as indicated in table 4.

TABLE 4:

NOMINAL SYSTEM R.M.S VOLTAGE (kV)	MAXIMUM DISTANCE (Metres)
44kV	5
66kV	6
88kV	6
132kV	7

10.4 The neutrals of high voltage supplies are to be treated as effectively earthed unless otherwise specified.

10.5 For the installation of high voltage surge arresters on the main transformer, refer to Transnet Freight Rail' s drawing BBB 0938

11.0 HIGH VOLTAGE AC DISCONNECTOR

The contractor shall supply and install the high voltage AC disconnecting switch in accordance with Transnet Freight Rail's specification BBB 7842.

12.0 HIGH VOLTAGE PRIMARY CIRCUIT BREAKER

The contractor shall supply and install the high voltage AC primary circuit breaker in accordance with Transnet Freight Rail's specification BBB 1267.

13.0 MAIN CURRENT TRANSFORMERS

13.1 The main current transformers shall comply with the requirements of Transnet Freight Rail specification BBB 0937.

13.2 The main current transformers shall either be fitted in the high voltage bushings of the main traction transformer or shall be the freestanding post type current transformers install on the line side of the main traction transformer.

13.3 In the event of Eskom or Local Utility requiring three current transformers for metering purposes the successful contractor shall supply and install the additional current transformer.

13.4 The ratios, accuracy and burdens of the current transformers shall be in accordance with Transnet Freight Rail's Specification BBB 0937.as specified:

14.0 MAIN TRACTION TRANSFORMER

14.1 The contractor shall be responsible for the delivery, assembling, filling of transformer oil and installation on site of the main traction transformer in accordance with Transnet Freight Rail's Specification BBB 5019.

15.0 AUXILIARY TRANSFORMER

15.1 The contractor shall make provision for the supply of an auxiliary transformer which shall comply with the requirements of SANS.780

15.1.1 The auxiliary transformer shall be three phase with a minimum rating of 50kVA or higher depending on the substation requirements.

15.1.2 The 3 phase auxiliary transformer shall be supplied from the tertiary winding of the main traction transformer

15.1.3 The auxiliary transformer shall be the sealed unit type suitable for outdoor installation. Full details of the transformer shall be submitted.

15.2 In the case of a double unit substation one auxiliary transformer may be provided unless otherwise specified.

15.3 The secondary winding of the auxiliary transformer shall be star-connected.

15.4 The auxiliary transformer shall supply the required kVA rating without exceeding the permissible temperature rise laid down in SANS 780.

15.5 The nominal no-load secondary voltage of the auxiliary transformer shall be 400V three phase.

15.6 Off-load, externally operated tap changing gear shall be provided on the transformer, with tappings to compensate for any change in the main transformer tapping.

15.7 All primary and secondary terminals, including the secondary neutral, shall be brought out through the transformer tank by means of bushing type terminals and shall be arranged for busbar/cable connections.

16.0 AUXILIARY TRANSFORMER PROTECTION

PRIMARY WINDING

16.1 The contractor shall make provision for overload protection of the primary winding. Refer to clause 8.8 of specification No BBB 2721.

16.2 The protection system shall consist of an approved type of overload relay with its associated current transformers.

16.3 SECONDARY WINDING

16.4 The contractor shall supply and install a three phase isolating and earthing switch for the secondary supply of the auxiliary transformer to the substation.

16.5 The isolating and earthing switch shall be fitted with mechanical interlocking of the key exchange type, which shall form part of the interlocking procedure for the substation. Refer to clauses 31.0 and 32.0 of this specification.

17.0 AC EARTH LEAKAGE CURRENT TRANSFORMER.

17.1 The contractor shall supply and install a bar primary current transformer for the AC earth leakage protection. The current transformer shall be installed on the support steel structure of the primary circuit breaker.

17.2 One terminal of the primary winding shall be connected to the primary circuit breaker frame and the other terminal shall be connected to the substation main earth electrode/mat. (Refer to drawing CEE-TBD-7 and BBB 3620).

17.3 The current transformer shall be class 10P10, ratio 50/5 or 100/5.

17.4 The current transformer shall be designed to withstand a test voltage of 2kV for 1 minute.

INDOOR EQUIPMENT

18.0 3kV DC RECTIFIER

18.1 The contractor shall supply and install 3kV DC rectifiers in accordance with Transnet Freight Rail's Specification BBB 0496.

18.2 Each rectifier unit and its associated control equipment shall be designed to form an independent unit.

18.3 The rectifier equipment shall be installed in screened bays fitted with gates.

18.4 The gates shall be fitted with mechanical interlocks of the key exchange type in accordance with clauses 31 and 32 of the specification.

18.5 The bay screens shall be constructed of approximately 25mm woven wire mesh or expanded metal fixed to tubular or angle iron frames complete with doors, pillars, gates etc.

18.6 The height of the screens and gates shall be similar to the height of the control panels but shall be not be less than 1,8 m.

18.7 In a double unit substation the rectifier units are referred to as the "A" and "B" units and shall be labelled as such.

18.8 It is required that each rectifier unit in a double unit substation can be isolated independently and earthed without shutting down the whole substation.

18.9 Individual rectifier units shall be screened from each other and from any other live common equipment. A mechanical key exchange interlocking system type in accordance with clauses 31 and 32 shall be fitted to ensure the safety of personnel working on the isolated rectifier equipment.

18.10 The rectifier units and bay screens shall be insulated from the floor.

19.0 3kV DC REACTOR

19.1 The contractor shall supply and install a 1.8 milli Henry 3kV DC air core reactor for each rectifier unit. The installation shall include the supply of all the required insulators, foundations, foundation bolts and fasteners.

19.2 The 3kV DC reactor shall be in accordance with Transnet Freight Rail's Specification BBB 3890.

19.3 The reactor shall be insulated from the substation floor by means of insulators.

19.4 Sufficient space shall be allowed for access to the reactor for maintenance and inspection purposes.

20.0 WAVE FILTER

20.1 The contractor shall supply and install the wave filter equipment in accordance with Transnet Freight Rail's specification BBB 3139 for wave filter capacitors and BBB 3162 for inductor coils.

20.2 A wave filter is connected in parallel with the rectifier output. The filter unit is a capacitive inductive circuit, which is tuned to resonate at specific harmonic frequencies.

20.3 The filter equipment shall be so designed that no individual harmonic voltage is greater than 2% of the output voltage.

20.4 The inductor coils shall have sufficient adjustment to compensate for change in the capacitance values due to ageing. Refer to Transnet Freight Rail's drawing BBB 3483 for assembly.

20.5 A 100 Ampere High Rupturing Capacity (H.R.C) fuse shall be fitted to protect the wave filter equipment.

20.6 The fuse holder shall be mounted on insulators.

20.7 The insulators shall be so designed that the flashover path is not less than 100mm and shall support the fuse at a distance of not less than 100mm from the bolts securing the base plate. The insulators shall have a minimum dry flashover value of 20kV.

20.8 Access to the wave filter equipment shall only be possible once the wave filter capacitors have been connected to rail, discharged and the primary circuit breaker tripped.
A 75 kilo Ohm resistor consisting of two 150 Kilo Ohm, 150 watt vitreous enamel resistors connected in parallel shall be provided for the discharging of the wave filter capacitors when the equipment is isolated and earthed.

20.9 The discharge resistors shall be mounted on a suitable insulation panel or bar, which shall be insulated for 3kV DC. A minimum clearance of 75mm must be provided between the terminals, and 100mm between any 3kV live portion of the equipment and earth.

20.10 The wave filter capacitors shall be earthed with 95mm² PVC insulated copper cables to the DC earth leakage system.

20.11 The wave filter equipment shall be housed in a separate explosion proof room or cubicle.

21.0 3kV DC POSITIVE ISOLATOR

21.1 The contractor shall supply and install the 3kV DC positive isolator in accordance with Transnet Freight Rail's specification BBB 4724.

21.2 The DC positive isolator metal cubicle/housing shall be insulated from the substation floor.

22.0 CONTROL PANELS

22.1 The contractor shall supply and install the AC primary circuit breaker control panel and the AC/DC distribution panel in accordance with Transnet Freight Rail's specification BBB 2721.

22.2 The control panels shall be insulated from the substation floor.

ELECTRONIC EQUIPMENT

22.3 The tenderer must be aware that high voltage surges and transient voltages can be induced in low voltage and control wiring due to switching and lightning. Special care shall be taken in the design and layout of the equipment to limit these voltages.

22.4 Electronic equipment shall suitably be protected against over voltages, surges and transients. Dehn type surge protection units or equivalent shall be used. Liberal use of metal oxide varistors is also encouraged.

23.0 BATTERIES

23.1 The contractor shall supply, install and commission a 53 cell 110 Volt Planté lead acid battery bank. The capacity of the battery can either be 100 Ampere hour rating, 200 Ampere hour rating or capacity dependant on the substation requirements.
The standard for the batteries shall be the 10-hour rate at 20°C. The battery shall be capable of delivering a minimum of 10 Amperes for 10 hours.

23.2 Batteries are installed in traction substations for control and protection purposes. The battery is used for the following functions:

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

24.0 BATTERY CHARGER.

24.1 The contractor shall supply and install the battery charger in accordance with Transnet Freight Rail's specification BBB 2502.

24.2 The battery charger shall be insulated from the substation floor by means of "Marley" or "Lino" floor covering not less than 2mm thickness.

25.0 TRACK FEEDER HIGH SPEED CIRCUIT BREAKERS

25.1 The successful tenderer shall supply and install the required 3kV DC high speed circuit breakers in accordance with Transnet Freight Rail's specification CEE.0099 as well as with the following additional requirements:

25.2 The high-speed circuit breakers shall be of the conventional truck mounted type as commonly used by Transnet Freight Rail in the 3kV DC traction substations.

25.3 High-speed circuit breakers shall be fitted with an automatic reclosing feature, which provides for 1 (one) reclosure at 20 to 35 seconds interval. Refer to drawings CEE-TBP-35. "Connection diagram for the high speed circuit breaker and electronic control relay".
CEE-TBP-39."Circuit diagram for auto reclosure for the high speed circuit breaker.

25.4 Transnet Freight Rail shall provide the auto reclosure relays. The relays shall be wired by the contractor in accordance with the requirements of clause 25.3.

25.5 The high speed circuit breakers shall be complete in all respects. This shall include housings, rack out trucks, base rails, main and auxiliary contacts and flapper gear and any other fittings or equipment required for the correct operation of the high-speed circuit breakers.

25.6 The high-speed circuit breakers shall be racked into breaker cells, each having two fixed contacts mounted at the rear of the breaker cell. One contact is connected to the substation positive busbar and the other to a wall bushing mounted in the building outer wall.

25.7 All other items of material such as cell slabs, main busbars, earthing connections, wall bushing plates or blanking-off plates, control cables etc, shall be included in the tenderer's offer.

25.8 Transnet Freight Rail shall provide details of the wall plate frame and standard cell slabs where applicable.

25.9 Where access is possible to the rear of the high-speed circuit breakers (busbar chamber) access barriers shall be installed.

25.9.1 The barriers shall be fixed to angle iron frames with fasteners which only be removed with tools. Warning signs shall be fitted to the barriers.

26.0 MODULAR TYPE STEEL HOUSED HIGH SPEED CIRCUIT BREAKERS

26.1 Where tenderers offer modular type high-speed circuit breakers they shall submit full information, construction and dimensional drawings with their offer.

26.2 Transnet Freight Rail specification CEE.0227 shall be used as a guideline.

26.3 The tenderers must be fully aware that the requirements of Transnet Freight Rail's specification CEE.0099 are relevant.

26.4 Transnet Freight Rail reserves the right to accept or reject offers for equipment after consultation with tenderers. Transnet Freight Rail's Senior Engineer, Technology Management, shall approve all designs.

26.5 The modular type steel housings shall be insulated from the substation floor.

27.0 REGENERATIVE HIGH SPEED CIRCUIT BREAKER

27.1 At certain substations Transnet Freight Rail will require 3kV DC regenerative braking energy absorption equipment. If required the successful contractor shall supply the high speed circuit breaker for the protection of the regenerative breaking equipment in accordance with Transnet Freight Rail's specification CEE.0099.

28.0 3kV DC UNDERVOLTAGE RELAY

28.1 The contractor shall supply and install a 3kV DC undervoltage relay with a high voltage potential divider in accordance with Transnet Freight Rail Specification BBB 3005 and shall provide the following:

28.2 Fibre optic technology must be used to provide galvanic isolation between the potential divider and the undervoltage relay.

28.3 The potential divider shall be mounted in the 3kV busbar chamber or in the high voltage compartment of the positive isolator cubicle in accordance with Transnet Freight Rail's Specification BBB 4724.

28.4 The potential divider shall be protected by an H.R.C fuse connected between the positive side of the 3kV DC supply and the input of the potential divider.

28.5 Insulation clearance shall be not less than 100mm. All normally live equipment on the potential divider shall withstand a test voltage of 10,5kV AC RMS 50 Hz for one minute to earth without breakdown.

28.6 If the undervoltage relay is wall mounted, an engraved warning label shall be fixed to the front of the undervoltage relay panel with the following warning:

WARNING

THE POSITIVE BUSBAR MUST BE ISOLATED AND EARTHED BEFORE WORK IS UNDERTAKEN ON THE UNDERVOLTAGE RELAY

28.7 The following connections shall consist of 95mm² cross-sectional area copper or copper equivalent conductors.

- Potential divider to negative busbar.
- Resistor base plate to DC earth leakage busbar.
- Relay metal case to DC earth leakage busbar.

SECTION 3: INSTALLATION

SUBSTATION EARTHING

29.0 INDOOR EARTHING (REFER TO DRAWING CEE-TBD-0007)

The successful contractor shall supply, install and comply with the following:

29.1. The supply and installation in the substation building of all earthing conductors for the earthing of all metal work which includes supporting frames, control panels, battery charger, positive isolator panel, track breaker cells, rectifier bay screens, chequer plates and metal bases of insulators mounted directly on the walls or floor etc.

29.2. The frames and bases of all items associated with the 3kV DC including the track feeder wall plates, shall be connected through the DC earth leakage relay to the negative busbar in accordance with Transnet Freight Rail' s drawing CEE-TBD-0007.

29.3. The DC earth leakage relay and the installation thereof shall comply with the requirements specified in clause 8.6 of Transnet Freight Rail' s specification BBB2721.

29.4. Earthing conductors which could be subjected to 3 kV DC faults caused by insulation breakdown, etc., shall be not less than 70mm² copper strap cross-sectional area or 95mm cross-sectional area PVC insulated stranded copper cable. Other earth conductors must have a minimum of 16mm² copper cross-sectional area.

29.5. The earthing system for the 3kV DC positive busbar chamber shall be supplied by the successful tenderer. The design of the system shall be in conjunction with Transnet Freight Rail staff.

29.6. The successful tenderer shall supply the portable earthing device and cables according to Transnet Freight Rail's requirements.

29.7. All connections to the DC earth leakage relay shall form part of a ring circuit for safety when part of the circuit is disconnected. Refer to drawing CEE-TBD-0007.

29.8. The earth conductors shall not be installed in such a manner as to bridge out the earth leakage relay.

29.9. The resistance between the DC earth leakage busbar and the substation main earth electrode/mat shall be not less than 25 ohms.

29.10. Holding-down bolts grouted in the floor shall not be in direct contact with reinforcing or in with the earth under the concrete floor in the substation.

29.11. Where mounting bolts are used for securing electrical equipment to the floor, these bolts must be insulated to prevent electrical contact with any reinforcing or floor.

29.11.1 The indoor substation equipment shall be earthed in groups as shown in Transnet Freight Rail's drawing CEE-TBD-0007.

30.0 OUTDOOR EARTHING (DRAWING NO CEE-TBD-7 AND BBB 3620)

The successful tenderer shall supply, install and comply with the following:

30.1 Outdoor yard earthing which includes earth spikes, trench earths, earth connections to the support steel structures and fence posts. The material used shall comply with Transnet Freight Rail's specification BBB 3059 and drawing BBB3620.

30.2 A rail-earth switch mounted on the gate that provides access to the outdoor yard and where applicable to the 3kV DC overhead feeder security area and provide all connections thereto.

30.3 In Transnet Freight Rail switchyards where the supply from the Electrical Utility is terminated on portal structures or where a flying busbar is provided the contractor shall earth these structures.

30.3.1 Install two 50mm² galvanised steel earth conductors, one each between the outside portal structure or flying busbar support and the gable of the substation building.

30.3.2 The earth conductor shall be suitably terminated and connected to the portal or flying busbar structures. A suitable bracket shall be supplied and mounted on the gable of the substation building. The earth conductors shall directly be terminated on the bracket and connected to the main earth electrode/mat.

Insulating of structures and electrical equipment.

30.3.3 The tenderer shall make provision for the insulating of the support steel structures for i.e. the primary circuit breaker, main current transformers and any other structure that is connected to the AC earth leakage system from the concrete foundation.

30.3.3.1 The insulating material shall be either the same material used for the insulating of the mast bases for the overhead track equipment or other insulating material that has been approved by Technology Management.

30.4. The tenderer shall make provision for the insulating of the base of the main traction transformer from the concrete plinth. Malthoid or any other approved insulation shall be used.

31.0 INTERLOCKING (mechanical)

GENERAL

31.1 The equipment for each substation shall include a mechanical interlocking system; preferably the "Castell" or other approved key type. Full details of the type offered instead of the “Castell type shall be submitted with the tender.

31.2 The mechanical interlocking system must be designed to prevent access to the high voltage equipment whilst "live" and ensure that switching and isolating operations are carried out in the correct sequence.

31.3 All equipment shall be delivered with the necessary interlocks fitted.

31.4 It shall not be possible to operate the locks and release the keys in any but the correct sequence or in any position of the switches or gates, other than the fully "closed" or fully "open" position, as the case may be.

31.5 When a unit is switched to local condition and isolated, no remote switching from the control office shall be possible. Tenderers shall furnish full explanatory details of the arrangement whereby the foregoing provisions are met.

31.6 The track feeder breakers shall remain closed throughout the isolation procedure.

32.0 ISOLATING PROCEDURE

Sequence to isolate a single unit substation rectifier unit.

32.1 Trip high voltage AC circuit breaker.

32.2 Open high voltage AC disconnecting switch-key “1” released.

32.3 Remove key “1”- AC disconnecting switch locked in open and earthed position.

32.4 Use key "1" to operate auxiliary supply's three phase isolating and earthing switch - key "1" trapped - key "2" released.

32.5 Use key "2" to unlock DC positive isolating and earthing switch.

32.6 Open DC positive isolating and earthing - key "2" trapped - key "3" released. Remove key "3". DC positive isolating and earthing switch locked in open position.

32.7 Use key "3" to open rectifier unit bay gate (and DC smoothing reactor screen if required).

32.8 If a number of keys are required to open the rectifier cubicles, a key exchange system may be used.

32.9 Procedure is reversed to switch the rectifier unit back on load.

32.10 The number indicated for the keys are for single unit substations only. Where there are two units in one substation the numbers of keys for the two units shall be A1 and B1, A2, and B2, etc. It shall not be possible to exchange keys between any equipment on different units.

32.11 The foregoing sequence is given as a guide and may be altered to suit tenderer's equipment. The design shall be approved by Transnet Freight Rail.

32.12 Where the wave filter equipment is not located in the rectifier bay, the access to the equipment shall be mechanically interlocked and form part of the interlocking procedure.

32.13 Access to the wave filter shall only be possible once the positive isolator is earthed and the primary circuit breaker is tripped. Refer to clause 20.8

32.14 Any deviation from the above guideline must be approved by Transnet Freight Rail.

33.0 INDOOR CABLING, BUSBARS AND ASSOCIATED EQUIPMENT

The contractor shall supply and install the following:

33.1 All low voltage PVC insulated supply and control cables.

33.2 3kV DC copper cables and copper busbars from the Anode wall plate to the rectifier and from the rectifier equipment to the DC positive isolating switches, DC smoothing reactors, and main DC negative busbar. In the event of aluminium (grade 6063) being used the minimum size shall by 50mm X 25mm busbar.

33.3 Where required, the supply and fitting of hot dip galvanised anode wall plates in the wall of the substation building, at the rectifier bays. The wall plate galvanising shall comply with SANS 121.

33.3.1 Wall plates shall be fitted with wall bushings, one for each phase and the neutral.

33.3.2 Designs and drawings of the wall plate arrangement must be submitted for approval after adjudication of the tender.

33.4 The interconnecting busbars from the anode wall plate to the rectifier.

33.5 The main 3kV DC positive and negative copper busbars. Minimum dimension of busbars shall be 100mm X 10mm copper or 127mm X 12,5mm aluminium (grade 6063) busbar.

33.6 The 3kV DC output positive busbar system, which includes high-speed circuit breaker busbars, and where required the outgoing feeder cables between the high speed circuit breaker busbars and wall bushings.

33.7 Barriers in accordance with clause 8.0 where exposed busbars exist between the positive isolator and the DC track breaker positive, busbar.

33.8 Cables from the DC smoothing reactor or main positive busbar to the wave-filter equipment.

33.9 Control cables from the rectifier cubicles to their respective control panels.

33.10 Cables from the auxiliary equipment to the substation control panels.

33.11 Connections and cabling between control panels.

33.12 Cables between the 110V substation battery and the auxiliary DC panel (2 core, minimum 16mm²).

33.13 Cables (95mm² stranded copper) to the wave-filter room(s) for rail (negative) and DC earth leakage connections to wave-filter equipment.

33.14 Earthing cables (95mm² stranded copper) between the DC earth leakage busbar and substation negative busbar.

33.15 Two core 16mm² and multicore 2,5mm² cables between panel and high-speed 3kV DC circuit breakers.

33.16 Two core 6mm² cables between the 25A circuit breakers on the DC panel and the Electrical Supply Utility meter room. Make-off and connect at the DC panel only.

33.17 All other busbars and cables required for the interconnection of the substation indoor equipment.

33.18 Cable glands for the termination of the cables at the control panels and other equipment. Neoprene shrouds shall be fitted over the cable glands.

33.19 The maximum current density per square mm for open conductors shall not exceed 1.55 Ampere for copper and 1.0 Ampere for aluminium.

33.20 Low voltage cables for indoor use may be unarmoured.

33.21 All high voltage cables shall be armoured XLPE insulated and shall comply with SANS 1339 and Transnet Freight Rail specification BBC 0198. All wiring used on the 3kV DC equipment shall have nominal 3kV insulation unless the clearances comply with those laid down in clause 8.9.

33.22 All negative connections and terminals associated with high voltage circuits and which are accessible without first having to isolate and earth such high voltage circuits e.g. the main negative busbar, DC earth leakage relay, etc., shall be of 95mm², copper or copper equivalent cross-section. The terminals shall be painted red.

33.23 Not withstanding the above clauses the contractor shall supply and install any other cables, conductors or busbars required for the successful operation of the substation.

33.24.0 BLOCK JOINTS

33.24.1 The contractor shall make block joints in the armouring of all the low voltage supply and control cables, which are connected between the indoor control equipment and the outdoor yard equipment.

33.24.2 The block joints shall be clearly visible and shall be not less than 200mm from the cable glands terminating at the outdoor equipment.

33.24.3 The block joints shall be sealed with a heat shrink covering to prevent the ingress of moisture.

33.25.0 CHEQUER PLATES

33.25.1 The contractor shall be responsible for the supply of all metal chequer plates required for covering of cable trenches inside the substation.

33.25.2 Earthing studs suitable for the fitting of 95mm² copper cable shall be welded to each chequer plate.

34.0 CABLES, BUSBARS AND CONNECTIONS. (OUTDOOR)

The Contractor shall supply and install the following:

34.1 The Inter-connections cables or conductors in the High Voltage yard.

34.2 The high voltage AC connections which shall be solderless, concentric grip, or other approved solderless type. The connections must have adequate cross-sectional area to suit both electrical and mechanical requirements.

34.3 Copper busbars between separately mounted outdoor equipment. The busbars shall incorporate a degree of flexibility to avoid any overstressing of connections due to foundation movement and expansion or contraction.

34.4 All negative connections and terminals associated with high voltage circuits and which are accessible without first having to isolate and earth such high voltage circuits e.g. the main negative busbar shall be of 95mm², copper or copper equivalent cross-section. The terminals shall be painted red.

34.5 Copper busbars with removable flexible connections or “all aluminium” stranded conductor may be used interconnection conductors between the main traction transformer secondary bushings and the anode wall bushings which are fixed to the anode wall plate of the substation building.

34.5.1 Where “all aluminium conductors are to be installed the following sizes and number of conductors shall be installed:

- 2 X 800 mm² “all aluminium” stranded conductor per each phase for 4,5 MW substations, or 50mm X 25mm aluminium (grade 6063) busbar in accordance to Transnet freight rail drawing BBF1615.
- 2 X 500 mm² “all aluminium” stranded conductor per each phase for 3 MW substations, or 50mm X 25mm aluminium (grade 6063) busbar in accordance to Transnet freight rail drawing BBF1615.

34.5.2 Where two different conductor material joints are used, the Bi-Metallic plates shall be applied.

34.6 Conductors from the high voltage AC line aerial conductors and between the surge arresters, AC disconnecting switch, high voltage AC circuit breaker, current transformers, rectifier transformer and rectifier.

34.7 Cables or busbars from the rectifier transformer to the auxiliary transformer.

34.7.1 The auxiliary transformer shall be connected directly to the tertiary winding of the traction transformer for new installations or existing installations where tertiary windings are employed on the main traction transformer.

34.8 Cable from the auxiliary transformer secondary to the short-circuiting switch.

34.9 Control cables from the high voltage AC disconnector, AC circuit breaker and main and auxiliary transformers to the substation control panels.

34.10 A multi-core 4mm² cable between the current transformers and the Electrical Supply Utility meter room. Make-off and connect at the current transformer only.

34.11 In the case of the Electrical Supply Utility Tee-supplies a multi-core 4mm² cable between the voltage transformers and the Electrical Supply Utility. The Electrical Supply Utility will do the cable connection.

34.12 In the case of the Electrical Supply Utility Duplicate Supplies one multi-core 4mm² cable between Transnet Freight Rail’s high voltage AC circuit breaker and the Electrical Supply Utility meter room. (For interlocking Electrical Supply Utility M.O.D's). The cable shall have 10% spare cores.

34.13 A multi-core 2,5mm² cable between the tele-control remote terminals on the control panel and the electrical supply utility meter room. (For tele-control of the Electrical Supply Utility equipment). The cable shall have 10% spare cores.

34.14 All other cables as specified. e.g. security lighting and alarms.

34.15 All control cables, security and alarm cables shall be armoured cables.

34.16 Not withstanding the clauses above the contractor shall be responsible for all cables, busbars and connections required for the successful operation of the 3kV DC traction substation.

35.0 LABELS AND TERMINALS

35.1 All labels shall be in English. All lettering shall be white on a black background. Lettering shall be a minimum of 6mm in height.

35.2 All labels shall be neatly secured by rivets or screws.

35.3 All conductors and cables shall be provided with identification tags at terminals.

35.4 All terminals and equipment such as switches and relays shall be suitably numbered according to the substation schematic and wiring diagrams. All terminal blocks and groups of terminal blocks shall be suitably numbered.

36.0 SUBSTATION NEGATIVE RETURN

The substation negative return system which can be in the form of the following:

- Buried XLPE insulated copper cable.
- Rail on sleepers.
- Aerial conductors.

36.1 BURIED XLPE INSULATED COPPER CABLE

36.1.1 The contractor shall install 2 x 500mm² single core XLPE copper cables from the substation negative busbar to the negative manhole situated near the railway line.

36.1.2 Transnet Freight Rail's staff will undertake the provision of the bare conductors from the negative manhole to track, as well as the rail connections.

36.1.3 The negative manhole to drawing CEE-TU-41 is to be supplied and installed by the contractor.

36.1.4 The negative return cables shall be laid, in 150mm of soft soil in a trench, at a depth of not less than 1000mm below ground level and spaced not less than 300mm between centres.

36.1.5 Where cables are likely to be damaged they shall be protected by concrete slabs. Refer to Transnet Freight Rail specification CEE.0023.

36.1.6 The cable route shall be provided with cable warning tape. Refer to Transnet Freight Rail specification CEE.0023.

36.1.7 The cable runs shall be marked by cable markers painted signal red. (Stores Item No 9/1503)

36.2 RAIL NEGATIVE RETURN.

36.2.1 Where rail is used for the negative return system Transnet Freight Rail shall supply and install the rail from the inside of the substation building to the railway track.

36.2.2 The rail shall be insulated from ground by means of concrete sleepers supplied by Transnet Freight Rail.

36.2.3 Where the rail enters the substation building it must be insulated from all concrete and brickwork to prevent stray current damage to building reinforcing or other metal. After installation the hole in the wall shall be sealed and made good by Transnet Freight Rail.

36.2.4 The rail shall be connected to negative output of the rectifier by means of a suitably rated busbar/cable supplied by the contractor. Transnet Freight Rail will make provision for terminations on the rail.

36.2.5 Transnet Freight Rail shall connect the negative return rail to the track by means of PVC insulated steel conductors.

36.3 NEGATIVE FEEDER MONITORING SYSTEM.

36.3.1 The contractor shall design supply and install a negative feeder monitoring system in accordance with Transnet Freight Rail specification BBB1843.

36.3.2 The negative feeder monitoring system shall be designed to trip the 3 kV DC track breakers in the event of the traction substation negative return circuit becoming open circuited due to cable theft of the negative return cables or other cause of failure of the negative return circuit.

36.4 AERIAL CONDUCTORS

36.3.1 Where aerial conductors are used for the negative return, the contractor shall provide the wall plates and wall bushings where required.

36.3.2 In the case of aerial conductors used for the negative return, Transnet Freight Rail shall provide the conductors and the installation.

37.0 3kV DC POSITIVE FEEDER CABLES

The positive feeder cables shall be either:

- Buried armoured medium voltage XLPE insulated cable.
- Aerial aluminium conductor

37.1 BURIED XLPE INSULATED CABLE

37.1.1 The contractor shall install two single core 6,6kV, 500mm² armoured medium voltage XLPE insulated cables with stranded copper conductors. The cables shall be manufactured with copper tape screen, armour and sheath in accordance with SANS 1339 and Transnet Freight Rail specification BBC 0198. The cables shall run from the high-speed circuit breaker busbar chamber to the associated track switch structure.

37.1.2 Tenderers are to allow for making off the cables with suitable terminations. Sufficient length of cable must be left buried at the base of the track switch structure for erection and connection to the track switch. Transnet Freight Rail will do connection to the track switch.

37.1.3 The medium voltage cables shall be laid in 150mm of soft soil, in a trench at a depth of not less than 1000mm below ground level and spaced not less than 300mm between centres.

37.1.4 Where cables are likely to be damaged they shall be protected by concrete slabs. Refer to Transnet Freight Rail specification CEE.0023.

37.1.5 The cable route shall be provided with cable warning tape. Refer to Transnet Freight Rail specification CEE.0023.

37.1.6 The cable runs shall be marked by cable markers painted white (Stores Item No 9/1539).

37.1.7 Should it be necessary for the cables to pass under the tracks suitable pipes will be installed by Transnet Freight Rail.

37.1.8 Where required, the contractor shall supply the necessary wall bushings for positive feeder cables.

37.2 AERIAL CONDUCTOR

37.2.1 In the case of aerial conductors used for the positive feeders, Transnet Freight Rail shall make provision for conductors and installation.

37.2.2 Where aerial conductors are used for the 3kV DC positive, the contractor shall provide the wall plates and wall bushings.

38.0 TRENCHING FOR OUTDOOR YARD EARTHING CONDUCTORS AND CONTROL CABLES.

38.1 Before any trenching commences the contractor shall consult with Transnet Freight Rail staff for approval of the routing of the trenches in the outdoor yard.

38.2 In existing substation outdoor yards the contractor shall remove the necessary crusher stone in the outdoor yard before any excavation commences. The contractor shall restore the crusher stone after the completion of the work.

38.3 Trenching includes all trenches required for the installation of the earthing system and control cables.

38.4 The depth of trenches shall not be less than 700 millimetres.

38.5 With the installation of new earthing conductors and control cables at existing substations, care must be taken not to damage existing cables in the high voltage outdoor yard during trenching operations.

38.6 The Contractor and Transnet Freight Rail staff shall inspect the trenches before and during the installation of the earthing system and control cables.

38.7 Before the trenches are closed a representative from Transnet Freight Rail shall inspect the earthing system and other cabling for damage.

39.0 FOUNDATIONS.

39.1 The successful tenderer shall be responsible for the design and casting of foundations for the portal and support structures in the traction substation high voltage outdoor yard.

39.2 Notwithstanding the supply arrangements (single or double) at any particular substation, tenderers shall clearly understand that all foundations and steelwork to accommodate the supply and to cater for the traction yard are to be provided and erected by the successful tenderer.

39.3 Wherever there is a combined traction and 11kV/6,6kV distribution yard, a flying busbar is to be provided in Transnet Freight Rail's yard. All foundations and steelworks required to suit this arrangement, including the erection and earthing thereof shall be included in tenderer's offers.

39.4 The foundations in the high voltage outdoor yard shall include the following:

- Voltage Transformers if applicable.
- Surge arresters.
- AC disconnectors.
- Current transformers. (If applicable)
- Primary circuit breakers.
- Main traction transformer.
- Auxiliary transformers.
- Portal lattice structures as required.
- Any other foundations as specified.

39.5 The successful tenderer shall carry out his own survey in regard to soil types and their load bearing capabilities.

39.6 Equipment support foundations shall be finished off 200mm above the finished earth level of the yard. The design must be such as to prevent standing water.

39.7 All foundation edges shall be bevelled, and the surfaces must be float finished.

39.8 All support foundations shall be at the same level.

39.9 The design of the concrete plinth for the main traction transformer shall include a concrete gutter around the perimeter of the plinth to contain any spillage of transformer oil.

39.10 Provision shall be made on the plinth for skid rails. The spacing of the rails between centres shall be a minimum of 1meter. Details of the design and load bearing parameters of the skid rail system, plinth and rail shall be submitted to Transnet Freight Rail for approval.

39.11 The auxiliary transformer if separate shall be provided with its own concrete plinth with a concrete gutter, or may be installed on the same plinth as the main traction transformer.

39.12 The 28-day strength of all concrete used shall be a minimum of 20Mpa.

39.13 Hand mixed concrete is not acceptable, it must be mechanically mixed.

40.0 SUPPORT STRUCTURES

40.1 The design, supply and installation of all steel structures for the support of equipment and tensioning of conductors shall be the responsibility of the successful tenderer.

40.2 Special attention shall be taken for the prevention of corrosion of all metallic parts.

40.3 The bases of insulators, studs, bolts, support structures and other parts made of ferrous material associated with the electrical connections outdoors, shall be hot-dip galvanised, in accordance with SANS 121.

40.4 Steelwork for outdoor installation in coastal areas, i.e., within 50km of the coast, shall first be hot-dip galvanised in accordance with SANS 121, followed immediately at the galvanising plant by the application of the Sterling paint system in accordance with specification CEE.0045.

40.5 Steelwork for outdoor installation in inland areas, i.e., at a distance greater than 50km from the coast, shall be hot-dip galvanised to SANS 121.

40.6 All high voltage equipment shall be provided with hot-dipped galvanised support structures or pedestals to provide a minimum clearance of 3,6 m (up to 88kV) or 4,1 m (above 88kV) from the lowest "live" high voltage connection to finished ground level.

40.7 Structural steel shall comply with SANS 1431.

40.8 All welded joints shall be seal welded with no gaps or blowholes.

40.9 All fasteners, nuts and bolts used for the installation of substation steelwork and equipment shall be hot dipped galvanized to prevent corrosion.

41.0 FENCING

41.1 The successful tenderer shall supply and install new perimeter fencing as specified.

41.2 The successful tenderer shall make provision for the levelling of outdoor yard if required.

41.3 The fencing shall be either of the following:

- Concrete palisade fencing in accordance to drawing CEE-TDF- 0016.
- Hot dipped galvanised steel palisade fencing with the minimum requirements of:
  Height 2,4 metres
  Size and thickness of pales 40mm x 40mm x 3mm thick.
  Corner and intermediate posts 100mm x100mm x 3mm.
  Horizontal cross bars 40mmx5mm.

41.3.1 The successful tenderer shall make provision for the installation of safety barriers in the high voltage yard in accordance with Transnet Freight Rail's requirements. (Refer to Transnet Freight Rail's Engineering instruction S.016)

41.3.2 The successful tenderer shall make provision for a metal barrier screen of 25mm-wire mesh or expanded metal to be constructed around the auxiliary transformer to prevent accidental contact.

41.3.3 The successful tenderer shall cast a concrete apron of 150mm wide x 300mm under the perimeter fences of the substation. The top of the apron shall be a minimum of 100 mm above the ground level.

42.0 GATES

42.1 The contractor shall supply and install two 4.6 metre wide X 2,4 metres minimum height lockable gates in the perimeter fence to allow for:

- Entrance to substation building and yard.
- Entrance to the high voltage outdoor yard adjacent to the main transformer (s).

42.2 Where access to the HV outdoor yard is gained between the substation building and perimeter fence, a fence the same height as the perimeter fence shall be installed. A 1000mm wide lockable gate shall form part of the fence.

42.3 Provision must be made for the fitting of a spark gaps and rail earth switch on the HV yard small gate. Refer to drawings CEE-TBD-7 and BBB3620. The spark gaps shall be provided by Transnet Freight Rail on request.

42.4 Where steel palisade fencing is used the gates shall be connected to the fence support post by means of a flexible connection to prevent electrolytic corrosion of gate hinges.

42.5 Warning notices and danger signs in accordance with Transnet Freight Rail's Electrical Safety Instructions shall be fitted to the perimeter fencing and gates. This shall be provided by Transnet Freight Rail.

43.0 CRUSHER STONE AND WEED KILLER

43.1 After completion of construction, installation of equipment, the laying of all cables and earthing conductors, a suitable weed killer approved by the Technical Officer shall be applied in HV outdoor yard.

43.2 Great care shall be exercised to avoid contaminating private property and water supplies.

43.3 After treatment with the weed killer, a 100mm layer of 25mm crusher stone shall be laid over the whole area of the Transnet Freight Rail high voltage outdoor yard (within the apron).

44.0 PAINTING

44.1 All indoor and outdoor steelwork, metal screens and barriers shall be painted in accordance with Transnet Freight Rail's Specification CEE.0045.

44.2 The finishing coats for indoor equipment shall be in accordance with SANS 1091.

Metal Bay Screens - Eau-de-Nil (H43).
Support frameworks (indoor) - Eau-de-Nil (H43).

45.0 DISTRIBUTION, LIGHTING OF SUBSTATION BUILDING AND STANDBY 400V AUXILIARY SUPPLIES

45.1 The successful tenderer shall supply and install all light fittings, plugs, conduits, distribution boards, switches, cables and other material in accordance with SANS 10142-1. Galvanised, alternatively PVC conduit and galvanised fittings shall be provided at all substations within 50km of the coast.

45.2 The contractor shall furnish a certificate of compliance for the 400V/220V AC distribution and lighting of the traction substation signed by the accredited person in terms of SANS 10142-1 and who is registered with "Electrical Contracting Board".

45.3 Complete Layout drawing showing the position/type of light fittings, position of plugs, distribution board and switches to be submitted to Transnet Freight Rail for approval.

45.4 220V AC fluorescent light fittings shall provided. The minimum lighting requirement shall be 100 lux in terms of the "Occupational Health and Safety Act".

11KV/6,6KV TO 400V AUXILIARY SUPPLY AND CHANGE OVER SYSTEM.

45.5 Where specified a 11kV/6,6kV to 400V distribution transformer will be installed to supply the traction substation in the event of substation failure or when the substation is taken off load.

45.5.1 The 3 phase 400V supply from the above transformer shall be connected to the control circuitry via a automatic change over switching system.

45.5.2 The change over switching system shall be mechanically and electrically interlocked.

45.5.3 Transnet Freight Rail shall supply and install a suitably rated 4core armoured cable from the 11kV/6,6kV to 400V distribution transformer to the change over switching unit.

45.5.4 A 1:1 ratio isolation transformer shall be installed between the 11kV/6.6kV to 400V distribution transformer and change over switching system.

45.5.5 The isolation transformer shall comply with specification BBC 0330.

45.5.6 The successful tenderer shall supply the isolation transformer unless otherwise specified.

EMERGENCY LIGHTING.

45.6 Fluorescent light fittings with its own battery back up supply shall be supplied for emergency lighting.

45.6.1 A minimum of three fittings shall be installed in a single unit substation and four in a double unit substation.

45.6.2 The light fittings shall be installed at the following locations:

- In single unit substations two in the main walkway between the control panels and rectifier unit. One flameproof fitting in the battery room
- In a double unit substation three in the main walkway and one flameproof fitting in the battery room.
- In additional locations where requested by the Project Manager/Engineer.

45.6.3 The light switch shall be clearly labelled " EMERGENCY LIGHTNING".

MOULDED CASE CIRCUIT BREAKERS

45.7 All low voltage circuits and equipment shall be protected by moulded case circuit breakers, which comply with specification SANS 156.

SECURITY LIGHTS

45.8 Where outdoor security lights are specified 400W high-pressure sodium fittings shall be installed at locations specified by the "Scope of Work".

46.0 COOLING AND VENTILATION

46.1 Where specified, 3 phase cooling fans shall be supplied and installed in the substation building.

46.2 The required filters, louvres and guards shall be provided and installed.

47.0 BATTERY ROOM

47.1 A three/single phase non-sparking extraction fan shall be installed for the battery room.

47.2 Only Ex non-sparking light fittings shall be installed in the battery room.

47.3 Light switches and plug sockets shall not be installed in the battery room.

47.4 No-smoking, naked flames and hand protection warning signs shall be fitted to the battery room doors.

47.5 A wooden stand treated with acid proof paint shall be provided for the batteries.

47.6 A hydrometer and logbook shall be supplied by the contractor for each installation.

47.7 The floor of the battery room shall be painted with acid proof paint.

48.0 CLEARING OF SITE

48.1 All rubble which is left over as a direct result of work performed by the Contractor shall be removed from the substation building and yard and disposed of by the Contractor. The substation floors and walls shall be left in a clean condition. All cable, wire and conductor cut-offs and surplus material shall be removed from site.

SECTION 4: SITE TESTING AND COMMISSIONING

49.0 SITE TESTS AND COMMISSIONING

The successful tenderer shall be responsible for carrying out on-site tests and commissioning of all equipment supplied and installed in terms of this specification and the contractual agreement.

49.1 ON-SITE TESTS

49.1.1 Functional on-site tests shall be conducted on all items of equipment, circuitry and interlocking to prove the proper functioning and installation thereof.

49.1.2 The successful tenderer shall submit a detailed list of on-site tests for the approval of the Project Manager/Engineer at least six weeks before tests are due to commence at the first substation.

49.1.3 The successful tenderer shall arrange for the Project Manager/Engineer or his representative to be present to witness the on-site tests at each substation.

49.1.4 On-site tests and subsequent commissioning shall not commence until all construction work has been completed. Construction staff, material and equipment shall be removed from site prior to the commencement of testing. Testing and commissioning of the substation equipment will not be allowed to take place in a construction site environment.

49.1.5 On-site tests shall include the following;

- Polarity tests on all CT's.
- Ratio tests on all CT's.
- Magnetising current of all CT's.
- Secondary injection of all relays.
- Trip testing, all relays must be checked for correct operation.
- The functionality of all electrical circuitry must be tested.
- The operation of both mechanical and electrical interlocking.
- Tests on primary circuit breakers and other primary equipment in accordance with manufacturer's instructions.

49.1.6 At the completion of the on-site tests the Project Manager/Engineer or his representative, shall either sign the test sheets (supplied by the successful tenderer) as having witnessed the satisfactory completion thereof, or hand to the successful tenderer a list of defects requiring rectification.

49.1.7 Upon rectification of defects the successful tenderer shall arrange for the Project manager/Engineer or his representative to certify satisfactory completion of on-site tests for that particular substation.

49.1.8 Acceptance by the Project Manager/Engineer 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.

49.2 COMMISSIONING OF EQUIPMENT

49.2.1 Commissioning will include the energising of equipment from the AC disconnects to the OHTE track feeder switches. The successful tenderer must prove the satisfactory operation of all equipment under live conditions.

49.2.2 On completion of commissioning the successful tenderer will hand the substation over to the Project Manager/Engineer in terms of the relevant instructions.

49.2.3 Tenderers shall allow a period of at least three days per substation between satisfactory completion of on-site tests and commissioning of equipment.

49.2.4 During this period the Transnet Freight Rail's Test staff will test the operation of all protective relays and circuits and set the protection relays at each substation.

49.2.5 The contractor shall rectify any faults found during the testing and setting of the protection relays.

49.2.6 The final testing of the substation must commence at least three days ahead of the contract completion date.

49.2.7 The commissioning of the protection equipment by Transnet Freight Rail will in no way absolve the successful tenderer from any of his responsibilities during the guarantee period. It is the successful tenderers responsibility to satisfy himself 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.

49.2.8 The commissioning dates for the substations will be dependent on the availability of power supplies from the supply utility as well as Transnet Freight Rail's electrification program and will be defined by the Project Manager/Engineer.

SECTION 5: GENERAL

50.0 QUALITY ASSURANCE

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

50.2 Arrangements must be made timeously for such inspections and type/routine tests in accordance with the equipment specifications are carried out before delivery of the equipment to the site.

50.3 Type/routine test sheets of the equipment shall be forwarded to the Project Manager.

51.0 GUARANTEE AND DEFECTS

51.1 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.

51.2 The guarantee period shall commence from the date of successful commissioning of the substation.

51.3 The guarantee period for all substations shall expire after a period of 12 months commencing from the date of successful completion of the contract or the date the equipment is handed over to Transnet Freight Rail whichever is the later.

51.4 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.

51.5 The cost of training shall be included in the tenderers quotation.

52.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

52.1 Drawings, instruction manuals and catalogues shall be supplied in accordance with Transnet Freight Rail specification CEE.0224.

52.2 The tenderer shall supply three copies of an instruction/maintenance manuals, schematic and wiring diagrams.

52.3 The contractor shall submit details of spares required in accordance with Transnet Freight Rail's specification no. CEE.0224.

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

53.0 SPECIAL TOOLS AND/OR SERVICING AIDS

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

54.0 TRAINING

54.1 The contractor shall submit details with the tender of the training courses which will be conducted by the contractor for the training of Transnet Freight Rail 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.

55.0 PACKAGING AND TRANSPORT.

55.1 The contractor shall ensure that the equipment be packed in such a manner that it will be protected during handling and transport.

55.2 The contractor shall provide transport for the delivery of the equipment to the site where required.

56.0 BIBLIOGRAPHY

[1] SANS 1019: 2008 Edition 2.5 Standard voltages, currents and insulation levels for electricity supply

APPENDIX 1

DRAWINGS ISSUED WITH THIS SPECIFICATION

DRAWING NUMBER	AMENDMENT	DESCRIPTION.
CEE-TDF-0016		Concrete fencing
CEE-TBD-7		Earthing Arrangements Traction Substations.
CEE-TU-41		Negative Return Cable Terminating Box.
CEE-TCK-1		Reactor 1,84mH, 1 500 A. (For reference purposes only)
CEE-TBP-1		Wiring diagram for auto reclosure for HSCB.
CEE-TBP-39		Circuit diagram for auto reclosure for HSCB
CEE-TBP-35		Connection diagram for HSCB and electronic control relay
CEE-TBP-38		Schematic Diagram of 3kV HV Protection.
CEE-TCL-63		3kV Busbar Chamber Arrangement: Cable Feeders.
CEE-TCQ-208		DC High Speed Circuit Breaker Cell Panel (Cell slabs) (sheets 1 to 10)
CEE-TBP-33		DC Track Breaker and Truck Wiring Diagram.
BBB 0938		Surge arresters mounted on traction transformer.
BBB 3620		3kV Earthing arrangement for traction substation
BBF 1615		Busbar connection assembly

SPOORNET

A division of Transnet limited

ENGINEERING AND TECHNOLOGY

TECHNOLOGY MANAGEMENT

SPECIFICATION

REQUIREMENTS FOR THE SUPPLY OF ELECTRIC CABLES

(Appendix to be filled in by client)

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Date: 5 September 2005

Circulation restricted to:

Engineering &Technology: Infrastructure Maintenance

Engineering &Technology: Infrastructure Engineering

Engineering &Technology: Technology Management

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1.0 SCOPE

This specification covers Spoornet's requirements for cables used for:

- Medium voltage reticulation systems, distribution systems, traction substation supplies, and 3 kV DC feeder applications (3,3/3,3 kV to 19/33 kV).
- Cables used for fixed installations (300/500 V to 1900/3300 V).

2.0 STANDARDS

The following publications (latest version) are referred to herein.

2.1 SOUTH AFRICAN NATIONAL STANDARDS

SANS 97	:	Electric cables - Impregnated paper insulated metal-sheathed cables for rated voltages 3,3/3,3 kV to 19/33 kV (excluding pressure assisted cables).
SANS 1339	:	Electric cables – Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV.
SANS 1507	:	Electric cables with extruded solid dielectric insulation for fixed installations 300/500 V to 1900/3300 V, Part 1-General, Part 3-PVC Distribution cables, Part 4-XLPEdistribution cables, Part 5-Halogen free distribution cables.

3.0 APPENDIX

The following appendix forms an integral part of this specification.

3.1 Appendix 1 : Schedule of Requirements: Details of the cable to be supplied.

4.0 TENDERING PROCEDURE

4.1 Tenderers shall indicate clause-by-clause compliance with the specification. They 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 tenderers shall motivate a statement of non-compliance.

4.3 The tenderer shall submit technical specifications of the cables offered.

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

5.0 MEDIUM VOLTAGE CABLES

5.1 IMPREGNATED PAPER INSULATED.

5.1.1 Paper impregnated lead sheathed (PILC) cables used for reticulation systems and traction power supplies and other applications shall be in accordance with SANS 97.

5.1.2 The voltage range for the cables shall be between 3,3kV and 33kV.

5.1.3 The cables shall be three core with stranded copper conductors.

5.1.4 The cables shall be paper insulated, screened type, lead sheathed provided with an extruded PVC bedding.

5.1.5 The armouring shall be galvanised steel wire with outer extruded PVC over sheath over the armouring.

5.1.6 The cable shall be so manufactured that it is fully protected against the effect of electrolysis.

5.1.7 Single core cables used for 3 kV DC application shall withstand a test voltage of 10,5 kV for one minute.

5.1.8 Cables shall be suitable for laying directly in soil and concrete trenches.

5.1.9 The cables shall withstand exposure to water, corrosive conditions as well as high ultra violet conditions caused by direct sunlight.

5.1.10 The cables shall be tested in accordance with SANS 97. Type test certificates shall be submitted with the cables offered.

5.1.11 The packing, marking and sealing of cables and cable drums shall be in accordance with SANS 97.

5.2 CROSS – LINKED POLYETHYLENE INSULATED (XLPE).

5.2.1 XLPE cables used for reticulation systems, 3kV DC traction feeders and traction power supplies and other applications shall be in accordance with SANS 1339.

5.2.2 The voltage range for the cables shall be between 3,8kV and 33kV.

5.2.3 Cables shall be single or three core with stranded copper conductors.

5.2.4 The cables shall be type A (armoured) for single and three core cables.

5.2.5 Single core type A cable shall be copper tape screened, aluminium wire armoured and provided with a PVC outer sheath.

5.2.6 Single core cables shall be rated for 3,8/6,6kV.

5.2.7 Single core cables used for 3 kV DC application shall withstand a test voltage of 10,5 kV for one minute.

5.2.8 Three core type A cable shall be copper tape screened, galvanised steel wire armoured and provided with a PVC outer sheath.

5.2.9 The manufacture of the single and three core cables shall be such that the cables are fully protected against the effect electrolysis.

5.2.10 The cables shall be suitable for laying directly in soil and concrete trenches.

5.2.11 The cables shall withstand exposure to water, corrosive conditions as well as high ultra violet conditions caused by direct sunlight.

5.1.12 The cables shall be tested in accordance with SANS 1339. Type test certificates shall be submitted with the cables offered.

5.2.12 Where specified flame-retardant and halogen free cables shall be in accordance with SANS 1339.

5.2.13 The packing, marking and sealing of cables and cable drums shall be in accordance with SANS 1339.

6.0 CABLES FOR FIXED INSTALLATIONS

6.1 Unless otherwise specified single and multi-core, wire armoured, extruded PVC insulated cables shall be used for fixed installations. The cables shall be in accordance with SANS 1507 part 1 and part 3.

6.2 The voltage range is between 300/500 V to 1900/3300 V.

6.3 Cables shall have stranded annealed copper conductors.

6.4 The cables shall be marked according to SANS 1507 part 3. Core identification shall be by means of colour code or numbering of the insulation.

6.5 The cable shall be so manufactured that it is fully protected against the effect of electrolysis.

6.6 Where XLPE or halogen free cables are specified the cables shall be in accordance with SANS 1507 parts 4 and 5.

6.7 The cables shall be tested in accordance with SANS 1507 parts 3, 4 and 5. Type test certificates shall be submitted with the cables offered.

6.8 The packing, marking and sealing of cables and cable drums shall be in accordance with SANS 1507.

7.0 QUALITY ASSURANCE

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

7.2 Arrangements must be made timeously for such inspections and type/routine tests in accordance with the cable specifications are carried out before delivery of the cables to the site.

8.0 INSPECTION AND TESTING

8.1 Spoornet reserves the right to carry out inspections and any tests on cables at the factory of the supplier/ manufacture.

8.2 Arrangements must be made with The Senior Engineer, Technology Management Spoornet for inspections to be carried out before delivery of the equipment.

SCHEDULE OF REQUIREMENTS

(To be completed by the client)

1.0 MEDIUM VOLTAGE CABLES

1.1 PAPER IMPREGNATED LEAD SHEATHED (PILC)

1.1.1 Rated Voltage (V): .....

1.1.2 Number of cores: .....

1.1.3 Length of cables (m): .....

1.1.4 Size of conductors (mm^2): .....

1.2 CROSS LINKED POLYETHYLENE INSULATED (XLPE)

(XLPE is recommended for 3 kV DC Applications)

1.2.2 Rated Voltage (V): .....

1.2.3 Number of cores: .....

1.2.4 Length of cables (m): .....

1.2.5 Size of conductors (mm^2): .....

1.2.6 Flame retardant (required/not required): .....

2.1 CABLES FOR FIXED INSTALLATIONS

2.1.1 Type of cable required:

- PVC Distribution cables: (Yes/ No): .....
- XLPE Distribution cables: (Yes/No): .....

2.1.2 Rated Voltage (V): .....

2.1.3 Number of cores: .....

2.1.4 Length of cables (m): .....

2.1.5 Size of conductors (mm^2): .....

END